Deliverable D3.2

Three reports on barriers and incentives for societal engagement under RRI, one for each R&I domain

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Content

1. Introduction

The aim of "Work Package 3: Mapping barriers and incentives for societal engagement under the terms of RRI" (WP3) is to identify and understand the barriers and incentives to doing societal engagement in research and innovation through an exploration of nine case studies. The societal engagement initiatives which comprised these case studies were selected because they applied the principles of RRI either explicitly, through clear alignment with the principles of RRI, or implicitly, exhibiting some elements of the RRI without the explicit reference to the policies or values enshrined by the concept.

Deliverable 3.1 described how we selected our case studies, the interview methodology we developed, and outlined our proposed method for analysis. The purpose of Deliverable 3.2 is to build on this work by providing the findings from the WP3 stakeholder interviews through three domain-based reports, with specific regard to the barriers and incentives to societal engagement in research and innovation.

The main objectives of this work package are to 1) identify key barriers and incentives for societal engagement under the terms of RRI across different R&I domains from the point of view of Third Sector[1] actors and other stakeholders contributing to RRI; and 2) to explore the similarities and differences in the perspectives of the different stakeholders contributing to RRI. Our results from this case study research, and particularly the results focusing on the barriers and incentives to engaging with Third and Fourth Sector Organisations[2] (TSOs and FSOs), will provide a foundation for activities at the WP5 conference, "Engaging society for responsible research and innovation (RRI): New options to move forward", being held in Brussels on 19 June 2017.

[1] **Third Sector 'actors' or organisations (TSOs)**, "is an umbrella term for various interest groups of citizens, such as civil society organizations (CSOs) and labour unions, as well as religious organisations and informal networks of citizens. …organisations of the third sector are often involved in science in society activities either due to moral, ethical and ideological concerns or in order to represent certain interests of groups of the society". (European Commission 2012)

[2] **Fourth Sector organisations (FSOs)** "integrate social and environmental aims with business approaches. Some fourth sector organizations go further by embodying features like inclusive governance, transparent reporting, fair compensation, environmental responsibility, community service, and contribution of profits to the common good". They are often described as "for-benefit" organisations. (Fourth Sector 2017) Adding this stakeholder category helped us to capture interviewees whose organisation didn't really meet the definition of a TSO and aren't necessarily part of the public or private sector, but which added value to projects through their engagement.

The first section of this deliverable focuses on the methodology for WP3. We begin with a short summary review of our selection of nine case studies, followed by a brief description of the data collection. We then provide a detailed description of our data analysis procedures, which were carried out collaboratively between all of the partners from this work package. This section includes tables which detail the top-level codes we have applied to the data; the sub-codes that emerged from the data which we initially coded as a 'barrier' or 'incentive' to researchers engaging with stakeholders; and a table that shows how the barrier and incentive sub-codes have been grouped into ten themes. The table in Appendix 1 provides specific definitions for each barrier and incentive sub-code.

Section Two is comprised of the three domain-based reports. The Nanotechnology case study report was written by Christian Hofmaier (USTUTT) and Mark Morrison (OPTIMAT), the Bioeconomy report was written by Daniela Fuchs (OeAW), and the Food & Health report was written by Emily Porth and Lada Timotijevic (SURREY). These reports vary in format, due to the differences in the nature of each research domain, but they are linked through the sub-codes that describe the barriers and incentives encountered in each case study. These same partners were also responsible for coordinating and carrying out all of the research and analysis for each of these domains, as described in Section One.

Section Three provides a brief summary of the barriers and incentives that were most prominent across all three research domains. We will then discuss the five most significant "challenges" to researchers engaging with TSOs and FSOs under the terms of responsible research and innovation (RRI). These challenges will be used to inspire content for the WP5 conference.

1.1 Methodology

1.1.1 Case Study Approach

Our task was to select 9 case studies, 3 in each domain of research and innovation, through which we could explore the barriers and incentives to carrying out societal engagement under the terms of responsible research and innovation. The case studies we selected needed to satisfy the following criteria: *A societal engagement initiative associated with*

research and innovation in the three domains of nanotechnology, food & health, and bioeconomy. This initiative must have taken place between 2011 and the present. It can be entirely publicly funded, or be a recipient of public-private funding. Other factors were considered as part of our search and recording criteria throughout the selection process as case studies were added to the list and then narrowed to create a short list (please see Deliverable 3.1 for the full details of our case study selection process). In the end, final decisions were based on the geographic spread of cases (we wanted to ensure the case studies selected did not have an Anglo-Germanic bias), whether they reflected a range of different forms of societal engagement and the core tenets of RRI, whether or not the case studies were fundamentally interesting, and if there were any conflicts of interest.

The selected nanotechnology case studies include: BMU NanoDialog, including NanoKommission (Germany); NanOpinion (International); and Tracing Nano, including NanoCap for Downstream Users (Netherlands). For Food & Health, the selected case studies are: A Healthy Future for the Potato (Netherlands); EPINET: In-Vitro Meat (International); and Well Now (United Kingdom). The selected case studies for Bioeconomy (with a focus on synthetic biology) include: Ecover/Solazyme (International); SYNENERGENE (International); and UK Synthetic Biology Strategic Plan 2016 (United Kingdom). Each of these case studies will be explained in depth in Section Two, along with the results of our analysis of the data from this case study. For more detail about why we selected each of these case studies, please see D 3.1.

1.1.2 Data Collection

Semi-structured in-depth qualitative interviews were carried out from September 2016 with stakeholders who were associated, or directly involved, with each of the selected 9 case studies (as described in D 3.1). The majority of these interviews were completed and transcribed by 31 January 2017, with a handful of final interviews taking place in February 2017. Table 1 below (a more detailed version of which was submitted as part of the PROSO mid-term review) summarises the interviews that we completed for each stakeholder group in each case study, with totals for all categories.

Table 1: Summary of WP3 interviewees by case study

Stakeholder Category	Nanotechnology			Bioeconomy			Food & Health			Totals by Stakeholder Category
	Nan-Opinion	TracingNano/ NanoCap	BMU NanoDialog	Ecover	SBLC Governance Group	SYNENER-GENE	Well Now	EPINET – In-Vitro Meat	Healthy Future for the Potato	
Third Sector Organisation (TSO)	1	4	1	4	1	2	1	1	1	16
Fourth Sector Organisation (FSO)	3						1	1		5
Policy			1		1		12		1	15
Research Funder				1			2			3
Academic	1	1			1	3	1	4	4	15
Industry			1	1	1				3	6
Total interviewees by case study	5	5	3	6	4	5	17	6	9	60
Total Interviews by research domain	13			15			32			60

We had a level of difficulty accessing particular stakeholder groups for some case studies. For instance, many of the individuals who represented TSOs as part of our selected nanotechnology case studies had moved on and no longer worked for the organisation that had participated in the original project; we were either unable to reach them for interview, or they declined to be interviewed. Accessing this stakeholder group was also an issue in "A Healthy Future for the Potato", where the project's stakeholder engagement activities will not happen until later in 2017. Researchers were, understandably, reluctant to connect us with the TSOs who had not yet decided whether they wanted to participate in the project.

Due to the short timeframe in which partners had to analyse their data, and because there were so many additional interviews obtained in the Food & Health domain, the decision was made to analyse only 15 of the 32 completed interviews. The selected 15 interviews represent diverse stakeholder groups, as well as the actors who were particularly involved in the project/programme.

1.1.3 Data Analysis

In research analysis, 'coding' is the process of categorising research data. These are the basic definitions for the terms we employ to describe the process of coding:

- A 'code' (also referred to as a 'top-level code') is a category that is applied to a basic segment of the raw data so it can then be assessed in a meaningful way.
- 'Sub-codes' are more specific categories within a particular top-level code.
- 'Themes' are used to describe and categorise how the sub-codes can be related to each other. Each theme should be clear and identifiably distinct from the other described themes.

In this deliverable we focus on the top-level codes of 'barrier' and 'incentive' because the PROSO project's main focus is on barriers and incentives to engagement. In the three domain-based reports presented in Section 2, we use the barrier and incentive sub-codes to describe the particular barriers and incentives discussed by interviewees. In Section 3, we use our knowledge about which sub-codes were prevalent in each case study and domain to understand which themes characterise the biggest 'challenges' to engaging with stakeholders.

Development of codes

As data collection came to an end in late January 2017, WP3 partners began to review key documents in order to prepare for the analysis. These documents included D 2.2, the policy and practice options presented in WP4, and the interview schedule we used to structure the data collection. All of these documents informed the top-level coding scheme for our initial deductive analysis of the interview data, which was focused on WP3's declared objective to identify key barriers and incentives for societal engagement under the terms of RRI, across different R&I domains and from the point of view of Third Sector actors and other stakeholders contributing to RRI. Each WP3 partner also became familiar with the interview data through the transcripts, which involved reading and re-reading the data, and noting down initial ideas. All of this was discussed as a group on 8 February 2017 to determine what major themes needed to be captured through the analysis.

After this discussion, the WP3 team at Surrey systematically generated top-level codes and developed a coding tree that was circulated to WP3 partners on 16 February. Those WP3

partners who are directly carrying out the analysis on the raw data applied the proposed top-level codes by coding one interview from each of their three case studies. We reviewed this process as a group on 27 February and discussed whether or not these codes were a good fit to the data. The top-level codes were revised again during that discussion, and applied again as the interview coding continued. Partners refined the top-level codes as they went, and we had another group discussion on 13 March to finalise the top-level codes for the initial analysis. These codes and their accompanying definitions are listed below in Table 2.

Table 2: Final top-level codes for WP3 data analysis

Codes	Definitions
Case Study Context	About the project/process: how the case study came into being, how it received funding, how people became involved, etc.
Personal Role and Background	Interviewee's background and info on their current role
Process/Project Development	How the process/project developed over time
Reasons for engagement	Why an organisation/stakeholder became engaged in the process/project and how
Funding Process	How the project came to be funded
Patents & Intellectual Property Rights	Whether there are patents on the innovation and whether this influenced or affected the project
Organisational Operational Context	Any reference to TSOs/FSOs' organisational structure, such as stakeholders, mission, external context (competitors, policy, etc.), and internal context (dynamics, working relationships, etc.).
Impacts	An impact is defined as 'an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia' (REF 2014). Impacts differ from 'successes' or 'failures' because they are quant- and qualifiable.
External Impacts	
Internal Impacts	
Framing	How the technology/research is framed (e.g. risk, ethics etc.)
Conflict	Conflicts about theory or practice
Intra-Project/Process Dynamics	Relationships between process/project collaborators
Engagement Relationships	Relationships with those with whom the project is engaging, both internal and external
Engaging with TSOs or FSOs	Engaging with TSOs/FSOs during the process/project
Engaging with Academia	Engaging with academia/researchers during the process/project

Engaging with Citizens	Engaging with citizens during the process/project
Engaging with Industry	Engaging with industry during the process/project
Engaging with Policy	Engaging with policy during the process/project
Engaging with Research Funders	Engaging with research funders during the process/project
Excluded Stakeholders	Who was not included in the process/project (and possibly whether they should/should not have been)
TSOs or FSOs engaging with the process	TSOs/FSOs engaging with the process/project (directional)
Engaging Inter-/trans-disciplinarily	Social science researchers working with natural science researchers
Formats of Engagement	Particular formats of interaction as part of the process/project
Barriers & Incentives to Engagement	These are barriers/incentives the interviewee has experienced, either in this project or in other work
Barrier	
Incentive	
Personal Views on the Technology	Their opinion on whether the technology at the centre of the project is good/useful/worthy of investment/etc.
Process Successes & Failures	What worked or did not in this process/project? What could have been improved or done differently?
Process Failures	
Process Successes	
Lessons Learned	When interviewee reflects on what they learned through the process/project and how they would do it differently in the future
RRI concepts/characteristics	Responsible Research and Innovation (however we want to define it…!)
RRI	When RRI is referred to specifically by the interviewee
Responsibility	
Transparency	
Trust	
Anticipation	

Development of sub-codes

The next task was to develop sub-codes that were specific to the top-level barrier and incentive codes, in order to ensure we could provide information to meet our objectives for this WP, and to ensure we provided relevant information to contribute to the development of the WP5 “Engaging society for responsible research and innovation (RRI): New options to move forward” conference materials.

Although the 'barriers' and 'incentives' top-level codes were deductively assigned based on the objectives of the PROSO project, and particularly by the objectives of WP3, we wanted to ensure that the specific barriers and incentives which we identified through the sub-codes were generated *inductively*: this means they needed to be based very closely on the actual data we collected. The inductive coding process is important in helping to confirm that the barriers and incentives presented at the conference are grounded in the lived realities of those who engage in research and innovation, and also ensure that PROSO's final output, the 'Policy and Practice Guide', will be as useful as possible.

A meeting was scheduled to discuss the sub-codes on 28 March 2017. Surrey sent out a preliminary list of sub-codes based on their data on 24 March and other partners had added to this list and asked questions about the sub-codes proposed by Surrey by 27 March. At this meeting, each proposed sub-code was discussed and defined; we ensured all sub-codes emerged inductively from the data. These were refined and discussed again at a meeting on 5 April and then finalised (see Table 3).

Table 3: Sub-codes to describe the specific barriers and incentives to TSO/FSO engagement

Sub-Codes for Barriers & Incentives
Anticipated outcomes (barrier or incentive)
Resistance to changing worldview about the topic or new ways of working (barrier)
Resistance to changing worldview about engagement (barrier)
Adaptability of worldview (incentive)
Conflict between stakeholders (barrier)
Accessible communication (barrier or incentive)
Organisational Practices (barrier or incentive)
Permitted discourse (barrier or incentive)
Academic culture (barrier or incentive)
Timelines (barrier)
Role of Key players/Change-makers (incentive or barrier)
'Critical Mass' required for change (incentive or barrier)
Perceived fixed categorizations of stakeholder groups (barrier)
Imagined publics (barrier)
Perception of an issue, research domain, or innovation (barrier or incentive)
Innovation Processes (barrier or incentive)
Resources to participate in engagement (barrier or incentive)
Engagement procedures (incentive or barrier)

Broader Social/Cultural/Political/Economic Influences (barrier or incentive)
Flexibility (barrier or incentive)
Transparency (incentive or barrier)
Empathy & Altruism (incentive or barrier)
Trust (incentive or barrier)
Reflexivity (incentive or barrier)
Other values (incentive or barrier)
Reputation (barrier or incentive)
Access to network (incentive)

It became clear through our discussions on 28 March and 5 April that the different domains of research and, particularly, the various case studies with their sometimes quite varied formats of engagement and project structures, often resulted in sub-codes that were unique to one particular case study, and were almost completely irrelevant to others. As such – and to keep the long list of sub-codes as manageable as possible – we tried to make these sub-codes flexible to encompass a number of situations, but simultaneously ensure they remained deeply meaningful. To fully explain the sub-codes and broader themes through the specific barriers they represent, we have provided definitions of the sub-codes based on our data; each sub-code has been defined through the way it has emerged in the data, rather than through other possible definitions (see Appendix 1).

These sub-codes help us to understand the more specific practices, policies, and beliefs that hold researchers and TSOs/FSOs back from successfully engaging with each other.

Development of Themes

The Surrey team met on 30 March and grouped the agreed sub-codes into themes that best described the most important commonalities between the sub-codes.

The proposed themes were then sent out to WP3 partners on 31 March, with the request that all consider:

i. whether the themes work in relation to the coded extracts and the entire data set;
ii. the prevalence of each theme appearing in individual interviews or several times across the data set (i.e., is a theme evident in one stakeholder group but not the other?);

iii. fundamentally, whether the proposed themes fit the overarching story about barriers and incentives, and whether we can commit to presenting these as the overall themes in this preliminary report.

The themes were discussed at the next meeting on 5 April, with a lot of valuable feedback and discussion from all WP3 partners. This meeting resulted in the WP3 team agreeing on a total of 10 themes, as well as which specific sub-codes should be associated with those themes (outlined in Table 3 below). These sub-codes are defined and contextualized with quotes in section 4.

Table 3: Themes and sub-codes to describe barriers & incentives for TSOs

Themes	Barrier & Incentive Sub-Codes
Anticipated Outcomes	Anticipated outcomes (barrier or incentive)
Perception of the issue/Worldview	Perception of the issue (barrier or incentive)
	Resistance to changing worldview about the issue or new ways of working (barrier)
	Resistance to changing worldview about engagement (barrier)
	Adaptability of worldview (incentive)
Perception of others	Perceived fixed categorizations of stakeholder groups (barrier)
	Imagined Publics (barrier)
	Conflict between stakeholder groups (barrier)
Organisational Practices and Culture	Accessible communication (barrier or incentive)
	Institutional Practices (barrier or incentive)
	Permitted discourse (barrier or incentive)
	Academic culture (barrier or incentive)
Momentum for change	Role of Key players/Change-makers (barrier or incentive)
	'Critical Mass' required for change (barrier or incentive)
Innovation processes	Processes of research prioritisation and funding (barrier or incentive)
	Resources for stakeholder/public engagement with research and innovation– time, skills, funds (barrier or incentive)
	Timelines (barrier or incentive)
	Engagement procedures for meaningful engagement (barrier or incentive)
Broader Social/ Cultural/ Political Influences	Broader Social/Cultural/Political/Economic Influences (barrier or incentive)
Values System	Flexibility (barrier or incentive)
	Transparency (barrier or incentive)
	Empathy & Altruism (barrier or incentive)
	Trust (barrier or incentive)
	Reflexivity (barrier or incentive)

	Other values (barrier or incentive)
Visibility	Reputation (barrier or incentive)
	Access to network (incentive)

The themes we have identified are important because they demonstrate the key areas where stakeholders encounter barriers and incentives to engaging TSOs (and fourth sector organisations, FSOs) in research and innovation under the terms of RRI. They help us to think about how specific barriers and incentives (sub-codes) work in combination with each other to either prevent or further engagement. We have used the themes to think particularly about the broader challenges to researchers engaging with TSOs and FSOs, and they are the focus of the 'challenges' in the final section of this report, which will directly contribute to the WP5 conference, "Engaging Society for Responsible Research and Innovation: New options to move forward".

2. Domain-Specific Analyses

This section contains the three domain-based reports. Each is presented in a slightly different format and will provide an overview of the case study, illustrate which sub-codes emerged through the analysis of our interview data, and provide an overall picture of the barriers and incentives that stakeholders felt were of most issue in that domain of research.

Please note that all provided interview quotes have been edited for readability and de-identified to maintain the confidentiality of our participants; they have only been contextualised by case study, not by stakeholder group, in order to maintain their anonymity. We focus on TSO and FSO barriers to engagement within the summary for each domain, as that information is of specific relevance to the WP5 conference.

2.1 Food and Health

2.1.1 Introduction to the Food & Health domain

The domain we refer to as "Food & Health" is vast, as are the number of contexts and topics in which engagement occurs. Food as a domain cuts across a range of sectors, from farmers, through manufacturers, retailers, restaurants, public sector institutions (procured foods) through consumers and their representatives (e.g. consumer organisations, third sector organisations). Whilst food has traditionally been regulated and managed through economic

policies (e.g. agricultural, food manufacturing, food safety policies), thus being confined to economic and business regulatory mechanisms, food policy is increasingly being used as an agenda for health. As the food policy for health is taking shape, based on the advent of nutrition and health science, there is an emergence of new food technologies based on nanotechnology, genetically modified organisms (GMO), and synthetic biology (e.g. nutrigenomics, nutriceuticals, functional foods), which are set not only to offer solutions, but will also challenge the established processes of food production and the management of any risks associated with such novel technologies. How food-related health is defined is therefore important as it shapes the normative criteria for the selection of solutions and the framing of health-related food risks and benefits.

Typically, the problems associated with food-related health are defined in terms of morbidity and mortality statistics, as the absence of disease and the restoration of the body to an optimal state of functioning. Many approaches are focused on interventions that help restore the body to wellness, and recently these have been increasingly discussed as the fight against the "epidemic of obesity" (WHO, 2012). Ultimately, food and health research is required to underpin public health nutrition strategies for addressing the increasing incidence of obesity and diet-related chronic diseases in the EU (JPI, 2012). However, the controversy is looming large in the current lack of full evidence of the determinates of diet-related behaviour responsible for the advent of obesity, the mechanisms through which diet and adverse health outcomes are linked, and fundamentally, the ethical basis for a policy that assumes individual responsibility for the obesity rates (Campos, 2011; Rich, Monaghan and Aphramor, 2011). Questions are raised about the normative criteria for a "healthy body", with TSOs and FSOs leading the charge to the accepted scientific wisdom.

Going beyond obesity as the dominant policy discourse is an increasingly important challenge for food and health policy as it relates to the issue of sustainable production (FAO, 2012; 2014). Sustainability and health are not always explicitly linked, but increasingly, the drive towards sustainable diets, often portrayed as meat-free or meat-reduced diets, has been discussed in tandem with the issues of healthy food consumption. Solutions for sustainable diets are typically offered through technological innovation that is itself subject to debate and controversy.

Food security is the overarching theme to each of these concerns – under- and over-nutrition (both are often linked to obesity), as well as sustainable diets, are considered to be examples of the increased food insecurity manifested in poor access to healthy, affordable, sustainable and safe food. Nevertheless, food security has become a particularly important topic in the light of demographic explosion, huge population movements and migratory trends, an increased polarisation of diets and lifestyles across socioeconomic disparities, with the worse-off being more likely to be associated with obesity and poor health outcomes (Food Chain Evaluation Consortium (FCEC, 2013).

Each of these broad policy themes – obesity, sustainability and food insecurity – that connect and coalesce around the domain of food & health, carry deep ethical questions, many of which have mobilised Third and Fourth Sector Organisations to discuss, debate and contribute to the scientific, policy and technological developments. The cases within this report, related to the food & health domain, are therefore carefully selected to reflect some of these core food innovation and policy dilemmas: one case focuses on social innovation in obesity intervention; one focuses on technological innovations for sustainable consumption and one is about enhancing food security through new potato breeding technologies.

This report will provide a context for understanding each case study and include how the programme or project came into being, how its engagement initiative developed, and how that engagement has proceeded. Whilst one of our case studies began last year and has not yet carried out their engagement initiative (A Healthy Future for the Potato), another ended two years ago (EPINET – IVM), and the third is ongoing for the foreseeable future after being run successfully for three years (Well Now). Each case thus provides an opportunity to examine the ways decisions are made about whether to carry out engagement with particular stakeholder groups, in which formats of engagement, and what ultimately contributes to the success of such initiatives.

2.1.2 Case study 1: A Healthy Future for the Potato

Introduction

Potatoes are one of the world's most important food crops and a key part of ensuring global food security. They are widely susceptible to blight and pests, but new innovations in potato breeding hope to create blight-resistant potatoes. Solynta, a company out of Wageningen University, has developed a method which allows potatoes to be reproduced more quickly using hybrid seeds. This could increase the speed at which potatoes can be modified through breeding, and thus make improved strains available in the form of seeds. It would also be far easier to ship potato seeds internationally, as they would occupy a fraction of the weight and volume of shipping potato tubers. However, growing potatoes from seed, rather than from tubers, would have huge implications for farmers, as well as the entire potato supply chain.

The Rathenau Institute, Wageningen University, and the University of Groningen are working together to study how this new reproductive method might change potato farming, and what possible implications this could have for farmers and other stakeholders. Their project, called "A Healthy Future for the Potato", is funded by the Netherlands Organisation for Scientific Research (NWO) under its MVI (responsible innovation) programme; it is explicitly RRI-focused. The partners in this project aim to "involve as many stakeholders as possible from the sector and from society in a debate on the potential implications of this new development in terms of productivity, fairness and sustainability" (Rathenau Institute, 2017). Through stakeholder engagement initiatives, the project will ask questions including, "How might the new method change potato farming? What will this mean for farmers, and for their collaboration with the companies that enable the improvements? And how can we use this innovation in a fair and sustainable way?" (Rathenau Institute, 2017). The project duration is five years. Solynta has begun trialling the potato seed in field tests in Africa, but as this was an unanticipated part of the innovation process, engagement with stakeholders in this geographical region is not part of "A Healthy Future for the Potato".

We selected this project in part because of its strong focus on societal engagement, and in part because it began only last year in 2016; as such, we have the opportunity to see and understand how RRI is being implemented now, how researchers are choosing to engage with which societal stakeholders, and which barriers and incentives to engagement are evident in this very current situation.

The relationships in this case study includes engagement between:

- natural scientist and social scientist researchers who are part of the project team
- the project team and the project's 'Valorisation Panel' (including Solynta)
- researchers (of all types) and stakeholders in the potato sector

Researchers will be carrying out their engagement activities with stakeholders in autumn 2017 in the Netherlands. This will entail creating different scenarios for the future, each of which will be modelled on social responsibility and seek to engage with the potato sector. The potential outcomes presented in the scenarios have been based on interviews with stakeholders in the potato industry and their ideas about what 'sustainability' looks like, and whether that vision is more ecological, social, or even economic in nature. There will be three separate workshops: the first presents the scenarios, the second would be discussing how to achieve those desirable futures, and the last would be a discussion about ways to move forward. It is planned that the same stakeholders will attend all three workshops.

Incentives

Anticipated Outcomes

In this case study context, the "anticipated outcomes" comprise what researchers and potato sector stakeholders imagine could happen through this new type of hybrid seed breeding. These outcomes could be either positive or negative and include a huge range of possibilities, from revolutionising world food security to pushing parts of the potato industry out of business because they are unable to adapt to the dramatic changes in the potato supply chain. Our interviewees indicated that imagining these outcomes played a significant role in their drive to be involved in the project, either as a researcher or as an engagement participant.

Those who are part of the project team or Valorisation Panel expressed their motivation to be part of the project by the potential for the potato seed to revolutionise potato farming and world food security.

> "It's exciting to see how quickly new improvements can be pulled out with this new breeding method. Because of the seed issue, the sharing of the products of research is potentially much easier because of the difference between transporting seed potatoes all over the world in big containers, or transporting seeds – almost in an envelope!

> There are less and less risks of transferring disease and it's a great opportunity to share the knowledge generated in Europe with farmers elsewhere. It's a tremendous opportunity, so there are all kinds of good prospects in this."

The potato industry stakeholders and particular TSOs are also concerned about the economic, environmental, and social changes possible through the innovation, particularly because there has been a lot of recent media attention to Solynta's development of the potato seed. This makes many people and organisations motivated to engage.

Values System: openness, transparency and responsiveness

The question that hangs over the development of a hybrid potato seed is: will farmers and the potato industry accept this innovation? The answer is about the adaptability of stakeholders' worldview, and it is intimately linked to how they perceive the innovation. In response to this uncertainty, both Solynta and the project researchers have become committed to discussing the process of innovation with as much transparency as possible.

Engagement is the core concern of the project because the project team wants to understand how the hybrid seed method would impact society and the industry, and whether the potato industry supply chain could accept and adapt to the innovation. This question of whether stakeholders will have an adaptive worldview, or hold one that is resistant to change so they will ultimately not accept the innovation, is an excellent incentive to researchers to carry out engagement with them.

Transparency appears to be the core value in the engagement communication strategy, and it was expressed by several interviewees. Many people involved in the project feel positive about the potato seed being accepted by stakeholders because of Solynta's very open approach to communicating with publics and stakeholders, and the same approach is being taken by researchers in the project when engaging with stakeholders.

> "I know Solynta is very open in what they are doing and engaging in discussions with the traditional trade. I was once at such a meeting and at one point the traditional potato growers expressed some scepticism, like, 'Hahaha, show me first!'. But at the end of the discussion, there was also an appreciation by the growers that Solynta is so open about what they are doing and what they expect will happen in the market."

Stakeholder resistance to the innovation is also seen as a valuable opportunity in the project: rather than convincing naysayers that they're wrong, researchers are using the information to respond and adapt research questions.

> "At this moment, we are already listening to all those people saying 'This is nonsense!' [laughing] It's already a very nice way to gain exposure, and to think, this is the kind of resistance you have to meet, and you should not try to convince them. Instead, you should absorb that information and work with it, and take it into account. So, you're not pushing a technology, you're investigating a technology and the impact it has on the environment and on the whole sector. For me, this means you can shift research questions very rapidly because you can take that into account."

Framed this way, the initial engagement with stakeholders is proving to be a great learning exercise, and a way for both researchers and participants to adapt their worldview throughout the engagement process. The five year length of the project also provides time for the natural scientists developing the hybrid seed innovation to respond to the concerns raised by stakeholders through the engagement with social scientists, which takes place in the first two years of the project.

<u>Engagement procedures and adaptability of worldview</u>

The team members whom we interviewed spoke a lot about the process of social scientists learning about plant science, and plant scientists learning about social science as an important first stage of the project. Interdiscisplinarity requires a long-term commitment on behalf of all researchers involved, and everyone in the project voiced their commitment to this process.

> "When you get out of your comfort zone, you learn so much more, and when you have met people who are also willing to step out of their comfort zone, then you really have something together which creates a long-term commitment. And it has to be long-term because you need to learn the language, you need to learn the culture of doing science in another discipline. It's completely different, and if you don't invest in that, you will never learn… and you will only invest if you do it for the long-term."

Participants also emphasised that project objectives need to speak specifically to how social science research can complement what plant scientists are doing with methodology. "Participatory plant breeding", which involves social scientists working with plant scientists and local farmers in field sites, often in developing countries, was held up as a research

tradition to emulate in this regard because it creates greater impact for scientists and for the local farmers who apply the innovation once it has been finished:

> "The way that local people look at their plants is totally different from the breeder, who measures this and that and has a different eye for plants. It's a research cross-fertilisation that's beautiful."

It is clear from interviewees' experience that meaningful interdisciplinary stakeholder engagement requires a willingness to adapt one's worldview to consider that of other disciplines, and to trust that different research methods will only contribute new and important information. For instance, interviewees recognised that the potato industry is quite conservative and plant science researchers who work in the field their whole lives can lose perspective on it; in contrast, social scientists who are new to studying the potato industry can see the situation with fresh eyes and engage with that network to best understand the social impact of the innovation.

The chosen format of engagement with stakeholders (scenarios and discussions with the same participants over three workshops) is also conceived as a way to help participants to adopt – at least temporarily – the worldview of other stakeholders. The presentation of possible future scenarios is intended to be collaborative and transparent, so researchers will engage with participants as collaborators in the engagement process, rather than positioning themselves as outsiders.

Barriers

Perception of Others - Perceived Fixed Categorisations of Stakeholders

Some interviewees held strong opinions about particular stakeholder groups, and this was particularly apparent in regard to non-governmental organisations (NGOs, which are a type of TSO). Several people spoke about their perception that European TSOs were not getting involved in the project because they are only interested in conflict.

> "Environmental NGOs – and now I'm going to say something really bad! – live from opposition. This means that some of them don't even want to be involved because then they become co-responsible. ...This means they can't attack the issue any more. NGOs have a tremendously important role to play in society, but many exist because of controversy, and when there's no controversy, they lose their reason for existence."

In this situation, conflict actually becomes an organisational value of TSOs that prevents them from engaging. Conversely, a fear of the conflict that is perceived to come as an inevitable part of engaging with TSOs can prevent researchers from engaging with that key stakeholder group, or even reaching out to them in the first place.

Other factors can also play a role in TSOs becoming involved. For instance, it was one interviewee's perspective that a large TSO, which was initially positive about engagement and attended initial meetings as part of the Valorisation Panel, stopped attending once representatives from the private sector became involved. This person lost a lot of respect for the organisation because of this situation, and it reinforced their idea that TSOs are difficult to work with. There was also the perception that the Valorisation Panel has ended up being primarily comprised of stakeholders from within the potato sector "because the topic is not important enough" to outside partners, like TSOs, who may be more focused on a single issue, or simply do not have enough staff to become engaged in an issue that isn't directly relevant to their angle on an issue.

There was also the perception – held, to an extent, by the scientists themselves – that natural scientists want to focus on the science, rather than becoming "distracted" by engaging with stakeholders:

> "If you want to be a super-scientist in genetics, you don't want to be distracted by the challenge of working interdisciplinarily. You don't want to distract yourself – you want to concentrate on genetics only. And that is the basis of this nerdy habit of natural scientists."

The need for plant scientists to focus their limited resources on developing the innovation and not on engagement was also voiced during interviews.

<u>Innovation Processes & Resources to participate in engagement</u>

Innovation processes, which include funding structures, are fundamentally tied to project timelines and whether researchers have adequate resources to carry out societal engagement. Public funding for research is decreasing in many European countries and this results in less policy stimulus for societal engagement projects. Some interviewees mentioned that public-private funding was being promoted as an ideal way to replace public funding, but it is not a feasible option through which to carry out engagement under the

terms of RRI. There is also a strong perception that industry partners will want the money they have invested in a project returned to them within two years, and that their production chain will be too rigid to consider doing something new (at least in the potato industry).

There are specific obstacles to researchers successfully carrying out engagement as part of innovation processes. For instance, a company creating a new product may not be sure what the end result will look like, which makes it difficult to determine which stakeholders are relevant to engage with. Timing the engagement process in line with the development of the innovation is also important and quite difficult because there is a need to ensure that engagement initiatives come after there is some awareness of the innovation. In the case of "A Healthy Future for the Potato", Solynta had won an award two years before the project began and received a significant amount of media attention. This media attention was crucial to stakeholders being interested to engage, and the project team did not think the same stakeholders would have been willing to participate in engagement prior to hearing about the innovation in the media over that two year period.

"We have quite a unique situation in that it's very clear what innovation is being developed in potatoes, and this method can be applied in many different ways, and it's in the news right now so it's current. Any later would have been too late; any earlier and they wouldn't have known about it and had the desire to become involved. We couldn't have had these conversations if it was not alive in the minds of other stakeholders."

Several stakeholders also asserted that projects involving RRI need to be at least 50% longer. This is not easy with the short-term funding model that is becoming more popular; policy makers need to recognise that by investing in long-term projects that sponsor PhD students, they are effectively creating people who are knowledge brokers, rather than just researchers. Knowledge brokers are far more valuable from a long-term perspective.

Academic Culture & Organisational Practices

Interviews revealed that the source of many barriers to societal engagement comes down to organisational practices, and to academic culture itself. In particular, interdisciplinary work proves difficult to do because of the boundaries posed by these institutions. For example, interdisciplinary collaboration requires a long-term commitment from researchers and internal support from organisations. Quite a bit of time is required for researchers from different disciplines to exchange methods and topical understanding, but academic career

progression depends on publishing a high number of outputs, and there is little spare time between teaching and research commitments; this means there often isn't enough time to learn a different disciplinary language and worldview for carrying out research. In line with this is the idea that RRI is a process and not a technique: as such, it is necessary to train students how to do RRI and societal engagement as part of their degree, and this requires more resources. A longer degree is at odds with most postgraduate programmes, which are under pressure to shorten time to degree and graduate more students.

It can also be difficult to publish interdisciplinary work because there are so few transdisciplinary journals with a high impact factor, so academics need to maintain another line of publishing in their home discipline in order to be taken seriously and advance in their career. Several interviewees mentioned the luxury of being able to do engagement work and being taken seriously at the end of a researcher's career, emphasising that it is very difficult to do interdisciplinary work involving societal engagement if one is early in their academic career.

Finally, researchers can also face stigma from colleagues within their home discipline if they choose to participate in interdisciplinary research, or research involving societal engagement. For instance, most social scientists are not trained to do applied research, and applied social science is often stigmatised because it is not so focused on theory. One interviewee described feeling as though there was a need to "become an evangelist, in that you're intruding on another system, or something that's already in place, and you have to change it from the outside".

Lessons learned from this case study

- It is dangerous to have perceived fixed categorisations of other stakeholders because researchers can spend most of their time through the engagement process trying to overcome those stereotypes. However, stakeholders can actively work to overcome those perceptions, as Solynta is doing through its commitment to transparency.

- Carrying out engagement under the terms of RRI requires long timelines and a research team committed to interdisciplinarity, with flexible innovation processes

and organisational practices. Institutions must openly advocate for and support societal engagement, whilst identifying and implementing new measures of success.

- Information provision and engagement need to be seen as a long-term process; there is a need to tell people about what is being developed so they have time to engage with it at an individual and stakeholder group level, prior to being asked to participate in an engagement process.

2.1.3 Case study 2: EPINET – In-Vitro Meat

Introduction

EPINET was a three year project funded under the EU 7th Framework Programme that began in May 2012. In-vitro meat (IVM) was one of 4 case studies in the project. The aim of EPINET was to explore "new ways for bringing more [technology assessment] methodologies into concert with each other, as well as with the concerns of innovators, policy makers and citizens'" (EPINET 2017). In particular, the goal of the IVM engagement workshop, which took place over two days in October 2013, was to explore why IVM attracts a lot of attention for its possible ecological, ethical and industrial advantages, and yet receives almost no public funding. By bringing together actors in the area of IVM research, EPINET asked participants to consider why IVM was not being funded, and whether in vitro meat be reconceived and reshaped in other ways.

The small, but growing, field of in-vitro meat is now more commonly referred to as "cultured meat", and the broader area of research involving creating animal products without animals, such as milk, eggs, and leather, is referred to as "cellular agriculture". IVM involves using stem cell research to grow animal muscle tissue in a lab that can then be layered to produce food for human consumption. Through this technique, meat is essentially grown outside of an animal. This innovation has primarily been used to grow cow muscle tissue ("beef"), and in 2013 a "cultured meat" burger produced by Maastricht University was cooked and tasted at a press conference. IVM has been aligned with addressing a variety of 'societal grand challenges', particularly the health of humans, other species, and the environment through reducing the need for large scale animal farming. However, new techniques to develop IVM more quickly and on a much larger scale would need to be developed for these benefits to

be realised. It is also crucial that public opinion on IVM change in order for it to become a socially acceptable alternative to meat.

EPINET-IVM had an interest in uniting the impacts of science and technology on society and the environment with the concerns of innovators, policy makers, and citizens; this implicit RRI approach and engagement with a variety of stakeholders (including societal actors), as well as the international scope of IVM development, were the primary reasons we selected it as a case study. When we selected this case, we assumed the project team had engaged with TSOs because of the website project description:

> EPINET also builds on and expands the notion of epistemic communities into that of epistemic networks by shifting the focus from epistemic and normative commitments of expert communities to networks forming as the result of new imperatives for S&T development as outlined in EU policy frameworks such as the Horizon2020 initiative. In principle, therefore, anybody responding to or contesting a grand societal challenge by engaging in innovation activities together with others is a potential member of an epistemic network. Such networks emerge on the intersections of communities traditionally separated as "expert" and "lay" knowledge. On that account, common experiences, insights, knowledge and creativity have to be included as relevant forms of expertise. The same, of course, goes for knowledge and normative commitments held by user-based communities, such as civil society organisations and other NGOs, patient organisations, professional organisations or labour unions. (EPINET 2017)

However, when we began doing interviews, it became clear the project team had only decided to focus on 'knowledge holders', which were quite conventionally defined. The EPINET engagement workshop was effectively conceived as a networking opportunity, and engaging with publics and TSOs was not perceived to be part of that remit:

> "It was a networking opportunity for the people involved, and it was the first time a lot of us had met each other for a little while, including some meeting each other possibly for the first time."

This focus provides an interesting perspective on why researchers ultimately chose to engage with only a single TSO called New Harvest, whose sole reason for existing is to fund research in cellular agriculture.

Incentives

Anticipated Outcomes

To an extent, research scientists are driven to engage with FSOs and TSOs because they want to widen their support base. By choosing to engage with those stakeholders who hold a

positive perception of IVM, the anticipated outcome is that researchers will be able to continue their work by gaining new supporters and creating additional funding opportunities. Researchers currently seem less interested to engage with stakeholders as a form of reflexivity, to help them consider the potential societal impacts of their innovation, and are more interested in promoting the existence of their scientific innovation.

> "We're just focused on a solution, and then all the benefits that come with that solution are kind of secondary because we're focused on solving the problem, 'How do we make cultured meat exist?', as opposed to 'How do we solve climate change?'"

From the perspective of stakeholders, TSOs and industry are driven to engage with cultured meat researchers and university labs by the anticipated positive outcomes of the technology, whether they are animal advocates, environmentalists, or interested in cultured meat as a consumer product. FSOs can also be keen to engage with researchers because they enjoy the knowledge exchange and the opportunity to contribute to cutting-edge research. It is not uncommon for artists, a type of FSO, to engage with the cultured meat research community. One interviewee described an unanticipated benefit of researchers doing societal engagement with artists:

> "Engaging [through art] forces the researcher to justify themselves to somebody who they might not necessarily feel that they're accountable to… maybe it won't influence or change what they're doing but maybe it will, so I think the interaction between them is valuable. I guess it's also about helping to define who your stakeholders are."

So, although many researchers are not actively seeking to become more reflexive about the wider impacts of their innovation, engaging with FSOs is one way that has been accomplished.

To date, *there have been no TSOs, FSOs, or other stakeholders who are choosing to engage because they are concerned about anticipated outcomes*.

> "A lot of our supporters are also techno-optimists and that's always the one unifying thing about all of our supporters: they all believe that technology is a very important part of change and that it will solve problems."

> "Most of the third sector involvement at the moment is from people who've decided that this is a great idea and want to get on board with it."

This lack of concern from stakeholders about anticipated outcomes is unusual for a type of emerging innovation like IVM, and the absence of conflict with stakeholders is a huge benefit to researchers who just want to move the innovation forward.

Values System: Transparency, Reflexivity/Responsiveness and Openness

Researchers carrying out cellular agriculture often see public engagement as part of their mandate. Transparency was mentioned generally as being a very important part of this engagement. However, researchers do not necessarily see it as their responsibility to ask bigger questions about the impact if cultured meat replaced traditional animal agriculture. Partnering with other stakeholders, particularly with artists (FSOs) and social scientists was seen as the primary way for scientists to engage in reflexivity about what they were doing, and to investigate the future social consequences of cellular agriculture:

> "We should all be doing that work [on the bigger questions]. That should be done by academia. That should be done by NGOs, whoever is capable, has the capacity to think about the entire system and what it would change in the entire system… economists, psychologists, landscape people, geologists, whatever, and in a really systematic way. What are going to be all the implications if you have a cow-free land or a poultry-free land, and that's something you have to consider. The industries are going to change. Farmers need to change."

Not all researchers want to engage in reflexivity, though – those who are interested will more or less self-select and will pursue societal engagement through if they're open to it.

> "People self-select if they want to participate in a project, and so you already get excited people, or people who want to try something different… with academics, it's often people who are a little bit disillusioned about their path, or the systems in place for how they're doing stuff, and so they're looking for alternatives."

Openness was also lauded as an important value that drives engagement. The artist who worked with EPINET-IVM was the driving force behind creating a small book that was based on many different perspectives about cultured meat. Each perspective was written by someone who was either a member of the project team or one of the workshop participants. It was intentionally written to be accessible to all audiences and was a very well-received project output. In particular, the transparency involved in providing perspectives that sometimes conflicted was an important part of the book for the project team:

> "The idea was to orchestrate part of the workshops so that the different voices, the different epistemic community representatives and their perspectives, became a kind of 'In-vitro meat is…' and this is what you see pictured quite nicely in this little book. People are quite honest here."

Critical Mass

The field of cultured meat is growing and continued growth is required to get noticed by important funders and private benefactors. A large proportion of industry and publics are now aware of the topic of cultured meat because of the efforts of key individuals, and although much of media was described as "spectacle" (particularly the televised "burger reveal" in 2013), it has been effective in creating awareness. Awareness is starting to reach critical mass in some areas, and EPINET's support of the development of the cultured meat network was a very small part of that process.

The critical mass of awareness about cultured meat is resulting in new opportunities for collaboration and some possible changes to the innovation process, particularly in regard to funding opportunities. Research scientists are now forming relationships with meat companies and Silicon Valley investors; they are actually being approached by those funders, which speaks to researchers' success in publicising information about their work.

> "There was a lot of media exposure over the years… it's still gaining momentum. I think it's very much in a pre-exponential phase, but it's still gaining momentum and last year it went a bit more quick than before, so there was an increase in pace. Obviously, if you hear about it from one place, it's not going to register, but if you hear two or three companies doing the same thing, then you have to start thinking, and a couple of major, very high profile investors are investing in it. … You see it on the news or some other kind of channel, and see this is a great idea, and you can no longer ignore it."

Critical mass is also mentioned vis-à-vis publics' acceptance of IVM. Researchers are more or less unconcerned about the so-called "yuck factor" from potential consumers; they imagined that the public perception of cultured meat and other cellular agriculture products will change once the opportunity to buy or taste those products exists. There was also the suggestion that one could move production out of a university lab and into rural facilities, like a barn, in order to make it more approachable. This approachability will give researchers and their funders access to the supply chain, which is a particularly important type of network in food innovation.

Barriers

Innovation Process & Resources

The major concern of those I spoke with, and which was the focus of the EPINET-IVM workshop, is the lack of public funding for cultured meat. Funding opportunities are

incredibly limited for such a trans-disciplinary field, and it was a common theme amongst interviewees that there cannot be breakthroughs in innovation without far more support than what is currently available.

> "We wouldn't have a cure for cancer or cancer treatments without a Department of Oncology and, today, there is no Department of Cellular Agriculture."

Innovation processes impact on creativity potential of innovators, and creativity was described as a kind of resource: research is widely perceived by funders and publics to not be a creative process, when it very much is.

> "I think science has been so dehumanised that people don't even think of scientists as creative individuals …Like the term 'content creator', it's so robotic that it completely disregards the fact that the creative process is not straightforward or easy and it's not a technical thing. You're not in a factory creating stuff. I think scientists are perceived that way."

> "What I see is the two institutions that really benefit from our national funding schemes are the national railways because scientists now need to travel tremendously… and the other is accountants because everything has to be accounted for. It has gone completely awry and it's sending the wrong message. It's sending the message 'we don't trust you, when we give you money, you need to tell us exactly what you're doing, how you're doing it, when you're doing it', and that turns into a very bureaucratic, automatic system that really doesn't support creativity, but is also not a joy or fun to do this work and engage with society."

FSOs can also find it difficult to work within funding processes because they often require defined, quantifiable outcomes, which can conflict with the creative process. Fundamentally, stakeholders agreed the innovation process needs to be more flexible, particularly in terms of timelines and project outputs. This is important because researchers, and academic culture more broadly, tend to move far more slowly than in most other types of organisations, and it can be difficult to coordinate timelines and project outputs.

<u>Perception of Others: Perceived Fixed Categorisations of Stakeholder Groups & Imagined Publics</u>

Given the focus on funding at the event, no one we interviewed thought the event would have necessarily been different if the remit had included TSOs. However, there was slight concern the one difference would have been TSOs creating conflict at event:

> "The idea [of the workshop] was to try to achieve some kind of dialogue, or some kind of learning process, where knowledge was central. …We agree that knowledge and values are connected, but the point is that if you start out with this stakeholder

> conception, sort of starting on the values side, then your point of departure will often be that of a conflict of interest or conflict of values. In that way, you are starting with antagonism. …If there was an NGO that was very hostile, then I think we might not have achieved so much."

Clearly, it could be problematic to convince researchers that engagement is a valuable part of the research process if there is a widespread perception that TSOs cause conflict. It is a particularly interesting finding in this case study because, at this point, the only stakeholders who have come forward are supporters of cultured meat.

Researchers are also eager to evade conflict by avoiding association with the "causes" that their supporting TSOs are associated with, such as animal welfare and climate change. This is despite the fact that those same causes are referenced in the media as the core anticipated outcomes for pursuing cellular agriculture. However, these causes can be the source of conflict between the different stakeholders who are supporting the research.

> "It's slightly awkward because so many of our supporters are animal advocates, but we're not really out there as an organisation that's against animal agriculture. We've made a point not to be that way because I think if big meat companies and lots of science companies want nothing to do with animal advocates because of their opposition to the research and meat production and all this kind of stuff, then they just want nothing to do with it. I didn't really realise how real that was until I was in these environments and hearing people talk about it because they didn't identify us as one of those [animal advocacy] groups. They would say things like, 'Yeah, we wouldn't even be here if you had pictures of factory farms on your website'."

Researchers also seem to have a lot of preconceptions about whether imagined publics would accept cultured meat products, but very little engagement with publics appears to have been done in other projects and contexts to date.

<u>Organisational Practices</u>

Researchers are often not open to engaging, but those who are, are the ones who instigate relationships with TSOs/FSOs in the first place. The main challenge is how to ensure the engagement process involves mutual learning and reflexive dialogue between stakeholders, when organisational practices and innovation processes do little to encourage it.

There was the widespread view that researchers are not trained to engage or to do it well. Interviewees also mentioned that it is difficult to strike a balance between doing research and talking about it:

> "Lots of scientists are just not trained to be public speakers or to be communicating their work outwards – that's a new thing in itself. So, the balance is a) being able to do it well and b) being able to balance that with actually doing the real work, and I think that the cultured meat field has a lot of people who are very vocal and great communicators and talk about how important it is, but I don't think it's really backed up enough by those people who are heads-down, working really hard on the science."

It is not solely about communicating research and doing it well, but also about doing it with transparency. Transparency was identified as the most important way to create trust between stakeholders, publics, and researchers, and it helps to avoid misunderstandings. One example of this was given was in reference to when people ask whether IVM scientists use hormones to create their cell cultures:

> "I know what a hormone is, and so are we using proteins that instruct the cell to proliferate? Yes, we are, because they are also instructed in the same way in our body, and if we don't instruct them, they don't proliferate! [laughing] So, we have to do that. Is it a hormone? Yes, technically, but it's not a hormone in the sense that people use it. So, transparency in itself is relatively straightforward and a no-brainer. In the implementation, however, you have to be skilful and thoughtful about it because there are a lot of things you cannot discuss with the public without creating misunderstanding."

Researchers working in cellular agriculture are often socially and intellectually isolated from others working on the same research questions, through both organisational practices and academic culture. This can lead to resistance amongst scientists to engage with other disciplines or people from outside of academia. There is a feeling that although engagement with society is taking place, engagement between scientific disciplines is still patchy.

Academic culture has its own set of social rules and expectations, and maintaining one's professional reputation through publishing and other research activities is a core part of that culture. Several interviewees expressed that the hierarchy implicit in academic culture was a barrier to societal engagement and interdisciplinary collaboration in IVM. Researchers do not feel they are able to ask difficult questions or carry out engagement with unconventional partners, particularly if they are junior academics; there is a perception that only full professors with seniority, or people unaffiliated with academic institutions, are able to do so.

Perception of the issue

IVM can be perceived as a controversial topic and universities involved in this novel innovation may shy away from controversy and potential conflict. Some interviewees talked about this as an organisational barrier to engagement, surmising that such a hostile reaction ultimately stems from specific perceptions at the senior level of universities. This is interesting particularly in relation to this area of research, because at this time no stakeholders have come forward in opposition to cultured meat. In one instance, a university where IVM research was taking place did not want their logo on press materials to promote an event because they were concerned cultured meat could be a controversial topic.

> "We are at the front line of technology, and yes, some people are not going to like it. But then you have a debate – that's what you should cherish as a university! Are you kidding me?! So, yes, you have to listen and talk to the public, and at some point, you need to have the guts to say 'I'm an expert in this, and you may not understand this yet, or you may not like it, but this is the best thing we can do, and I'm going to do it anyway."

Cellular agriculture researchers need the support of their academic institutions, research organisations, and funders to carry out societal engagement, and it is currently lacking in all of these areas.

Lessons learned from this case study

- Researchers need to be taught how to do engagement, but they also need to be provided with the resources and physical spaces in which to do the engagement.

- From the perspective of the cellular agriculture community, current innovation processes don't support creativity or engagement. This must change, in addition to new public funding routes becoming available for such a transdisciplinary field of research.

- Even though EPINET-IVM is a unique case where an innovation has so far not been restrained by critiques from interest groups, there was still a small concern that including TSOs might lead to conflict and the engagement event would not have achieved as much. Is the case here that 1) researcher perspectives on TSOs need to change, or 2) that new types of engagement formats and procedures are needed?

- Organisations are reluctant to be part of societal engagement involving new innovations because of the potential to encounter conflict about controversial research, and because they are concerned about the impact on their reputation.

2.1.4 Case study 3: Well Now

Introduction

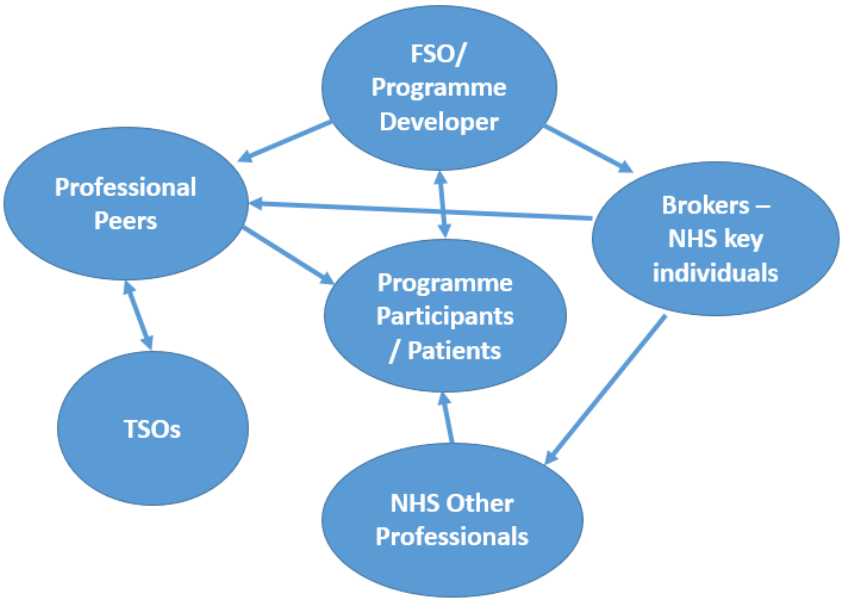
Well Now is a programme created by self-proclaimed "radical dietician" (Aphramor 2017) and researcher Dr Lucy Aphramor. Focused on the broad concept of "well-being", the programme helps people to develop a positive relationship with food and with their bodies. Through recognising that obesity carries a lot of stigma in our society, and that traditional "weight management" programmes focus solely on body weight as a measure of success, Aphramor has used her research and personal experience to develop a programme that addresses both of these issues. Instead, Well Now focuses on improving health measures that include level of physical activity, stress, diet quality, as well as mental and emotional health markers such as food preoccupation. The programme also takes a social justice and "weight inclusive" approach that promotes the acceptance of bodies at all sizes. Following that RRI responds to the "values, needs, and expectations of society", Well Now is a pioneering example of *social innovation* in public health. RRI is implicit in Well Now because the programme not only seeks to challenge dominant narratives about the "obesity epidemic" by refocusing on more holistic health outcomes, but it also takes responsibility for the often harmful outcomes of more traditional weight loss programmes. In this regard, it is a particularly unique programme.

Well Now was taken up as a mainstream programme by the NHS Highland (National Health Service Scotland) in late 2014. Through our work on this case study we interviewed stakeholders in Inverness who were involved in: bringing Well Now to NHS Highland; delivering the programme or other related personalised dietetic interventions; evaluating its success; or supporting the programme at a more community-based level. These interviews helped us to understand how changing the philosophy behind the "healthy weight" programming available through the National Health Service impacted health service delivery, as well as mental and physical health outcomes for patients.

Through this research we also gained a broader understanding of the barriers and incentives to developing and changing social programmes that were designed to better meet the needs of society. Social innovation has been a highly neglected area of study within RRI literature and this makes Well Now a particularly important case study. It is an example of what happens when processes of engagement were bottom-up, driven by the palpable and explicit need of stigmatised communities (based around non-normative weight) for a novel approach to health in larger individuals. It is largely based on the principles of autonomy, respect, and social justice and is a unique example of the efforts of a community of organised individuals (e.g. Dr Lucy Aphramor as an FSO, the dietitians who are co-opted on this course; professionals within the NHS; and a Third Sector Organisation) and unorganised citizens (self-referring people and patients referred through the NHS) to develop a long-term solution to an issue that is defined as a key health challenge to Scotland. In particular, it demonstrates the value of the Fourth Sector in bringing about a change in not only service delivery but the values and perspectives that enter the debate when developing social innovations.

The data captures engagement relationships between several stakeholder groups, including:

a) Between Well Now programme developer (Lucy Aphramor, an FSO) and the "key individuals" – the programme brokers who were responsible for bringing Well Now into the NHS
b) Between these key individuals/brokers and the NHS (the organisation and its practices and policy managers)
c) Between Lucy Aphramor and professional colleagues/peers she trained to deliver the programme
d) Between the key individuals and their professional colleagues
e) Between key individuals and their colleagues trained to deliver the programme, in engagement with TSOs (with the aim of supporting the programme participants)
f) Between key individuals and their colleagues trained to deliver the programme, in engagement with programme participants
g) Between professional colleagues and programme participants (who were referred to Well Now as patients in other parts of the NHS – but it is important to be clear that not all programme participants were also patients).



Interviewees discussed all of these relationships as they developed through the three years the programme has been running. Although some of this data is about the challenges of engaging with TSOs, most discussions focused on engaging with programme participants, and engaging with the NHS and professional colleagues, many of whom were resistant to ideas presented in the programme.

Incentives

Momentum for Change: Critical Mass & Values System

Critical mass is described within the data as a change in worldview that occurs when a few key individuals articulate such worldviews and values to develop a narrative that is communicated to the point when a critical mass in the organisation is able to recognise it, understand it and even adopt it. The potential to reach a point of critical mass is closely linked to the concept of worldview, though it is more strongly reflective of the dynamic processes of influence within a system that create a tipping point for a shift in the dominant position on an issue, from that of a majority to a minority view. The change in worldview then needs to filter through rest of organisation through education and adoption of core values.

To achieve critical mass, timing is key: enough key individuals need to be mobilised and brought together with the same worldview, whilst being supported through organisational and innovation practices (i.e., funding becomes available, programme being flexible enough to 'tick boxes' in currently existing policy, even though the programme outcomes may ultimately challenge what is 'ticked'). The data suggests that critical mass, though a group process, comes through the activity of passionate individuals, not institutions:

> "My own feeling is it comes down to individuals and their passion for this, as opposed to necessarily an institution. So, all the policy drivers in Scotland are telling NHS organisations that they need to be interested in prevention, they need to be interested in health inequalities, so all the messages are right, but I'm still not seeing it happening on the ground."

A key part of achieving critical mass is professional colleagues and programme participants having openness and flexibility as part of their worldview. The interviews make it apparent that relationships that are characterised by mutual trust are crucial to enable conversion of worldviews. For instance, the language and terminology used to describe the common aspects of obesity and health had to shift if Well Now was to achieve the critical mass, in order to enable colleagues to respond more positively. For instance the founder recounted how she had to drop the use of the phrase "health at every size" (the idea that a person can be healthy, no matter how large they are), because it couldn't be accepted by people with a "weight normative" approach to healthcare, and it was contrary to much of the accepted discourse among the professionals whose co-option onto the course was paramount.

Beyond the co-option of professionals, 'critical mass' was further achieved through making the programme sufficiently well known so that people in the local community want to engage with it. This could only be achieved by the programme being flexible enough to be adapted to the needs of the local community, but with its core values intact. This demonstrated the commitment to engagement as a two-way process.

A part of developing critical mass was doing research with programme participants to create an evidence base that justifies the programme's ongoing existence, and the adoption of its principles and engagement format into other areas of the organisation. This is important in order to expand the critical mass beyond the programme participants, their local communities and professionals, towards those in positions of power (i.e, NHS decision-

makers). In essence, achieving critical mass was a long process, which acted as an enabler of further engagement with the programme and its routing into the mainstream of health service provision.

Anticipated Outcomes

Sufficient clarity and shared understandings about the anticipated outcomes is another important incentive to engagement in the context of this case study. In particular, interviewees mentioned the need for programme participants, policy managers, and key individuals/colleagues delivering the course to have clarity about how the anticipated outcomes may have differed from actual outcomes. The issue was that of being explicit about what outcomes "matter" and how they may require a different approach to identifying the outcome criteria and the way of measuring them. The programme therefore set out to develop these measures through identifying clear principles of programme approach as one that is non-judgemental, shame-reducing, self-accepting, and leading to a change in worldview and perspective of self (participants became "empowered", gaining "awareness" and "confidence").

The programme curriculum focused on changing how "success" is measured, from the perspectives of participants, professional colleagues, and policy makers. The indicators of these outcomes were carefully considered, and this was linked to changes in worldview. Furthermore, following the initial piloting of the programme, what became apparent was that people who would lose weight in a conventional weight management programme also lost weight in Well Now, plus have additional 'health gain' outcomes (i.e., lowered stress, body acceptance). This meant that actual outcomes of Well Now surpassed what the anticipated outcomes for a normative weight management programme would be (although a normative weight management programme would not have been tracking the other health outcomes in the first place!).

Ultimately, to ensure that outcomes matched the expectations, there was a continuous effort to engage with and maintain the momentum for engagement with various communities and stakeholders. A significant part of this was a willingness to trial new engagement formats to reach rural communities, support more participants to finish the programme, support participants after completing the programme, develop different

versions of the course for teens and children, and implement the programme in collaboration with new organisations in different communities. These efforts could develop into Well Now cafes in the future; partnering with TSOs outside of health care sector to deliver Well Now and reach more diverse audiences; as well as promoting the programme's core values through unconventional engagement activities, such as performance poetry readings.

Importance of Values System: Flexibility, Reflexivity, Respect, Egalitarianism, and Empathy

The Well Now programme emerged from the clear articulation of the core values of respect for autonomy, focus on shame reduction, empowerment, and self-acceptance. This was based on the social justice approach initially inspired by the work on critical pedagogy by Paolo Freire (1973) that advocates development of critical consciousness about the "culture of silence" that functions to perpetuate the dominant version of the world and its power relationships, as well as Nancy Krieger's (1994) ecosocial epidemiology that argues for a critical re-examination of the claims of causation within the mainstream epidemiology.

This theoretical grounding was reflected in several aspects of the programme which organisers were careful to align with these values, including the physical and emotional environment. Organisers went to great lengths to make people feel comfortable, both in terms of physical and emotional environment. This encouraged people to keep coming back because they felt included, valued, and welcomed:

> "To meet with somebody, and every single bone in your body lets them know that their story matters – that's the starting point."

The choice of engagement format – to deliver the programme in groups – was deliberate because it helped to create a sense of community, and it disruptedthe "them and us" polarised worldviews. The programme chose to make engagement as "power with" , rather than "power over", as the group dynamic disrupts the more traditional healthcare approach of an "expert" interacting with a "patient" in a power relationship. They also used technology to reach more people, especially if physical spaces are inaccessible for larger individuals.

Furthermore, the programme made space to acknowledge participants' stories and experiences, and made it clear that they matter. The programme was driven by the explicit

commitment to giving voice to those who had been affected by the shame and stigma of being a larger person as a key part of their personal progress. In that sense, participants' choices were respected and they were not told what to do; there were no provided dietary requirements or restrictions, and participants were encouraged to stop looking at food in moral terms (i.e., to stop classifying a food as being either "good" or "bad"). There was no way to "fail", and this was key to empowering participants to make changes in their lives that led to health gains.

Programmes in other "tiers" of the weight management programme, including those within schools, shared the same core values. This means that parents and children received the same messages and could achieve health gains with the same philosophy. As such, the programme demonstrated flexibility, reflexivity, and empathy as key values in programme development.

> "We're wondering what a teen Well Now course would look like or what the possibilities for that would be, so we're just starting that piece of work. …We're just piloting one or two of the exercises that within the Well Now course with young people to think about what if we had a teenage group, what would be the best way of doing it? What would work without it seeming to have a 'fat club' kind of image, you know?"

Barriers

Resistance to Changing Worldview & Institutional Practices

These sub-codes were most explicitly evident in interviewees' recounts of the effort needed to manage expectations of programme participants and other professional colleagues. Well Now inherited a very long waiting list when the programme came into being, which meant that participants had been referred expecting bariatric surgery as the intervention. Their anger at such an unexpected shift in anticipated healthcare intervention made the worldview transition more difficult, which often discouraged individuals. The participants' initial expectations meant that they were very difficult to engage with in the new programme framework. The professional colleagues who had referred them for bariatric surgery had limited awareness about this happening and the emotional reactions that followed the re-assignment of participants from bariatric surgery to Well Now.

Another important element of the changing worldviews is the fact that there was considerable resistance to adopting this new approach and what it stands for within the NHS

as an institution. The interviewees expressed difficulty working with professional colleagues and integrating the core values into other aspects of institutional practice. Some dieticians in particular struggled with the philosophical change in approach to treatment, as such changes contradicted the core of their training as dieticians:

> "Dieticians are trained in judgement. So, if you're asked to sit with an idea and are told 'you've got this wrong', you go straight into shame and it's so painful that you can't sit with it. So, the response is to deny and attack. Whereas, I was training a group of midwives in NHS Highland [to use the Well Now approach], and they were just running with it, they were completely running with it, and I went to them at break and I said, 'Sometimes, you know, different professions sometimes struggle with these ideas' – to put it mildly! [laughing]. 'What do you think, do you know why you can hear what I'm saying?'. Because these midwives were just up for the revolution! And what was brilliant was, they said, 'Oh, we're always getting things wrong!', and that was it. They were so confident in their professional identity, they could allow that sometimes we get things wrong, and that's how we come to learn. It was just brilliant, and that's what I want for dieticians, to learn from our mistakes, not to discard them and dismiss them."

Another crucial barrier to engaging with the programme and with the needs of its participants and proponents is resistance to changing the worldview emanating from government policy, which funds healthcare interventions for obesity. Most weight management programme outcomes will be based on BMI reduction. Thus, the Well Now programme, though ostensibly opposing the weight-based approach to obesity reduction (and the BMI as its main measure), nevertheless had to adopt BMI as a means of complying with the institutional practices and worldviews. The programme, however, continued to press for the recognition of alternative outcomes to be measured in order to demonstrate success under different terms, advocating for the weight-normative quantitative measures to be changed.

This, in turn, led to the difficulty with patients encountering completely different messages and core values in different parts of institution; for instance, despite the Well Now size acceptance approach, it was still being referred to as a "weight loss service" by the majority of other health care professionals.

To date, TSOs have been involved in Well Now to provide support for those who have finished the programme to continue their healthy behaviours, and maintain the community of support they developed with other Well Now participants in their course. For instance,

attempts were made to connect programme alumni with the local leisure centre so they could continue to be more physically active, with the support of other alumni. However, the same leisure centre may also run a "Weight Loss Challenge" where the gym member who loses the most weight wins a prize, which is in direct conflict with the approach taught in Well Now. These organisations need to be flexible in supporting engagement and to be open to adapting worldview, even if other programmes they run may not have the same ethos.

Organisational Practices and Culture

This section primarily refers to the organisational processes of managing patients and participant referrals into the programme. There was a wide recognition of the difficulty with diverse groups entering the programme because some patients are referred by health professionals within the NHS, and other participants hear about the programme and choose to attend. In some cases, patients receive a letter inviting them to attend a course without knowing what to do with referral – or in some cases, not even being told they've been referred! The different ways that people are introduced to Well Now has an impact on whether they engage with the programme at all, and their openness to engaging with it if they do attend.

The course was 6 weeks long, with a two hour course each week within that period. Some participants felt that too much information was given in just 6 weeks. However, those delivering the programme felt if they opted to spread out the process of engagement over a longer period of time, they would lose momentum. Currently, the organisers are testing alternative engagement formats.

Finally, there was no formal follow-up strategy as part of the programme to help people maintain their change in worldview or behaviour. Some partnership with TSOs continued to help participants to engage with what they've learned, but participants were not fully utilising that opportunity; other participants would attend other programmes, like "Scottish Slimmers", but these are built on profit and run under completely different worldview. The challenge is in trying to build strategies to "self-manage" into the programme.

> "We're trying to address almost from the beginning of the course to get people to start thinking about what they might do after the course is finished and to think – because people develop relationships and friendships of support within it – do they want to carry on meeting up? And how will they work that out for themselves? We need

people to self-manage, but we are also thinking about how we can better support people at a strategic level, so whether that's through some form of social media of whether it's having an annual meetup, or whatever."

Lack of Resources & Broader Influences

Lack of resources is a significant barrier to engagement, and one that is the most important barrier to any form of organised participation. In the context of the current case, this barrier was partly aggravated by the need to meet the demand for courses in remote areas of the Scottish Highlands (an important geographical barrier) with limited funding for staff in those areas. Facilitators were often volunteers who worked a day job in addition to running the course, which meant that they had a lot less time and energy to put into the course than facilitators working for the NHS/local council – and participant experience suffers as a result. In addition, there were not enough resources to support programme alumni afterwards and the programme largely depended on the time/energy of individual facilitators.

Finally, the Well Now philosophy is founded on social justice, which recognises that poverty and inequality are significant obstacles within the broader social, political, and cultural context. The programme organisers are aware that this in itself is an obstacle- participants will not necessarily be able to engage with the course, either by attending or being able to make health gains, because they lack related resources (time, money, fundamental belief in themselves).

Lessons learned from this case study

- Public health policy and funding priorities need to support innovative programming that focuses on long-term health outcomes, rather than just focus their budgets on what is perceived to be an immediate need (like hospital wait times). The shifts in ideology and practice are a central part of worldview and this cannot be changed overnight.

- Engagement programmes are most successful when they are designed and adapted to suit the local community/culture

- There is a need to reach a critical mass of key individuals spreading a new message about engagement in order to change institutional practice; changing the worldview

of professional colleagues in order to be in line with that is a long-term dialogue process.

- People delivering the programme need to really believe in in the worldview and in the engagement format in order for the programme to be effective and make it successful.

- People delivering the programme recognise the worldview difference across organisation is problematic; one can't change that overnight, so they must try to help participants to develop reflexivity so they can handle those different worldviews when dealing with those other professional colleagues.

2.1.5 Domain Synthesis

- Potato Project and EPINET demonstrate that researchers who are willing to engage with TSOs, FSOs, and across disciplinary boundaries are usually open to, and go actively looking for, those collaborations. The challenge becomes how to get researchers who aren't open to that to change their worldview about engagement.

- Potato Project and EPINET stakeholders both voiced concerns about working with TSOs because of the perception they often bring conflict to a project. This was not a concern in Well Now, and the interesting difference is that the Well Now programme was designed to 'tick the boxes' of the organisation, and to be adapted to a variety of contexts. In contrast, the other projects more or less presented their agenda and asked for engagement. This points to researchers needing to think about how they present their work to a variety of stakeholders, and how they can create a space where the project can be adapted to the agenda of relevant TSOs and FSOs, whilst maintaining transparency about what researchers are hoping to achieve through the engagement.

- Reputation and organisational practice influence which researchers and organisations feel able to engage. This insight emerged most strongly from the Potato Project and EPINET, and is particularly relevant to technological innovations.

- Organisational culture and resistance to changing worldview (whether about engagement or the innovation itself) a common theme across all 3 case studies. This demonstrates that changes need to be made within innovation processes and organisations, and within the research teams themselves, in order to support societal engagement becoming fully embedded in research practice. Although our research findings demonstrate there is a long way to go until this happens in the case of technological insights, the Well Now case study demonstrated how it is possible to reach a "critical mass" through key individuals in order to facilitate a change in worldview. This is also a long-term process, but it is possible with the right people who are willing to "evangelise" societal engagement.

2.2 Nanotechnology

2.2.1 Introduction to the Nanotechnology domain

Nanotechnology is not a single technology, but has applications in many different existing industries. At the nanoscale (around 100 nanometres or less, with 1 nanometre equal to 1 billionth of a metre), materials can show marked changes in optical, magnetic, electrical, chemical and physical properties; this has been known for some time, but has only largely been exploited in recent decades. Zinc oxide, for instance, is used in sunscreen because although larger particles are transparent, nanometre sized particles are white and able to block UV light. Similarly, titanium dioxide has traditionally been used as a white pigment in paint, but at the nanoscale it is transparent, as well as highly reactive in UV light. This facilitates the breakdown of organic materials, a property that is exploited in products such as 'self-cleaning' windows. There are many more examples of materials being developed that could have use in medicine, electronics, transport, energy, textiles and other industries.

The novel properties of nanomaterials that were being exploited in these new product developments also raised concerns about what effects they may have on human health and the environment. As a result, the European Commission (EC) and other government agencies began funding research into the safety aspects of nanotechnology. In Europe this continues today as the 'Nanosafety Cluster', a consortium comprised of many different stakeholders in nanotechnology.

The domain is particularly unusual for its early public engagement activities, beginning around the year 2000, before there were many real products on the market or even significant commercial activities. Partly in response to the genetic modification (GM) debate in Europe, and partly because of the unknowns in nanosafety, government agencies across the globe sought to have constructive, upstream dialogue with stakeholders including TSOs, industry and academia, in addition to wider society. The purpose of this engagement was to support the responsible development of nanotechnology, while not significantly delaying innovation or preventing its expected economic benefits. Examples include:

- The nanoJury, which included the University of Cambridge; Greenpeace; Wellcome Trust and the Guardian newspaper (UK), and involved members of the wider public to hear 'evidence' from a number of stakeholders on nanotechnology developments. Its purpose was to influence policy making through articulating public concerns.
- nanoTruck, funded by the German government between 2004 and 2015, was a mobile exhibition staffed by scientists that visited schools and other public centres to allow members of the public to engage with scientists and learn more about nanotechnology.
- The Project on Emerging Nanotechnologies was a project delivered by the Woodrow Wilson Centre in the US that provided a database on products containing nanomaterials and up to date information on risks and safety issues.
- The series of 'Safety for Success' workshops, organised and supported by the EC which ran between 2007 and 2011, brought together TSOs, industry, academia and policy makers to discuss the latest nano-safety research and highlight areas of concern.

As a result of these and other activities, there were a number of codes of conduct developed to guide responsible innovation in nanotechnology until 2010. These set out strategic issues that organisations should consider when engaging in research and development using nanotechnology, and encouraged an open dialogue with other stakeholders. Examples include the EC's Code of conduct for responsible nanosciences and nanotechnologies research, and the Responsible Nano Code (developed in the UK by the Royal Society, Insight Investment, Nanotechnologies Industry Association, and the Knowledge Transfer Network). Chemical companies such as BASF also published their own codes of conduct.

Three case studies have been selected which represent different approaches to public engagement on nanotechnologies and involve diverse stakeholders. They illustrate the benefits that participants in the projects have gained, but in some cases also common issues of the lack of a wider impact from, and short-term support of, these activities.

2.2.2 Case study 1: NanOpinion

Introduction

NanOpinion was a project funded by the European Union under the 7th Framework Programme between 2012 and 2014. Its aim was to foster public communication and dialogue about nanotechnologies in the European Union. The consortium consisted of partners from 11 countries. In contrast to the other projects in the nanotechnology domain, NanOpinion focused on citizens rather than organisations as the target group (with a special emphasis on hard-to-reach groups) as part of the engagement activities. Going beyond one-way communication in order to raise awareness and enable citizens to make educated choices, the project gathered and monitored the opinions of thousands of European citizens via a large variety of engagement methods, including both face-to-face and online activities. Using these methods the project aimed to inform policy decisions on nanotechnology through a greater understanding of citizens' concerns regarding specific issues. RRI was implicit in the goals of NanOpinion, as the output from the citizen dialogues could help support greater responsibility and accountability in R&I amongst research organisations, industry, and in public agencies funding such research.

Incentives

Anticipated Outcomes

NanOpinion participants believed that the project outcomes would inform new ways for stakeholders (namely, government agencies and industry), to engage with wider society as a whole, as well as more specifically in terms of specific groups, e.g. school pupils.

Members of the public who were engaged with during the project were also motivated by the fact that their opinions could be fed back to the EC.

Adaptability of Worldview/Institutional Practices

Interviewees each had significant experience in public engagement activities, in nanotechnology and in other domains. As such they realised the benefits of focusing on specific technological applications, and in particular those which would be of interest to target groups, as a way to motivate engagement.

Momentum for Change

Nanotechnology was seen as a highly relevant topic for engaging with school pupils for science and technology. This served a dual purpose of 1) raising awareness of the importance of nanotechnology to society directly to young people and indirectly via these young people to their friends and families; and 2) encouraging young people to consider a career in science and technology, thus helping to reverse the decline in suitably qualified individuals.

Resources

Nanotechnology is a key enabling technology for the EU, but is not core to many organisations' objectives. For example, it is not part of the general school curriculum, and without EU funding, educational TSOs would not have been able to participate. Resources were a major incentive to be able to shape the project objectives to match their organisational objectives.

Barriers

Anticipated Outcomes

The perception of partners is that what should have come out of the project was not realised. There were a number of key recommendations that were reported to the European Commission, which it was generally positive about, but to date nothing has been acted upon.

Engagement Procedures

A key barrier for the educational aspects was that the project timings (as a result of the start date, which was dictated by the EC) were not aligned well with the academic year. This meant some activities needed to be rushed through.

> "We had an issue that we had too many activities the kids had to do, the students had to do. And I remember the first one coming out quite quickly but the 2nd one was towards the end of the project. So of course the timeline of the activities of partners didn't exactly match with the academic years. So if I remember correctly, the 2nd activity wasn't used as well in classroom as we expected because of that."

To overcome this barrier the work which is done in a project and the activities which engage the target groups have to fit those groups. The project should be planned accordingly beforehand.

Perception of an Issue

For effective engagement and dialogue, issues must be associated with a topic or development that is of interest to the stakeholder group being engaged – the "me and mine" approach. Even when considering specific topics, such as nanotechnology in medicine, there are multi-layered aspects such as benefits and risks to the individual, ethical issues and wider societal aspects such as equitable access to new developments and how personal data is stored and used. Each of these need careful consideration when planning the engagement.

There were some difficulties in aligning the needs of the project with the (commercial) needs of the media partners, who to a large extent felt that the selected topics had been discussed over several years already, were no longer controversial, and had lost some of their newsworthiness.

> "newspapers were supposed to get money from the commission but then they had issues because of course you cannot control what they say, they're supposed to be free press and all the constraints from the commission about logos and disclaimers were causing a number of issues. They were miscategorised, it would have been better to subcontract them than actually make them partners. Because they couldn't really, I mean, they're newspapers. They couldn't write deliverables, they couldn't write reports. And that was a bit of waste of their expertise in a way."

Resources

The project successfully engaged with school pupils and the wider public through street demonstrations, however this was to a certain extent just gaining traction when the project ended. The feeling was that there needs to be a longer term commitment to provide continuity to such engagement exercises. Particularly for TSOs there are not the internal resources to continue delivering material or engaging in partnership with others. One

interviewee characterised in their own words the problem with short term projects: "It went well, but as in every project. When you finish it, that's it."

b) Translation costs for engagement materials into multiple Member State languages was an issue, particularly as the target for engagement was the wider public, which may have limited understanding of other languages.

Accessible Communication

In a project such as NanOpinion there were many different outputs, however it was not possible to tailor these to every potential stakeholder group. For example, the policy document includes analysis of citizens' views on nanotechnology that is likely to be used by government agencies, however it is unlikely to be used by educational authorities due to its size and format, despite having relevant information.

> "The biggest issue is that we have very different targets. I am looking at the education results and stuff. And the thing is: The document is not … education will never look at it for example. So sometimes in these projects you kind of try to target too many things so they are not actually compatible, because the commission requests that you look into education, you look into dissemination, you look into research and you do activities and you do workshops. They are way too different. They expect everybody and everything to be targeted at the same time. So I would actually make it kind of smaller independent projects and then they can work together."

Also in this regard, there needs to be consideration of how different communication tools are used effectively together, for example using social media to allow people to reflect on and discuss what they have heard at a workshop or on a radio or TV show. It was not always possible to join up these different tools in the most effective means and across different Member States.

Lessons learned from this case study

- There is still too much of a short-term focus on such engagement projects – they generally need longer than a few years to achieve impact.

- There needs to be commitment from funding agencies to act upon research outcomes should a project be evaluated a success.

- There is difficulty in effectively engaging with a limited budget across a number of Member States (due to language) and the number of communication tools required.

- There needs to be greater control of project timing devolved to the partners, e.g. to match with the (annual/seasonal) timetables of target groups.

- Greater impact can be achieved when specific topics relevant to the target groups are selected, however this does not always align well with funders' requirements to take a cross-section of society or address broader societal concerns.

2.2.3 Case study 2: TracingNano / NanoCap

Introduction

Two related projects were selected for the second nano case study. NanoCap was in many ways the first of its kind, a project funded by the EU under the 6th Framework Programme that aimed to deepen the understanding of environmental, occupational health and safety risks and ethical aspects of nanotechnology, by organising a structured discussion between environmental NGOs, trade unions, academic researchers and other stakeholders. It provided opportunities for capacity building in the NGOs to allow them to formulate their positions, inform their members and the general public, and to become active in the debate on nanotechnology at a European level.

TracingNano was a follow-on from NanoCap and focused on improving the traceability of manufactured nanomaterials (MNMs) in products and articles for downstream use. It also focused primarily on the input of TSOs. It was funded by the Dutch Ministry of Infrastructure and Environment, to explore the position of Dutch TSOs regarding the problem of openness and the practical use of MNMs in products. The issues that the project sought to address were two-fold. First, that there was a lack of knowledge and understanding about the potential impacts of many MNMs on human health and the environment. This was particularly true in regard to the wide range of uses of MNMs, and the way they are combined with other chemicals and materials. Second, apart from cosmetics and foodstuffs, there is still no legal obligation to declare which MNMs may be within a product. While most of these are likely to be safe under the specified use, the project took the position that

workers, employers, and consumers had the right to make informed decisions. Through a series of workshops, stakeholders had the opportunity to make their demands explicit and have them implemented. Although the engagement process was initially carried out within the Netherlands, the project reached out to TSOs that operated in other European countries and across the whole of Europe, in order to put pressure on the European Commission to establish a framework for traceability. This was an explicit manifestation of RRI as the project partners sought to increase transparency from manufacturers on products containing MNMs for the purpose of ensuring that workers, employers, and consumers can make informed decisions.

Incentives

Anticipated Outcomes & Perception of the Issue

Interviewees engaged with the projects because they believed the project outcomes would lead to greater responsibility and accountability amongst stakeholders, and would inform future EU policy and framing funding programmes.

> "This was one of the main reasons, because it was a new topic, as I said. And we had really promoted to our membership the need to participate in such a project. So the real impacts of the project when it comes to society after the end of the project, was visualised from the very beginning. We knew that this project […] has a potential to really influence the policy agenda, or the policy debate at European level."

The objectives of NanoCap and TracingNano aligned well with the missions of the participating TSOs – to improve their understanding of environmental, health and safety aspects of nanotechnology for the purpose of protecting workers handling MNMs and the environment.

Momentum for Change

NanoCap led to a clear change in direction for trade unions and environmental NGOs, allowing these organisations to take an informed stance and subsequently engage more effectively with government and industry. For the trade unions, this led to a renewed interest in the health and safety aspects of technology, rather than focusing solely on economic factors such as jobs and salaries.

Access to Network

NanoCap allowed trade unions access to the European Chemicals Agency (ECHA) and other relevant groups, e.g. in academia, to put forward their views and concerns in the appropriate arena, and to be in turn informed by new research and best practices in the safe handling of different nanomaterials.

Values System

Transparency and trust were indicated to be key incentives by a number of TSOs: that there should be no hidden agendas and that each participating organisation should engage openly with others.

NanoCap was successful in building trust amongst the different participants: environmental NGOs, trade unions and academics. This was key to achieving its objectives, and had the added benefit of mutual learning, and ongoing, albeit limited, engagement beyond the project. This in turn led to the development of more credible and nuanced arguments to specific developments.

> "But I think the issue of exposure to different sectors of society, different people representing those different sectors, in a genuine way, is that trust that needs to develop is an important element of the success or not of a research project."

Building trust also provided opportunities to influence others' positions through informal channels, rather than taking a formal, often legislative approach. For example, early projects such as NanoCap and TracingNano influenced decisions to fund research into the safe handling of nanomaterials.

Adaptability of Worldview

The process of discussion and exchange of information between project partners influenced each one's perspective on nanotechnology, focusing attention on specific issues for the TSOs and enlightening the academics as to the level of understanding that TSOs had and the rationale behind their concerns.

Barriers

Resistance to changing worldview about the topic

From the NGO and trade union perspective, few if any of the recommendations to come out of the projects have been taken up by the EC or Member State governments. In contrast, the approach that was taken – establishing an observatory on nanotechnology – was not what was called for by the TSOs, or by the EU Parliament. According to those interviewed, it does not inform stakeholders about specific material properties, risks or manufactured amount, nor does it have any regulatory authority.

> "Another challenge was how to put forward those resolutions in the political arena. We had the chance to get into different working groups, but only that."

In relation to this, there is a strong sentiment from TSOs that while their concerns and opinions are being heard, they are not being taken into account to shape policy. That despite the inclusive approach, decisions are predisposed towards the economic goals of industry and government, rather than societal values and needs.

> "We are heard but sometimes or very often that's not taken on board. I feel that we are just given the floor and that's it. That's not really engagement. Like: They were there. And because they were there: wow, social dialogue and engagement and outreach and Europe is involving."

Perceived fixed categorisations of stakeholder groups & Values system

Preconceived perceptions of stakeholder groups was mentioned by several interviewees as a barrier to effective working relationships, in particular between industry and TSOs. Each expects the other to follow rigid paths that are not aligned with their own objectives.

> "We came already with a bit of a trust thing [into the project]. […] On the other side: That's the company policy and we can't get out of that. There was very little trust from the very beginning of our relationship."

Resources to participate in engagement

It is often difficult for small TSOs to have the necessary skilled personnel or the time to participate in projects that are important, but not core to their activities.

> "The topics and the way it is formulated is the result of large negotiations and a mixing of interest and not necessarily the interest of the NGOs. So it is quite a difficult job, to have the CSO focus in your research questions and not mixed up with all different other interests. […] This is the problem of priorities and the limited number of people they have employed, and those with the knowledge necessary to be able to discuss nano. In their organisations is also one or two persons, and they are involved with other environmental problems. So practical problems lead to priorities they have to set themselves, and not to choose for nano."

As stated for other projects, there also needs to be a longer term commitment to provide continuity to such engagement exercises. In many cases it will take several years for impacts to be realised, and without the external funding it is difficult for TSOs to continue engagement.

Institutional Practices

Although this is no longer the case, one participant commented on the negative reaction from academics to TSOs being concerned about issues with MNMs, that this should be left to the experts in academia. Another participant commented on issues with academic culture in different Member States – some encourage public engagement as part of the 'job' others see it as very much an add-on, with little or no recognition for efforts undertaken and benefits accrued.

> "I had always had an interest in that, but I've always understood it to be no pay back. You know, hobby things, because clearly in the environment I have been it harms your scientific career if you spend time doing these things. […] In the UK it is part of the job, but here and in Sweden where I was, it was framed as being an additional task "

There was a feeling amongst TSOs that the individuals from industry or academia who engage in nano safety projects generally take these aspects seriously. The issue is whether they are able to influence the decision makers in the company.

> "My intuitive reaction is that there are researchers […] who really do want to have that kind of feedback, who do want to better understand societal views or elements of this side of views. But I'm not sure that that necessarily translates into a kind of structured integration of those views into the developments that come from their work or the potential applications that are developed through the research that has been done."

Lessons learned from this case study

- Lack of action on project outcomes is an issue for TSOs, and there is the sense that they feel disenfranchised, and as a result may not participate in future engagement activities.

- Funders and policy makers should provide greater clarity on the purpose of calls for funding, how achievement of the overall programme goals will be monitored, and how outputs will be used and impacts measured.

- Nanotechnology was still at an early stage of development at the time NanoCap was funded; so there was an opportunity for TSOs to engage in the debate and help shape its development, before it became a commercial reality. This is something that should continue for other emerging technologies.

2.2.4 Case study 3: BMU NanoDialog

Introduction

NanoKommission/NanoDialog is a national dialogue process in Germany under the lead of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. Its aim is to support an exchange of ideas between civil groups and stakeholders on the opportunities and risks of nanotechnologies and thus help promote responsible and sustainable use of nanomaterials. High level representatives from industry, research institutions, ministries, labour unions, environmental and consumer protection organisations are involved in this two-way communication process. Although the process started as early as 2006, it is still ongoing with the fifth phase started in June 2016. The method of engagement changed in 2011 after the first two phases, and at this point the original name 'NanoKommission' was changed to 'NanoDialog' to reflect this different approach. The process went beyond exchanging ideas; for example, recommendations regarding safety and the responsible use and research of nano materials that resulted from the NanoKommission were applied and became implemented in industry procedures. Due to its early starting point, NanoKommission/NanoDialog has no explicit references to the concept of RRI because, effectively, RRI did not exist when it was founded. However, its explicit aim to promote the responsible and sustainable use of nanomaterials clearly shows that RRI is at least implicit in the NanoKommission/NanoDialog, at a very early stage in the innovation process. This implicit approach to RRI, as well as the long duration of this initiative and its multi-actor design which includes many key stakeholders, makes NanoKommission/NanoDialog a key case study for PROSO.

Incentives

Perception of Topic/Anticipated Outcomes

In the early 2000s, nanotechnology was in an early stage in the innovation cycle, but still a somewhat unknown field. In order to secure responsible development, many stakeholders

were keen on having a broader dialogue about how to bring this technology forward. For industry, nanotechnology was very promising and is was felt that it should not suffer the same fate as the GM debate in Germany.

> "At the time in 2004/2005, when the societal and political discussion about nanotechnologies started, we as an organisation had learned a lot from the GM discussions, in which we were involved. And with the background of our sustainability management we decided that we had to start a dialogue process at an early stage so we endorsed the idea of creating the Nanokommission."

For consumer organisations, the topic became relevant because it looked like nanotechnology was destined to find its way into people's everyday life and questions about risks and safety arose.

> "The motivation was that at the beginning – in 2005/2006 and even before – the public became aware of products with the nano label. They were advertised with nanotechnology and its effects. […] With every new development and the possibility to make nano structures […] visible it was easier to work with the technology and there was a need to move the technology further. And then indeed, regarding upcoming questions about the technology, we decided we definitely need more transparency about what is going on in this broad field."

However, the perception of the topic changed with time, and in the public's eye the focus switched from nanotechnology to other new developments. So today, for smaller NGOs above all, it is a question of how to allocate existing resources, which are limited. This makes the perception of the topic for some groups suddenly more of a barrier than an incentive to engage in dialogue processes. This is a phenomenon that is illustrated in the barriers section below. However, in the beginning, the topic was deemed important by many stakeholders and so they were willing to enter into an open dialogue on a large scale with the aim of understanding every important aspect of the technology.

> "And this was the primary goal and, thank God, the first time that a dialogue of that scale and depth and with this intensity was conducted for such a topic. That's what I remember. Of course, we had discussions about technologies before. But these came too late, think of the GM discussion. And we wanted to learn from those and try to include many groups at a very early stage in order to find solutions, figure out requirements, define reasonable frameworks and identify research fields worth pursuing."

<u>Engagement Procedures and Values System</u>

The design of the engagement process was another important factor that promoted participation. All the interviewed stakeholders agreed that the continuity of the process was a big plus. Regular meetings and discussions with pre-processing of relevant issues for the

next meeting and follow-up procedures led to efficient discussions without a lot of warm-up time.

> "The more the organisational aspects are fleshed out and the clearer they are, […] the easier it is. These are things that influence my feelings and my inclination to engage with the issue at hand. And this, yes, I would say that this is a factor of success, if you are able to provide this. […] If you are able to design the process in such a way, it definitely helps to run an event successfully."

The continuity enables people to build up trust and, as one interviewee put it, to be able to discuss openly about all aspects.

> "You have a certain core of people who are present every time. In this way, you build a certain continuity and it is extraordinary how easy it is to talk to each other and one's opinions are respected and it gets less harsh. You can create such a climate when you have this core of people who bring this culture in the discussion every time, I would say. And then you can go more in depth and that makes the difference."

In contrast to other one-off events, which consist of only presentations and nothing else, the design of the engagement process helps to deliver more sustainable agreements across groups.

Adaptability of Worldview

Within an engagement process like this, the interviewees stated that responsiveness to other views and the willingness to take on new angles are key in order to come to terms with the issues at hand. The organisers as well as the participants have to make sure that this is guaranteed at every stage of the process.

> "In these dialogues, you bring your views not only to the awareness of the organiser, but to every other participant. And of course it is important that those take in the issues of the consumer and let their actions be influenced by them. That is a huge value. At the same time, I have to understand the views for example of the industry, and have to deal with issues I am not aware of at first. And I expect that from everybody else, too."

The ability to take on other points of view is the foundation for a successful dialogue process. The continuity of the process helps to create a climate where the participants are able to learn how to do this.

> "The broader the issues are discussed at the beginning, the more we are able to find solutions and create a dialogue which is sustainable. Then, after some time, I know I can talk to people who have a different background and different perspectives from my own and can discuss with them in a constructive way: regarding this issue, we are of the same opinion; on this point we disagree, but maybe we find a way in-between.

> They take my point of view to their organisations and I take theirs back to mine. […] This is a learning process for both sides, which I think is essential and cannot be replaced. And this works only if this process is cultivated."

Access to Network

As mentioned above, the design of the engagement process made it possible to raise awareness of the issues each participant deemed important. The continuity and the trust that was built up during the process made knowledge transfer from one participating organisation to the other easier. In this climate of continuity and trust, the interviewees stated that the resulting network led to outputs and other projects beyond the NanoDialog itself.

> "The first phase had huge impact. First, a nationwide network developed which today still exists. Of this stakeholder network originated follow-up projects, some between companies and researchers, some between companies and civil society organisations. The essential factor for creating these projects was this network. The positive thing about the process was meeting and working on an issue over a long period of time. If you have one time events, everyone gives a presentation and nothing happens. […] This would probably not have happened without the NanoDialog."

Momentum for Change

The fact that several key players across all stakeholder groups were willing to support the creation of a nationwide engagement process was crucial for the development of the NanoDialog. This was a process that was something entirely new according to one interviewee:

> "First, there has to be the possibility to enter such dialogues. The broader they are and the more independently they are organised the better. Therefore we have to thank Mr. Lahl that he made that possible in the first place. It was unique, we did not know something like this before, not in this scale. […] We should be very happy that it worked out and the right people at the right time had the willingness, the ability and the resources to take action."

Barriers

Role of Key Players

What happens when there are not the right people at the right time in the right place to participate in such a large engagement process? The interviewees agreed that this is a problem especially for smaller organisations. There are cases in which it depends on a single individual competent enough and with the time and capacity to deal with the issues.

> "And that is particularly the case with civil society organisations. There is often only one person. And when this one person leaves the organisation for whatever reasons, then the issue is no longer existent. So some organisations could not participate anymore, because they simply had nobody who could work on this."

This is not only true for actors in civil society but also for actors in the economy:

"The large companies have the position in the market and the right people to deliver. Whereas SMEs often don't have the capacity needed to create transparency."

This illustrates that the role of individuals who are willing and competent enough to participate in engagement processes is a big one. But even when there is such a person, the organisation has to have the resources to engage.

Resources

That is not a problem in projects in which the people who work in it are funded by a third body. But in engagement processes where only travel expenses are met, the organisations have to allocate resources of their own. This again is a big issue for smaller organisations.

> "For us, as a small association, the workload is a great challenge. This should not be underestimated. Of course the design and the preparatory work of the organisers make it easier, but nevertheless you have to deal with issues which are not part of your everyday work. For a two day discussion you have to invest a whole amount of time more. […] There are no funds dedicated to support civil society organisations and make it easier for them to participate."

Institutional Practices & Perception of Issue

Where resources are scarce, organisations have to set priorities. One influencing factor is the perception of topic. The NGOs stated that in the later stages the nano debate was not that prominent anymore in the public eye. The focus shifted to other technologies or issues. As a result some decided to reallocate their resources.

Another factor that influences the decision to participate or not is the design and the aim of the engagement process. It has to be worthwhile for the organisations, as one interviewee put it:

> "If every association and every industry stakeholder would try to include NGOs in their dialogues, we would not have the ability to fulfil the demands, because one person who would be responsible for this, could not possibly travel from one event to the other all year long. We have other tasks on our hands. I have five different topics for which I am responsible, and nano is a small one in this context. And then there is always the dilemma: Do we have the time? Is the dialogue productive enough to engage?"

Lessons learned from this case study

- A long term engagement process is a very effective way to create a climate in which real open dialogue between stakeholders is possible. The continuity allows participating organisations to build up trust and forge a responsive network in which knowledge transfer is easier and, like in this case, might lead to follow-up activities which foster the dialogue about nanotechnology, or any other, beyond the borders of the engagement process itself.

- Limited resources are a huge problem for smaller organisations across all sectors when they have to decide to engage in a process or not. External funds would lower the barrier.

- Considering the lack of resources, stakeholders only participate in engagement processes which they think are worthwhile. A process with a clear mandate and structure from which the stakeholders can anticipate possible outcomes and with clear tasks for the participants is more appealing.

2.2.5 Domain Synthesis

- Anticipated outcomes is a common driver for engagement in the case studies. Participants believed that the outcomes from the projects would influence future policy decisions at an EU Member State or national level. In some cases, individuals that were interviewed were of the opinion that this has not happened. However, each was clear about the impacts project output had on their own organisations and those that they work directly with.

- Lack of resources to participate is another common theme. While nanotechnology is an important topic to all of the stakeholders interviewed, it is one of many that they consider and in many ways it is not core to their organisational objectives. In the first two cases, they would not have been able to participate in such activities without EU funding and as a result be more informed about potential benefits and risks. In the third case the lack of external funding combined with staff changes made it impossible for some organisations to continue engagement. A process with a clear mandate and structure from which the stakeholders can anticipate possible outcomes and with clear tasks for the participants can encourage potential participants to allocate their limited funds to it.

- Trust and perception of others was important to all of the stakeholders, in terms of working effectively within a project where partners may have different perspectives and objectives, and ensuring that opinions would be heard and, if justified, taken into account by external stakeholders to the project. The continuity of engagement processes helps to build up trust and create a climate in which the above is possible.

2.3 Bioeconomy

Introduction to the Bioeconomy domain and synthetic biology

Bio-economy has only recently emerged as a cross-cutting research and innovation (R&I) field tackling several Grand Challenges (such as food security, management of renewable resources or climate change). The concept of bio-economy, initially introduced by a report of the OECD, aims at reconciling the idea of economic growth with that of sustainable development (OECD 2009). The European Commission, by elaborating a bio-economy action plan, helped specifying this concept, but still there is no unanimous understanding of this term (European Commission 2012). According to different sets of interest, various and partly competing interpretations have occurred. Some TSO[3]s, such as environmental Civil Society

[3] **Third Sector 'actors' or organisations (TSOs)**, 'is an umbrella term for various interest groups of citizens, such as civil society organizations and labour unions, as well as religious organisations and informal networks of citizens. …Organisations of the third sector are often involved in science in society activities either due to moral, ethical and ideological concerns or in order to represent certain interests of groups of the society'. **Civil society organisations (CSOs)** are TSOs, but they are more specifically defined as being 'non-governmental, non-profit, not representing commercial interest, [and] pursuing a common purpose in the public interest' (European Commission 2009). CSOs are the organisations who often deal with issues related to equality,

Organizations (CSOs) for example, used the emerging debate over bio-economy to link the issue to past conflicts over genetic engineering. They consider bio-economy as a new way to make biotechnology marketable. In the political discourse, in contrast, bio-economy is especially linked to a *resource-saving, plant-based economy as a precondition for sustainability*. As the European Commission states: "Establishing a bio-economy in Europe holds a great potential: it can maintain and create economic growth and jobs in rural, coastal and industrial areas, reduce fossil fuel dependence and improve the economic and environmental sustainability of primary production and processing industries". In this view bio-economy appears particularly important in terms of societal engagement because of its great relevance to the Grand Societal Challenges: "The bioeconomy's cross-cutting nature offers a unique opportunity to comprehensively address inter-connected societal challenges such as food security, natural resource scarcity, fossil resource dependence and climate change, while achieving sustainable economic growth" (European Commission 2012:3). Synthetic biology as a (relatively) new and emerging research field fuels the hopes of achieving the objectives of bioeconomy. Synthetic biology is mostly referred to as the design and construction of new biological parts, devices, and systems, and the re-design of existing natural biological systems for useful purposes. Synthetic biology aims at introducing engineering principles into biology. Based on recent insights from genomics, big data and other fields, metabolic pathways or organisms are constructed from standardized parts and devices (Benner & Sismour 2005). In the perspective of bio-economy as a *resource-saving economy*, synthetic biology has been advocated to contribute to sustainable use of natural resources through specifically designing new organisms and pathways for applications serving societal needs[4]. One example could be the research on bio-fuels where algae are used to convert sun light, water and CO_2 into fuel (see for instance Aro 2016).

Societal engagement in the field of synthetic biology

Currently, synthetic biology has developed into a prominent field of research explicitly addressed by the demands of Responsible Research and Innovation (RRI). Even more so than nanotechnology, the technology is in an experimental stage and practical applications are

diversity, and inclusiveness in scientific institutions, and these can include student associations as well as higher education institutions who are involved in implementing equality programmes (European Commission 2012).

[4] See, for instance, the German Advisory Board on Bio-economy: BioÖkonomieRat (2011). Prioritäten in der Bioökonomie-Forschung. Empfehlungen des BioÖkonomieRats, Berlin; accessed at: http://www.biooekonomierat.de/fileadmin/templates/publikationen/empfehlungen/BOER_Empfehlungen_%20Nr.%2002.pdf. (26.5.2017)

rare. With only very few concrete issues to decide on, future expectations prevail. As with other emerging technosciences, the role of participation and public dialogue has not been determined; rather, societal engagement is in an *experimental stage*. This means that societal engagement is usually *organized by professional participation specialists and carried out under controlled conditions*; it is *rarely linked to public controversies, to the pursuit of political participation, or to the experiences of people directly affected*. This form of participation, in other words, is hardly realized as a protest expressing real demands "from below", but rather as an experiment which is frequently set up as a research project and observed from start to finish by the team of researchers who are present throughout the whole process (Bogner 2012).

Up to now, with a view to synthetic biology, we observed several attempts to foster societal engagement mainly initiated by research funders and academia.

- In the UK, two ambitious participation experiments took place so far. The "Synthetic Biology Dialogue" (2009) was initiated by the Biotechnology and Biological Sciences Research Council (BBSRC) to identify public concerns around Synthetic biology. In three workshops, 160 people were brought into dialogue (Bhattachary et al. 2010). Another example from the UK is the project "Synthetic Biology: public dialogue on synthetic biology" (2009) initiated by the Royal Academy of Engineering. Here, 16 citizens talked in a half-day meeting the current level of awareness of synthetic biology (which is low) (King & Webster 2009).

- Science Cafes: Between 2009 and 2011, Science Cafes on SB were held in five cities across Canada (Navid & Einsiedel 2012). The number of participants ranged from 25 to 150. From the organizers' view, the Science Café was primarily a knowledge-translation tool following the Public Understanding of Science (PUS) paradigm. So, after the issue having been introduced by experts, the discussion was mainly in a question-and-answer format. For the laypeople involved learning more about synthetic biology was the primary motivator for participation.

- Focus groups: During the last decade focus groups organized by social scientists were held in several countries, among them in Baltimore (Maryland) and in Linz (Austria); all of them had been initiated primarily for academic reasons, namely in order to reveal whether collective imaginations on synthetic biology resemble those of the GMO controversy (Kronberger et al. 2012).

- Online deliberation: The first online deliberation process was set up in the course of an FP7 funded EU project („Synbiosafe") dealing with biosecurity and biosafety issues. 124 registered participants from 23 countries took part as discussants in a virtual conference lasting for one month (Schmidt et al. 2008).

- Under the 7th FP the EU has taken up synthetic biology as a major topic for initiating societal engagement and sustainable exchange between science and various societal actors. In the context of the MMLAP Programme, the project SYNENERGENE (one of the three PROSO case studies) is dedicated to develop methods and measures to initiate and foster societal engagement with synthetic biology on different levels contests, exhibitions, public dialogue events, citizen conferences etc.).

- Since 2004, the International Genetically Engineered Machine (iGEM) Foundation[5] (an independent, non-profit organization) runs three main programs: the iGEM Competition of undergraduate students interested in the field of synthetic biology; the Labs Program as a program for academic labs to use the same resources as the competition teams; and the Registry of Standard Biological Parts which is a growing collection of genetic parts use for building biological devices and systems. The annual iGEM competition involves groups of young students from all over the world in a similar way as in computer sciences. As part of their task, participating students have to deal with impacts of the technology as well, especially questions of "safety" and "responsibility".[6]

In sum, two main points can be observed when looking at engagement in the field of synthetic biology: First, a tendency of engagement **moving upstream**: In order to influence technology development effectively, societal engagement has to set in at an early stage. This resulted in the quest for moving participation 'upstream' (Wilsdon and Willis 2004). Second, the **experimental character and the focus on invited participation**: With regard to synthetic biology, societal engagement is hardly realized as protest, expressing genuine pressure 'from below', but rather as experiments which are frequently organized in the form of research projects. This engagement is at risk of being removed from real-world contexts without any closer link to the public debate or political decision-making. A peculiarity of societal engagement within the field of synthetic biology is the extensive outreach to students (e.g. iGEM) intending to foster an academic research focus while raising awareness for side-effects of the technological approach or application at use.

Thus, engagement activities in synthetic biology predominantly occur in the form of 'invited participation' (Wynne 2007) where 'the public" or stakeholders are invited 'upstream' to join organized deliberation on an issue at stake. Especially in relation to RRI, invited societal engagement can be regarded as the more prevalent form of engagement, not only in the field of synthetic biology. However, at the same time, TSOs have been monitoring synthetic

[5] http://igem.org/About (25.05.2017)
[6] http://igem.org/Facets (29.5.2017)

biology for almost ten years now which has led to occasional bottom-up activities against synthetic biology (applications) as well. These forms of 'uninvited' engagement are rooted in concerns about the issues at stake; usually, they are realized through other formats than (research) projects and (organized) dialogues (e.g. through protests of affected groups). In our case studies, we aim at considering both ideas of TSOs involvement, 'invited' as well as 'uninvited' engagement- with an emphasis, however, on the former.

2.3.1 Case study 1: Ecover/Solazyme

Introduction

In short: What is it about?

In 2014, Ecover[7], a producer of detergents, had decided to substitute palm (kernel) oil with algae oil derived from processes claimed to be based on synthetic biology techniques. These techniques attracted attention and protests from various TSOs (in this case more specifically: CSOs) throughout 2014. Triggered by this debate, mediated dialogue events took place, some directly linked to this particular occasion, some of them to guide the deliberation on synthetic biology more generally. The introduction of algae oil in these particular detergents has been put on hold up to now (May 2017).

In this debate on Ecover products we distinguish two phases: the first phase encompasses the public debate between CSOs and Ecover, the second one covers two attempts of mediating this debate with regard to different aspects. This sequence of "uninvited" and "invited" participation is particularly interesting since it enriches the analysis of the dialogue formats (which are focus of the analysis) with details of the preceding debate.

The story around Ecover products

Uninvited participation: Public debate and protest

In 2014, the company Ecover/Method[8] released information about their plans to substitute palm kernel oil in their detergents with algae oil produced by the US company Solazyme,

[7] Ecover is a Belgian laundry detergent producer with the mission to produce environmentally sustainable products https://www.ecover.com/about-us/ [05.05.2017].

[8] Method is an US American laundry detergent producer with the mission to produce environmentally sustainable products. In 2012 they joined forces with Ecover "to create the world's largest green cleaning company" http://methodhome.com/about-us/our-story/ [05.05.2017].

Inc[9]. In April 2014, Ecover announced in an article in *The Guardian*[10] that a test batch of 6000 bottles was released in the UK. [11] Having monitored and criticized activities in the field of synthetic biology for quite a while[12], this particular announcement prompted a couple of CSOs, especially the Action Group on Erosion, Technology and Concentration (ETC Group) and Friends of the Earth US, to publicly react on the issue of synthetically engineered algae. After ETC group had been in touch with Ecover several times, ETC Group contacted a journalist at the New York Times who subsequently published an article on May 30th 2014. This article elaborated on the use of "biofuel tools in household products"[13]. When the company didn't react, ETC Group published an open letter to Ecover/Method on its website in June[14], which was officially supported by representatives of 24 CSOs[15]. Subsequently, an online petition[16] against Ecover/Method's use of genetically engineered algae in consumer products, supported by several CSOs[17], was launched and, according to an article by Jim Thomas published in The Ecologist, received considerable support by consumers. While a vividdebate in online and print media followed, personal contact and conversations between different actors were pursued too.

An intense debate between ETC Group and Ecover in June 2014 was published in the online blog section of the magazine of *The Ecologist*[18]. Here, ETC Group criticized Ecover as a 'green' company to use sugar-derived synbio algae oil[19], followed by Ecover's response[20] and, again, ETC group's reaction[21]. Finally, in July 2014, ETC Group reacted one last time, stating that Ecover had put their ideas on using genetically engineered algae oil as an

[9] Solazyme Inc. was founded in 2003 with the mission of utilizing microalgae to create a renewable source of energy and transportation fuels. They produced the algae oil for Ecover. "Solazyme officially changed its name to TerraVia Holdings Inc. in March 2016 with a redefined focus on food, nutrition, and personal care. As part of the change, the company stated that its previous fuel and industrial oil products and workings would operate under Solazyme Industrials." (Wikipedia Solazyme based on: http://investors.terravia.com/releasedetail.cfm?ReleaseID=960149 (5.5.2017). Homepage of TerraVia: http://terravia.com/ (5.5.2017).

[10] https://www.theguardian.com/environment/2014/apr/02/ecover-algae-laundry-liquid-palm-oil (5.5.2017)

[11] http://www.theecologist.org/blogs_and_comments/Blogs/2450666/ecover_is_as_green_as_ever.html (5.5.2017).

[12] ETC group stated they had been watching synthetic biology since 2005; for example, a report called "Extreme Genetic Engineering: An Introduction to Synthetic Biology" had already been published in 2007. Online: http://www.etcgroup.org/content/extreme-genetic-engineering-introduction-synthetic-biology (20.07.2017).

[13] https://www.nytimes.com/2014/05/31/business/biofuel-tools-applied-to-household-soaps.html?_r=0 (5.5.2017).

[14] http://www.etcgroup.org/content/open-letter-ecover-method (5.5.2017).

[15] For a list of supporting CSOs please see: http://www.etcgroup.org/content/open-letter-ecover-method (5.5.2017).

[16] http://www.syntheticisnotnatural.com/ (5.5.2017).

[17] For a list of supporting CSOs please see: http://www.syntheticisnotnatural.com/ (5.5.2017).

[18] http://www.theecologist.org/theecologist/266662/about_us.html (5.5.2017).

[19] http://www.theecologist.org/News/news_analysis/2439594/ecover_pioneers_synthetic_biology_in_consumer_products.html (5.5.2017)

[20] http://www.theecologist.org/blogs_and_comments/Blogs/2450666/ecover_is_as_green_as_ever.html (5.5.2017)

[21] http://www.theecologist.org/blogs_and_comments/Blogs/2450666/ecover_is_as_green_as_ever.html (5.5.2017)

ingredient in their detergents on hold. Related to this process, the issue of different definitions of synthetic biology was brought up in *The Guardian* in July 2014[22]. Up until now, Ecover has not pursued the idea of marketing products based on synthetic biology processes further. [23]

Main issues of the debate

The debate of using algae oil in certain products instead of palm kernel oil raises complex issues. The following section points out different reasoning concerning synthetic biology products and especially Ecover's products. This is merely an outline of the public debate as argued by the actors of the field. It does not seek to offer final conclusion on the issue at stake. It rather is intended to give an idea about issues considered important by the respective groups.

As a starting point, it is important to acknowledge that all parties agree that it is in principle necessary to substitute palm (kernel) oil for more sustainable resources for certain products (among them detergents). Palm oil, currently used in a variety of different products, among them detergents, has been linked to deforestation because of land-use changes which again impacts carbon emissions and biodiversity. Thus, Ecover's attempt to substitute this particular ingredient is widely and positively acknowledged. Ecover's arguments in favor of substituting palm oil with algae oil were a smaller ecological footprint compared to most tropical oils: while starting off with producing algae oil from Brazilian sugarcane at first, they claimed to explore other food stock as well in order to reduce the footprint as far as possible.[24] Here, Ecover referred to the use of sugar certified by the *Bon Sucro* label - which claims to only use agricultural land for sugar production -, thus reducing deforestation by not converting new land into agricultural land.[25] Other alternatives, such as coconut oil were considered to be a competition to food, while existing agricultural practices for natural feedstocks were considered far from sustainable. This prompted the search for sustainable agricultural sources, like sustainable coconut oil, locally grown rapeseed oil, and agricultural waste streams, which were considered "just as important as finding alternative sustainable

[22] https://www.theguardian.com/science/political-science/2014/jul/08/what-syn-a-name (17.07.2017)
[23] http://www.theecologist.org/campaigning/2478572/synthetic_biology_ecover_must_come_clean.html (5.5.2017)
[24] https://www.theguardian.com/environment/2014/apr/02/ecover-algae-laundry-liquid-palm-oil (5.5.2017)
[25] http://www.theecologist.org/blogs_and_comments/Blogs/2450666/ecover_is_as_green_as_ever.html (5.5.2017).

technologies" [26]. Environmental risks were perceived as low as Ecover claimed the algae oil production to be a natural process taking place fully contained throughout the whole lifecycle (with the algae being incinerated after oil production). However, they argued "the development of a global regulatory framework" on synthetic biology. Throughout the whole debate, the question remained whether to define Ecover's practices as synthetic biology or not – which Ecover at some point claimed not to use (see below). This has impact on whether synthetic biology is perceived as something new and disruptive or rather well-known and evolving.[27]

In short, Asfeld/Stemerding (2016) identified the most prominent issues related to the debate which had evolved around the question of "[f]irstly, whether the technologies applied are revolutionary or not and what that implies for the management of possible risks. Secondly, whether algae-based oils are more sustainable than existing alternatives; and thirdly, whether engineered algae can be considered a stepping stone for more sustainable innovations." (Asveld/Stemerding 2016:16).

As announced above, Ecover's statements were fundamentally challenged by CSOs during the further course of discussion. While the **definition of synthetic biology** in general is contested and contains a lot of variables, CSOs claim that Ecover, after first having confirmed its new ingredient as produced by synthetic biology, moved then away from using this term (I02). Some CSOs describe synthetic biology as a more disruptive technology than methods of genetic engineering in use. Other stakeholders, however, describe it as being similar to the GMO debate or biotechnology already used in industrial processes. Sometimes, **regulatory instruments are said to not being tailored** to techniques used in synthetic biology, provided that synthetic biology methods are considered something new at all. In the context of regulation, the question of **risk** is of major importance, e.g. aspects such as control and safety, uncertain environmental impact of altered algae or missing ecological risk assessment protocols. It was argued that existing safety regulations as applying to GMOs might not be appropriate and should be adjusted to synthetic biology processes in particular (e.g. regarding safe containment, agreed biosafety protocols).

[26] http://www.theecologist.org/blogs_and_comments/Blogs/2450666/ecover_is_as_green_as_ever.html (5.5.2017).
[27] http://www.theecologist.org/blogs_and_comments/Blogs/2450666/ecover_is_as_green_as_ever.html (5.5.2017).

Regarding social impacts of the debate, a couple of aspects related to the **supply chain of the product**, especially with the **livelihoods of farmers** and **alternative approaches** were discussed. As the algae used for the process are heterotroph[28], they rely on energy sources. Mostly during the discussion, the resource of interest for Ecover was sugarcane food stock from Brazil. However, as CSOs argue, sugarcane production is linked to similar ecological and social problems as palm (kernel) oil (loss of biodiversity, CO_2 emissions from both land use change and burning of the bagasse, poor working conditions, driving forest destruction into the Amazon). Sugarcane grown and harvested under the label of *Bon Sucro* was said to not sufficiently address all of the environmental and social problems outlined. Coconut oil was proposed as an alternative as it was considered to have the least impact on food sovereignty (contrary to Ecover's argument above) and "cultivation generally does not require chemical inputs, and food crops are often grown in the shade of the tall trees. Growing coconut for oil therefore does not need to block off land use for food in the way that sugarcane does"[29]. According to CSOs, the **use of more traditional goods**, such as coconut oil, could support local farmers and avoid a disruption of traditional markets' by focusing on synthetic biology products. With regard to **consumer protection**, the question of **information, adequate labelling** and **corporate reputation** was discussed. Ecover, as a company with the mission to produce sustainably, has been challenged about the decision of using altered algae with regard to the question whether it would fit their 'green' label. While they have announced their decision to use algae ingredients publicly (see above), certain CSOs claimed that a transparent labelling policy (not only labelling the test batch as containing algae oil, but also inform about the synthetic biology component) would be necessary in order to ensure consumer transparency. However, in the run of the follow-up debate, especially the "Enabling the Conversation on Novel Biotech" project, a variety of other issues was identified as similarly important (see below).

Invited Participation: A Follow-up on the Public Debate

The public debate around Ecover products induced an interest in taking a closer look at possible controversies in the field. Hence, subsequent to CSO protests, mediated formats of engagement were introduced. While they rooted in the debate around synthetic algae oil

[28] Meaning they do not live on light (phototroph) but have to use some sort of energy source in order to survive. However, this means they can grow in the dark as they are not dependent on light.
[29] http://www.theecologist.org/campaigning/2478572/synthetic_biology_ecover_must_come_clean.html (5.5.2017)

and Ecover's decision to use it, the formats discussed in the following took up the discussion on two different levels: on a more concrete level, the debate became centered on Solazyme's sustainability strategy regarding their products; on a more abstract level, the discussion took on the deliberation on synthetic biology products in general.

The "Enabling the Conversation on Novel Biotech" Project

One of the activities related to the case of genetically engineered algae oil in detergents was the project "Enabling the Conversation on Novel Biotech", a joint project between Forum for the Future[30] (a CSO), Friends of the Earth England, Wales and Northern Ireland[31] and the Biotechnology and Biological Sciences Research Council (BBSRC)[32]. The project started in September 2014 and was funded by the BBSRC (£50,000) (Forum for the Future 2015). While the project was undoubtedly triggered by the public debate around Ecover the intention and decided aim of the project organizers slightly differed. Main focus of the project therefore was stimulating the debate on a more general level rather than on the level of particular industrial products. According to the organizers, "[t]he aim [of the project] was to create a resource that would help users understand the diversity (and uncertainty) of definitions of synthetic biology, the potential applications, the spectrum of concerns, various personal perspectives and the steps involved in making robust decisions about the technology" (Forum for the Future 2015:2). Thus, between September 2014 and April 2015, the working group iteratively developed a tool, including input from interviews "with a diverse range of stakeholders throughout autumn and winter 2014", an online consultation in February 2015 and a multi-stakeholder workshop in March 2015 (Forum for the Future 2015). This main result of the process was the publication of the Synthetic Biology Deliberation Aid[33]. As the description of the Deliberation Aid says, it is supposed to guide debates on "sustainability and potential applications of synthetic biology" (Deliberation Aid 2015: 5). In order to do so, the Deliberation Aid provides a variety on definitions on synthetic biology (including definitions from the UK Research Councils, the European Commission and a couple of CSOs, among them Friends of the Earth and ETC Group), a technology appraisal infographic (illustrating the "main factors […] to assess synthetic biology and its applications"), a variety of illustrative applications to discuss, and a set of personas to help explore different

[30] https://www.forumforthefuture.org/ (5.5.2017).
[31] http://www.foeeurope.org/england-wales-northern-ireland (5.5.2017).
[32] http://www.bbsrc.ac.uk/ (5.5.2017).
[33] Online: http://www.bbsrc.ac.uk/documents/1507-synthetic-biology-deliberation-aid-pdf/ (5.5.2017).

perspectives. The main factors identified for technology appraisal cover factors such as Purpose, Science, Impact, Management (Deliberation Aid 2015:12).

Main issues of raised in the Deliberation Aid

The "Enabling the Conversation on Novel Biotech" project identified a variety of additional issues as crucial which were then further explored in the workshops of the project. Questions to tackle these issues have been published in the Deliberation Aid in order to broaden the debate beyond prominent issues such as ecological risks and regulation. These issues have been systematized along different factors (purpose, science, impact and management) each comprising of different sub-factors and questions to explore them. According to the Deliberation Aid, the dimension of Purpose would thus cover factors such as Purpose of technology, Alternatives, Equality and Unintended Consequences; the factor of Science comprises Level of Change, further diversified in Species, Experimentation, and Combination; the factor Impact is related to Livelihoods, Resource Use, Reversibility, Biodiversity, Health, Containment and factor Management focuses on Openness, Transparency, Governance, Ownership, Engagement (Deliberation Aid 2015:12). In order to further explore these factors and trigger the debate, these factors are tackled by specific questions (please see Deliberation Aid 2015:24f).

Solazyme Roundtables

In contrast to the "Enabling the Conversation on Novel Biotech" project, other activities in the wake of the Ecover controversy specifically focused on the issue of genetically engineered algae oil[34]. The Roundtables initiated by the Ecover supplier Solazyme were closely linked with the debate around Ecover. Robertsbridge Group (UK) and Future500 (US) initiated stakeholder processes on behalf of Solazyme to inform to the company's sustainability policies by contributing perspectives of different actors (I02). These stakeholder roundtables were considered as independent from the Ecover company as Ecover was not involved neither in the organization nor as participants of the events. However, Ecover observed the process; especially Solazyme's conclusions as increased transparency regarding the technology processes used were considered helpful for future debates (I04). One CSO stated that they were invited to a couple of breakfast meetings organized by the Robertsbridge Group to provide comments on Solazyme's palm oil strategy.

[34] http://www.syntheticisnotnatural.com/ecover-roundtable-response-synthetic-biology/ (5.5.2017)

While the chosen framing of these dialogues differed from the intents of the "Enabling the Conversation on Novel Biotech" project certain linkages content-wise did exist (I14). Another CSO recalled having been invited in a meeting in San Francisco; however, as it was not organized by Ecover themselves, it was not considered to be of interest for them or a stakeholder meeting at all, for that matter (I02).

Thus, it appears that Solazyme's roundtables were not taken seriously by a number of CSOs for a variety of reasons: in October 2014 – in parallel to the former mentioned project 'Enabling Conversation on Novel Biotech'[35] – a number of representatives of CSOs[36] published an open letter arguing why they declined their invitation to a series of roundtables managed by Robertsbridge Group[37] and Future 500 on behalf of Solazyme, Inc. While CSOs apparently had expected a stakeholder dialogue organized by Ecover to discuss their use of Solazyme's products, they expressed their disappointment to be invited to contribute to Solazyme's own "operations and aims." [38] It was argued that this shift implied a particular framing of the debate which was seen as hardly offering space to discuss the risks and concerns CSOs had; also, it remained unclear, whether or how Solazyme at all would take them into account moving forward. CSOs then criticized the shift of organizing the debate from Ecover to Solazyme as this was considered to be Ecover's issue and this shift also would suggest that "a sustainable use of synthetic biology is at all possible at this time" [39]. Also, they pointed out that the invitation management was considered not appropriate both regarding timing (too late to attend and make travel arrangements) as well as regarding the invitees (a fairer representation of groups from impacted areas or frontline communities was required).[40]

The process was described as having had potential for being inclusive in the beginning. However, invitations were received at short notice which led to frustration concerning inclusiveness and respectfulness towards the invited parties (I03).

[35] Here, Forum for the Future was criticized as biased and "technology enthusiastic".
[36] The letter was signed by: http://www.syntheticisnotnatural.com/ecover-roundtable-response-synthetic-biology/ (5.5.2017)
[37] http://www.robertsbridgegroup.com/ (5.5.2017)
[38] http://www.syntheticisnotnatural.com/ecover-roundtable-response-synthetic-biology/ (5.5.2017)
[39] http://www.syntheticisnotnatural.com/ecover-roundtable-response-synthetic-biology/ (5.5.2017)
[40] http://www.syntheticisnotnatural.com/ecover-roundtable-response-synthetic-biology/ (5.5.2017)

The public debate around Ecover's use of Solazyme's algae oil was led by a handful of actors, mostly restricted to Ecover and several CSOs (mostly particular representatives of each CSO). Shortly, it was extended to the broader public as the petition was launched. With the change of character of the debate from the public to project-like formats (what we called "uninvited" and "invited"), the variety of actors involved broadens: additionally to the actors of the uninvited debate (industry: mostly Ecover, but also Solazyme/TerraVia and campaigning CSOs), research funding concerned with public engagement (BBSRC) and CSOs who promote engagement processes per se, as they mediate between different perspectives in the light of transition towards sustainability, got involved.

In more detail, incentives and barriers to CSOs engaging in the processes will be analyzed from different actors' perspectives. The results are based on interviews with and statements of key stakeholders in the course of events.

Incentives

Adaptability of worldview

While this covers a broad variety of aspects, with regard to the "Enabling the Conversation on Novel Biotech" project, the aspect of **extending participant's horizons and bringing in new perspectives** seems to be the most prevalent. As a precondition to enable exchange from an industry's perspective, however, **expert knowledge of stakeholders** on the respective issues is required (regardless of the format of information exchange). Regardless of the respective opinion or underlying mission (e.g. of TSOs) this was considered crucial in order to open up the dialogue and bringing in new aspects; therefore the focus of debate lies on a rational exchange of arguments.

One interviewee emphasized the importance of well-informed participants:

> "If you talk to [CSO1], they were quite well informed, they have a very specific opinion and a very extreme one but they tried to relate as much as possible on science and about real effects. I did like them as a discussion partner, they pushed us by asking the right questions, even if I don't agree with their point of view, but they are the right discussion partner. I had problems with the way [CSO2] were discussing, because they weren't using any arguments they were just having a mantra almost. That really is a lot more difficult." (I04)

Thanks to the multi-stakeholder deliberation, issues which had not been considered in depth before surfaced and helped to further the discussion (e.g. the question of livelihoods of farmers in different parts of the world and the impact of sustainably changing supply chains). The organizers point to the opportunity to assess these aspects as rolled out in the Deliberation Aid in a more systematic way than before and having a kind of procedure to follow (Forum for the Future, BBSRC). Also, while the issue at stake was synthetic biology, a certain transferability of the developed process (Deliberation Aid) to other technology areas was seen as a positive impact of the deliberation.

Trust

Regarding participant and organization structure, organizing parties of invited engagement activities pointed to the benefits of a broad range of stakeholders to attend. Hence, multi-perspective deliberation was said to create broad commitment among different actors. In order to achieve this aim, organizers refer to the importance of **independence** from governmental authorities as well as industry - both of the organization as well as the deliberation process itself - as one crucial factor. Also, **transparency** about aims and procedures of the process was mentioned as important prerequisite for such processes. Independence and transparency were considered preconditions for establishing trust in such a process by organizers and funders, as exemplified in the following:

> "[W]e pride ourselves on being a little bit more independent […] than just being able to be paid. I mean that's, it's continually a challenge […] and it's a total valid challenge, and we have to continuously […] question ourselves, keep an eye on what we are doing to make sure that […] we are not going to be influenced by that." (I01)

Another interviewee recalled their experience with a previous engagement process:

> "And being open and transparent and honest about our motivations enabled that to be a productive relationship. " (I08)

Reputation

In this context, reputation of partner organizations may support multi-stakeholder deliberation as they may serve as **'gate keeper' to the respective communities**. Thus general **trustworthiness** of the process as a whole may be enhanced:

> "I think to have any organization that is traditionally seen as […] against something [GMOs] as well as someone that is traditionally seen as for something [protection of environment] just made the project seem so much stronger because it had different

> perspectives in it. And it did mean that we could engage different types of people." (I01)

This shows in favor of involvement of CSOs known as particularly critical increasing the probability of support from the CSO community in general, or organizations rather pro synthetic biology enabling exchange with their respective network partners. As a result, the process may be opened up by getting particular stakeholder on board.

Barriers

Invited multi-stakeholder engagement – the focus of this case study – following preceding protest activities seems to hold certain challenges in order to allow for the process to be considered successful by all stakeholders. One of the predominant barriers to societal engagement here seems to refer to a **lack of shared understanding** about what such processes should look like and who should organize it, be excluded or involved at all. Issues such as framing of the process, trust in other participants, independence of the organizers, and roles of parties surface in relation to this.

Engagement procedures & Adaptability of worldview

Preceding the two cases of invited societal engagement stakes had already been made clear. One of the demands by CSOs involved in the (media) debate was the call for a stakeholder dialogue on behalf of Ecover in order to further discuss the use of altered algae in their products. However, there seem to exist a quite different understanding of how such stakeholder dialogues should look like and whether deliberation processes (such as the "Enabling the Conversation on Novel Biotech" project) or workshops to advice company's strategies (such as Solazyme's initiative to discuss their sustainability strategy) could meet these CSO's demands of a stakeholder dialogue. In their letter to Ecover, CSOs criticized the Solazyme Roundtable for wrong sponsors of the roundtable, asking wrong question in general, choosing the wrong timing with regard to invitation policy, and wrong stakeholders participating. Additionally, they criticized Ecover for engaging with "another wrong convener" and proposed a "new, transparent and open process":

> "We do appreciate Ecover's interest in proceeding responsibly on this matter and take your sincerity as a given. For that reason, we ask that Ecover return to its original commitment, and consider working with us to develop a fair and trustworthy process

> to ask whether synthetic biology can be used sustainably or responsibly at this time, and whether it should be used commercially by Ecover."[41] (Highlights by author)

Here it becomes clear that from a CSO's perspective, the undertaken efforts were not considered to be the original stakeholder dialogue which was expected from Ecover. Focusing "Enabling the Conversation on Novel Biotech", the process was defined as something going beyond the discussion on one particular application and intended to open up the debate on how to discuss and integrate different perspectives on the technology *per se.* Thus, the project aimed at contributing to a wider technology governance discourse however, the perspectives taken between industry and CSOs differ widely (see *perception of issue* below). However, from an industrial perspective, it seems that it was still hoped that the approach of the project would contribute somehow to solving the controversy nevertheless. With regard to this, it was considered crucial to allow for a non-biased conversation and an adequate procedure for deliberation by ensuring transparency and independency of the process rather than organizing one themselves.

Values System

Related to this, Ecover taking **responsibility** for its own action was a major point. Deliberation on synthetic biology in general (such as the "Enabling Conversation on New Biotech" project) did not meet this requirement. This deliberation did not appear to all CSOs as being the initially expected stakeholder involvement; although it was sometimes quite appreciated as a project on its own. Different CSOs gauged the idea of such general multi-stakeholder deliberation differently for several reasons. Nevertheless, this approach does not seem to satisfy the need for the initial demand of stakeholder deliberation to discuss whether Ecover – especially in hindsight of their 'sustainable' image - should use products deriving from synthetic biology processes at all, as illustrated by the following:

> "There was one table that was about […], [the companies] were there, and, again, [there] was a lack of information from what I heard. I think there might have been another case study too but, again, it certainly wasn't the stakeholder process." (I02)

However, with regard to the issue of transparency (as mentioned by organizers above) where it was claimed that the project was never intended as a stakeholder process to resolve the issue (and clearly communicated as such), statements like this may also show

[41] http://www.syntheticisnotnatural.com/ecover-roundtable-response-synthetic-biology/ (5.5.2017)

that **managing expectations of included parties** remains a crucial challenge in order for such processes to be considered successful by all.

Perception of an issue, research domain, or innovation

The question of framing of the debate becomes virulent on two levels: First, the question remains whether a labelling of this particular algae oil as synthetic biology is adequate at all. In the process of the debate, different perspectives on this were taken. Second, the **framing** of the organized discussions was criticized unanimously for **narrowing down the scope** - finally at least – to the question on *how* to use synthetic biology in consumer products in line with company strategies (rather than discussing *whether to use it at all*). From organizers' side it was stated that for the deliberation exercise the latter had been considered to be too high level; as a result, concrete applications of the technology were in the focus of the discussion. Industry claim that the stakeholder process was intended to define the boundaries of *where* a certain technology can be used in an ethical way as technologies were perceived as being mainly defined by context of use (rather than being "good" or "bad" per se). However, this reasoning was not shared by all participants of the debate: for some CSOs, synthetic biology was deemed criticizable altogether. From this critical point of view it was argued that the selected frame of discussion depicted synthetic biology as (necessary) part of a sustainable future – an assumption that seems not to be shared to the same extent by all involved CSOs. One critical voice said that quite clearly:

> "The question they were asking us is; in what way can we use synthetic biology that you will be comfortable with or it would be okay to use these biotech techniques that you would be comfortable with. That wasn't the discussion we wanted to have." (I02)

As a result the framing of the dialogue at stake had an impact on stakeholders' willingness to participate.

Engagement procedures

The issue of process framing is closely related to aspects of process organization. In order to establish trust between participating actors, aspects such as independence of organizers and transparency regarding aims and roles of involved parties seem to be most significant for all stakeholder groups (see above). As an indicator of openness of the process, inclusion of *all relevant* stakeholder groups is a crucial demand. However, considering themselves as main stakeholders in this debate, some CSOs expressed their critique regarding **invitation policy**

of both societal engagement activities ("Enabling Conversation on Novel Biotech" as well as the Solazyme Roundtables). CSOs considered critical voices (e.g. ecologists researching impacts of synthetic biology, environmental groups, critical CSOs etc.) and affected groups (e.g. coconut farmers) to be **underrepresented or missing** in the discussion altogether. They suspected that industry's support of the projects would impact the neutrality and balance of the deliberation processes themselves as illustrated by the following quote:

> "I think we were invited [...], but [i]t was very last minute and didn't appear to be the stakeholder meeting that […] were claiming. […] It didn't seem to be a very fair alternative voice in that." (I02)

A partly successful invitation policy to the workshops of the "Enabling the Conversation on Novel Biotech" project reinforced the impression of some to be intended as an 'industry friendly' discussion regarding framing (see above) by TSOs. While from organizer's side, the afore mentioned web-consultation (February 2015) was intended to offer any interested person the opportunity to provide feedback online, financial restrictions and access to respective groups, as well as acceptance of invitations by CSOs, limited the chance of a "truly inclusive (face-to-face) process" from the outset (e.g. making the participation of the farmers happen).

Lessons learned from this case study

The debate around Ecover in the PROSO context stands for an attempt of **transforming uninvited bottom-up engagement** (in the form of protests) **in invited engagement formats** of different kinds. Synthetic biology has been in the focus of CSO interest for almost ten years now and there have been various attempts of inviting the public and different stakeholders in debates 'upstream'. However, this case is of special interest since it is one of very few engagement activities around *marketable* applications of synthetic biology, showing the complexity of factors to take into account when implementing and scaling-up research in the real world.

Regarding stakeholder (and especially TSO) engagement, three aspects stand out in this particular case:

The first challenge of TSO involvement in the debate around Ecover points at the **variety of involved CSOs** and hence the manifold roles and perspectives taken on by them. It does not seem appropriate to talk about the role of TSOs in general, since the CSOs differ quite a lot

regarding size, organizational structures, and perspectives on issues as well as deriving different roles within these processes. They understand themselves as moderator or organizer (e.g. Forum for the Future) as well as campaigning CSOs (e.g. ETC Group, Friends of the Earth US). Hence they involve in different ways in the debate, either as enabler of deliberation or as advocates for certain issues (such as environmental responsibility, healthy and safe ingredients in consumer products). However, their roles may be linked to their taking different stances on the technology itself: from regarding synthetic biology products as a possible contribution to a sustainable lifestyle to rejecting it altogether regardless of the purpose of its use.

Additionally, CSOs may consider themselves as **representatives of various public(s)**: dependent on who they consider as their core clientele, their perspective on issues varies considerably. Whereas some CSOs focus on consumer awareness and consumer responsibility regarding the products on the market (e.g. labelling), others especially emphasize the impacts of technology on the livelihood of producers (e.g. coconut farmers). Also, the **variety of expectations** linked to these invited engagement formats seems to be crucial: Transparency concerning the role, course of the process and outcomes needs to be clarified to establish trust between different actors involved. When taking into account the wider debate, the “right time and place” for having the discussion was interpreted differently by different stakeholder groups. By some, both the meta-deliberation on synthetic biology applications and the dialogue exercise of the producer (instead of the re-user of the product) were not interpreted as serious stakeholder dialogues of the responsible party. Others, on the contrary, considered the meta-deliberation as one way of debating these issues without imposing their interests and interfering with the organization of the dialogue too much.

With regard to the organizational process **invitation policy** seems to play a critical role: from a critical perspective, timely invitations are interpreted as indicators for respectful interaction and for contributions being appreciated in the debate. However, in combination with (perceived) narrow framing, invitations on short notice confirm suspicion regarding the intention behind stakeholder deliberation.

2.3.2 Case study 2: The Synthetic Biology Leadership Council (SBLC)

Introduction

In short: What is it about?

The process of Synthetic Biology Governance in the UK gained momentum with the Synthetic Biology Dialogue initiated by the BBSRC (2010) and the Roadmap for Synthetic Biology in the UK (2012) [42]. One of the recommendations of the roadmap related to the initiation of the Synthetic Biology Leadership Council (SBLC). Both activities, the Roadmap as well as the SBLC, assign an important role to public and societal engagement and consider themselves as part of a responsible decision-making in the frame of RRI. . Therefore, the SBLC represents an expert and stakeholder council on the issue of synthetic biology which aims at putting RRI requirements into practice. In the PROSO context, the SBLC provides an excellent example for analyzing the role of TSOs with regard to RRI in synthetic biology governance.

The SBLC in some detail

The Synthetic Biology Leadership Council[43] was founded 2012 as a response to one of the recommendation of the Synthetic Biology Roadmap for the UK (2012)[44]. The Roadmap was developed by an industry-led group of stakeholders[45], building on UK government strategic initiatives including the Strategy for Life Sciences (2011) and the Industrial Strategy (2012). "The roadmap set out a clear vision for SynBio in the UK that it should be *economically vibrant, diverse and sustainable; of clear public benefit, and cutting edge*. The roadmap made five over-arching recommendations to establish a *SynBio Leadership Council*; invest in

[42] https://connect.innovateuk.org/documents/2826135/3815409/Synthetic+Biology+Roadmap+-+Report.pdf/fa8a1e8e-cbf4-4464-87ce-b3b033f04eaa (26.07.2017)
[43] https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/synbio-leadership-council (8.5.2017)
[44] https://connect.innovateuk.org/documents/2826135/3815409/Synthetic+Biology+Roadmap+-+Report.pdf/fa8a1e8e-cbf4-4464-87ce-b3b033f04eaa (8.5.2017)
[45] Membership of the UK Synthetic Biology Roadmap Coordination Group (as listed in the Roadmap) are: Chair – Lionel Clarke (Shell); Joe Adams /Peter Sutton (GlaxoSmithKline), Janet Bainbridge (UK Trade & Investment), Ewan Birney (European Bioinformatics Institute), Jane Calvert (University of Edinburgh), Amanda Collis (Biotechnology and Biological Sciences Research Council), Richard Kitney /Paul Freemont (Imperial College, London), Paul Mason (Technology Strategy Board), Kedar Pandya /Talit Ghaffar (Engineering and Physical Sciences Research Council), Nikolas Rose /Claire Marris (King's College London), Dek Woolfson (University of Bristol). Technical Secretariat: Andy Boyce (Biotechnology and Biological Sciences Research Council). Observers from UK Government: Department for Business, Innovation and Skills: Ron Egginton, David Uffindell, Government Office for Science: Michael Edbury.

a network of *multidisciplinary research centres* to establish an outstanding UK SynBio resource; create a skilled, energized and well-funded UK-wide *SynBio community*; invest to accelerate technology responsibly to market; assume a leading international role"[46]. The roadmap impacted major funding and policy activities, "including the establishment of new synthetic biology research centres, the Innovation and Knowledge Centre at SynbiCITE, DNA synthesis facilities, training centres and a seed fund for innovative companies."[47] As another result of the Roadmap, in the end of 2012, the SBLC was founded. According to the website of governmental services in the UK the "SBLC has overseen implementation of the roadmap recommendations and provided continued focus and leadership for the UK's interests in the rapidly developing field of synthetic biology. The SBLC is working with industry, relevant academic disciplines (including engineering, biology, chemistry, physics, mathematics, the social sciences and ICT), regulators, non-government organizations (as part of TSOs), and other government departments to strategically oversee the development of a successful SynBio industry sector in the UK."[48]. In 2016, the SBLC published a new strategic plan for synthetic biology in the UK focusing on commercialization of synthetic biology products in particular: "[t]his strategic plan […]aims to accelerate the commercialization of synthetic biology products and services with clear public benefit, building upon the strength of the UK research base. It focuses on five key areas of strategic importance, [namely] accelerating industrialization and commercialization; maximizing the capability of the innovation pipeline; building an expert workforce; developing a supportive business environment, and building value from national and international partnerships."[49]

The SBLC is jointly chaired by a minister and a representative from industry or academia (actual situation: minister to be confirmed, representative from industry). There are neither formal periods nor a pre-set termination date. The independent council consists of a variety of actors[50], including executive non-departmental public body[51], industry, government

[46] https://www.gov.uk/government/groups/synthetic-biology-leadership-council (25.05.2017)
[47] https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/2016-uk-synbio-strategic-plan (25.5.2017)
[48] https://www.gov.uk/government/groups/synthetic-biology-leadership-council (8.5.2017)
[49] https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/2016-uk-synbio-strategic-plan (25.5.2017)
[50] https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/sblc-members (8.5.2017)
[51] Executive non-departmental public bodies: "These have varying degrees of independence but are directly accountable to ministers. There are 4 types of non-departmental public bodies (NDPBs). Executive NDPBs do work for the government in specific areas - for example, the Environment Agency." From: https://www.gov.uk/government/how-government-works (8.5.2017)

departments, research funding, natural and social scientists and a national charity. It is self-financed and independent from government; secretariat is provided through Innovate UK[52] by the Synthetic Biology Special Interest Group.

The SBLC Subgroup Governance

In order to extend the focus, the subgroups can be convened by the SBLC. They are intended as a mechanism to involve a wider expertise on particular issues. So far, a couple of subgroups with different emphasis have been established (e.g. the subgroup on science & technology[53]).The most visible subgroup up to now is the SBLC Subgroup Governance which was founded in 2013. Its task is to more intensively reflect on governance related questions: "[t]he Governance Subgroup of the Synthetic Biology Leadership Council (SBLC) will provide support and advice to the SBLC and encourage an open, adaptive and consultative approach to Governance within the UK's synthetic biology innovation ecosystem."[54] The SBLC Governance Subgroup also includes actors from sciences, social sciences, a national charity, think tanks, industry and industry associations, research funding, government departments, a law firm and an executive non-departmental public body[55]. Members of both the SBLC and the SBLC Subgroup Governance are invited members; some members are part of both the SBLC and the SBLC Subgroup Governance. Both councils meet three times a year; the minutes of the meetings are published online[56].

The debate in the SBLC Governance Subgroup focuses on a variety of topics, among them understanding and discussing regulations and initiatives regarding synthetic biology (e.g. EU directives, Convention on Biological Diversity, Nagoya Protocol etc.); the concept of RRI which represents an important reference of the SBLC Subgroup's Governance strategy; and the reflection of the SBLC and Subgroup's role in relation to the question of public engagement.

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[52] Innovate UK is the UK's innovation agency. It is an executive non-departmental public body, sponsored by the Department for Business, Energy & Industrial Strategy. https://www.gov.uk/government/organisations/innovate-uk/about (25.5.2017)

[53] For more information, please see: Meeting Minutes of the SBLC, meeting no. 13 on 10th March 2016. Online: https://connect.innovateuk.org/documents/2826135/3815406/SBLC13+Minutes+FINAL.pdf/b7a788b7-e7f9-4b42-b8e8-f125f07a3939 (29.05.2017).

[54] https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/Governance-sub-group (8.5.52017)

[55] https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/Governance-sub-group (8.5.2017)

[56] https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/what-are-the-aims-of-sblc- (8.5.2017)

Extending the focus of the SBLC and the Subgroup Governance

With regard to the work of the SBLC and especially the SBLC Subgroup Governance, potentially critical voices from CSOs are acknowledged, yet hardly involved constantly and consistently. Rather than involving a variety of CSOs, individuals and organizations who serve as representatives of CSO or public perspectives are included (I11). Member invitations to the SBLC and the Subgroup are restricted with regard to the manageability and efficiency of the governance process. Even from a critical perspective, these mechanisms were considered sufficient in general; however, attempts to include different perspectives in processes of strategy development were considered crucial.

In order to extend the expertise of the SBLC and to include societal voices not represented in the committee, different strategies and mechanisms have been established: First, the Subgroup Governance (and other subgroups) can be understood as an instrument of informing the debate in the SBLC on certain (governance) questions. Second, it was decided from the outset of the SBLC to have at least one public meeting a year.[57] In these meetings "registered observers" (among them representatives of different CSOs) have the opportunity to engage in discussions[58]. Usually there are about 30 to 40 people attending the open meetings apart from the members of the SBLC itself. The format of the open meeting is usually a sequence of presentations on the work of the SBLC (including the Subgroups) with following Q&A sessions; however, to discuss certain issues in depth, break out groups have been organized in one meeting as well[59]. Third, the SBLC uses the online-platform of the Special Interest Group Synthetic Biology[60] for collecting feedback on specific issues (e.g. for commenting on the update of the roadmap).

[57] https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/what-are-the-aims-of-sblc- (8.5.2017)

[58] These registered observers are listed in the meeting minutes. These can be obtained on the website of the SBLC and Subgroup Governance: https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/what-are-the-aims-of-sblc- and https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/governance-sub-group (both 30.5.2017)..

[59] For more details on open meetings see minutes of SBLC meeting no 4, 7, 10 and no 15. Online: https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/sblc-members (30.5.2017).

[60] The Special Interest Group is a platform where people interested in information and events on synthetic biology can register for free. The Special Interest Group provides information and update on meetings and conferences. According to insiders, the platform has about 800 to 1000 members with different levels of activities. Online: https://connect.innovateuk.org/web/synthetic-biology-special-interest-group/about-us (22.5.2017)

With regard to TSO engagement within the SBLC and especially the SBLC Governance Subgroup (the main focus of the interviews), the following analysis aims at revealing incentives and barriers for CSOs from different perspectives. The analysis is based on interviews with key stakeholders in both groups as well as close observers of the synthetic biology landscape in general in the UK. As expected, the identified barriers to societal engagement vary among our interviewees depending on their institutional affiliation, their professional background, experience and worldviews.

Incentives

Adaptability of worldview

While this covers a broad variety of aspects, with regard to the SBLC Subgroup Governance the aspect of being kept up-to-date regarding debates on synthetic biology seems to be most prevalent. Both, the **individual and collective learning effect** as well as the opportunity to **broaden one's perspective** were brought forward by all interviewed stakeholder groups equally. This effect seems to be linked to the frequency of the meetings. For most actors involved, the SBLC Subgroup was considered an opportunity to stay informed of actual policy debates and to broaden one's horizon; with regard to this, information inputs from various stakeholder groups were appreciated:

> "It keeps me abreast as well. You have to read the papers, and you are involved, and partly, for me, I am learning all the time and I consider it to be a learning experience. Learning about people, learning about SynBio, learning, learning, learning." (I05)

Barriers

Perception of an issue, research domain, or innovation

From a critical perspective, the orientation of the SBLC - from the outset - maintains a **framing of fostering innovation and commercialization** of synthetic biology in the UK. This initially derives from the UK Roadmap, but continues in the *Biodesign for Bioeconomy* document. Hence, alternative framings may be underrepresented as they are difficult to integrate in an economically directed strategy. Examples of such framings would be different perspectives on business-society-relationships, different models of agriculture, different priority settings or a thinking more oriented towards finding solutions to societal problems in general including, but not restricted to technical possibilities. Some interviewees argued that there was a tendency to narrow down debates (e.g. aspects of RRI) to politically easily

manageable issues focusing on well-established aspects of risk and safety or regulatory issues. Against this backdrop, the fundamental question of whether a particular technology development is legitimate cannot be addressed:

> "There's a sort of implicit or sometimes explicit sense that when it comes down to choices, and people making choices about applications for technology, then the best or the only way to do that is through the market. […] As a sort of secondary view that regulation […] should solely be concerned with questions of […] health and safety, however defined. And that means that all the wider questions about what the technology is for and what sort of problems people would like to address, don't get talked about at an early stage." (I06)

To sum it up, a stakeholder relates this to the concept of RRI:

> "I think it's much harder to engage in an up-stream open dialogue than it is to do more […] constrained and […] measurable things, so I think the way that [RRI has] been interpreted […] has been much more in terms of risk and safety in regulation. But I think it's partially because of the difficulties of actually operationalizing RRI." (I07)

Engagement procedures

Related with the question of *perception of an issue* and *framing* is the question of the **composition** of the SBLC and Subgroup Governance, especially regarding the **inclusion of TSOs and public opinions**. The SBLC has been criticized for its narrow set-up in terms of included stakeholders. However, a certain ambiguity remains since the SBLC was described as to be one of the few - if not the only Leadership Council - where actors such as social scientists (focusing on wider societal issues related to synthetic biology) are involved at all (I07). Nevertheless, it was stated that an extension of the core group in an alternative direction would change the SBLC's whole nature. Accordingly, it was stated that for a wider societal voice it is difficult to be heard in such committees:

> "If you take the leadership council as one example, or you take even a research council, […] the membership of those bodies are primarily either academics, scientists that have an interest in getting the funds through, or they are private sector business people who obviously have an interest in sort of applying the science and exploiting that science for economic and other ends, and the wider societal voice is not heard around the decision making table. It is only accessed through managed activities like public dialogues." (I06)

Role of key players/change-makers

Advocacy of specific issues seems to a great part rely on the activity of individuals which may be reinforced by the restricted number of members of the SBLC and the Subgroup Governance. While the Subgroup Governance puts emphasis on questions of governance,

therefore giving them more space within the SBLC as a whole, the **exchange between these two groups** (and hence bringing in important points to the SBLC) **was described as mostly depending on key individuals.** In this regard, the lack of wider public engagement in the context of the SBLC has been explained with the lack of respective advocates:

> "But there's nobody from within the community standing up and saying I really think we should do this [Public Engagement] now. [T]here doesn't seem to be a real desire or intention to do it in any sort of a systematic way at the moment. [However,] [t]hat could change." (I06) (highlights added)

Lessons learned from this case study

The SBLC and the Subgroup Governance represent independent expert and stakeholder councils which provide input and information that can be taken up for policy-making on synthetic biology. It is not part of the governmental service system, hence not authorized to give concrete instructions. Nevertheless, the publications related to the SBLC ("A Synthetic Biology Roadmap for the UK" 2012, "Biodesign for Bioeconomy" 2016) have gained considerable attention within the policy realm.

The lessons learnt from this case are twofold. First, it becomes clear, that the council has a specific political set up with a quite clear agenda. It is a point of coordination which "oversees the continual development and delivery of the vision and roadmap" (Roadmap 2012: 33)[61]. The clear work description of this recommendation of the Roadmap **predefines the framing of debates, thus restricting the scope** for alternative framings that do not correspond with aspects of the mainstream agenda. The concept of RRI serves as a backdrop of the council in general and is being debated as a frame of reference within the SBLC (and the Subgroup). Therefore, the requirement of societal engagement and societal responsiveness - as laid out by RRI - is interpreted as being met by setting up a multi-stakeholder deliberation. However, the agenda and composition of both groups impact the way of how the debate on synthetic biology develops.

[61] In more detail: "The leadership council should act as a focal point for the development of the synthetic biology sector in the UK, bringing together key interested stakeholders representing a wide diversity of interests, including: industrialists; leading academics; regulators; social scientists; the research councils; Technology Strategy Board; learned societies; CSOs; other stakeholders; and relevant government departments" (Recommendation 5.1 in the UK Roadmap 2012:33, highlights added).

Second, related to the political agenda, the opportunity for breaking the frame on the issue of synthetic biology is balanced against the operationalizability of the council. Critical voices towards a purely innovation and growth-oriented agenda or strongly in favor of fostering laypeople engagement seem to have well-defined - and sometimes described as **restricted - opportunity for their suggestions to be taken up** (e.g. public meetings). In this context, the opportunity for different actor groups feeding into discussions (e.g. for updating the roadmap by publishing the "Biodesign for the Bioeconomy" document) could be further increased by more and earlier (with respect to **time frames**) opportunities to **provide input** for revision in order to demonstrate serious attempt to integrate a broader variety of issues.

2.3.3 Case study 3: SYNENERGENE

Introduction

In short: What is it about?

SYNENERGENE, a project funded under FP7 by the EU (2013-2017), serves as an example for societal engagement organized by participation experts and explicitly connected to the requirements of RRI. This project was set up by scholars with the aim to invite stakeholders and "the public" to engage with synthetic biology for a limited period of time. The project's focus lay on enabling deliberation by applying new and innovative (or even experimental) forms of participation; hence, concrete political-decision making processes are not in the main focus.

SYNENERGENE in some detail

SYNENERGENE[62] completed in June 2017 was a four-year project and funded as part of the European Commission's Mobilization and Mutual Learning Action Plan (MMLAP) under the 7th Framework Programme (amount of funding: 3.960 Mio. €). The project aimed at contributing to RRI in the field of synthetic biology by initiating societal engagement and sustainable exchange between science and various other societal actors such as industry or civil society. It was dedicated to develop methods and measures to initiate and foster societal engagement with synthetic biology on different levels. By drawing from a wider range of perspectives, the project aimed at adding on to existing pools of knowledge that help shape technologies responsibly.

[62] https://www.synenergene.eu/ (7.5.2017)

To do so, the SYNENERGENE consortium organized a diversity of events which varied widely in formats, target groups, attendance and duration (e.g. contests, exhibitions, public dialogue events, citizen conferences) (Bauer/Bogner/Torgersen 2016; for an oversight on different events please see[63]). In order to enable long-term exchange between different stakeholders, SYNENERGENE provided a variety of structures for exchange between stakeholders: four thematic platforms (on the issues of SynBio Futures, Public Science & Participation, Art, Culture & Society, Research & Policy), two cross-cutting core dimensions (International Dimension, Online Communication), and several open fora (for Business, Science, Civil Societies, Policy, Media).[64]

SYNENERGENE provided the opportunity for CSOs not only to be part of single events (as contributor or moderator), but to be involved in long-term processes and the set-up of the project from the very beginning. Several CSOs, as part of the consortium, co-shaped the agenda of the project and performed as organizers of events and other activities as well as participated in single events. Here, it is important to keep in mind that SYNENERGENE events addressed a broad variety of target audiences, ranging from "the public" to particular stakeholder groups deliberating on specific issues or applications of synthetic biology. In this report, we will not provide an in-depth analysis of the various *single events* carried out in the context of SYNENERGENE. Due to the mere numbers of participatory events this is not feasible. With regard to PROSO, it is especially the involvement of CSOs in a consortium that is of interest, thus our case study focuses on interactions within the consortium. SYNENERGENE's project consortium consisted of 27 partners in 16 countries[65] from science, technology assessment, art, science communication and CSOs.

However, certain activities were mentioned to be helpful to the CSO community even when not involved in SYNENERGENE directly: especially the Civil Society Forum and the webpage SynBioWatch[66] (see below). The flexible structure of the project allowed for adapting to changing (political or societal) needs for deliberation throughout the process. Thus, in addition to "traditional" CSOs, further groups of the public became involved in the project by participating in as well as organizing of some events: 'Do-it-yourself' (DIY) biologists and the

[63] https://www.synenergene.eu/events (7.5.2017)
[64] https://www.synenergene.eu/information/project-organisation (7.5.2017)
[65] For project partners please see: https://www.synenergene.eu/whos-involved/partner (7.5.2017)
[66] http://www.synbiowatch.org (24.5.2017)

biohacker movement representing an alternative approach to science and scientific research. Because of their non-institutionalized research cultures, issues of societal benefits (e.g. contributions to the solution of societal challenges) or risks (e.g. biosafety) are approached differently.

Main issues of the debate in the project

As the project was funded under the header of RRI, the concept served as an explicit point of reference underlying all activities striving for developing a responsible handling of the question whether and how society should approach synthetic biology via multi-stakeholder deliberation. Hence, the issues regarding synthetic biology within the SYNENERGENE project were manifold and depended on identified needs for deliberation. In general, the events addressed hopes and concerns regarding synthetic biology as a technology; also, subtopics or particular aspects of synthetic biology such as questions of risk, safety, ethics, legal, and social consequences were deliberated on. Within the whole range of subjects, also the concept of bioeconomy and its relation to synthetic biology from the perspective of different stakeholder groups or the public was discussed.

Incentives

Values System: Flexibility & Reflexivity

With regard to the incentives for the engagement with the SYNENERGENE project, the project partners explicitly mentioned the benefit of flexible structures of the project. All interview partners commendatory emphasized the opportunity to set their own agendas and to design processes according to the consortium partner's needs. This gave CSOs and other actors the opportunity to bring their issues to the table and to reframe the issue of synthetic biology according to their own interests and concerns where necessary. The flexibility of the project structure, in other words, helped to avoid a narrow, pre-defined framing. This was described by one interviewee:

> "I think we had the expectation that this whole thing remained flexible…to have the opportunity to adapt to changing conditions, e.g.to a new scientific break-through, or to react to actions of relevant institutions outside the project context. […] [The project now contains] a huge number of so-called extra activities which were not planned this way." (I09) (Translated by authors)

Access to networks

When asked about benefits of involvement, the opportunity of **obtaining access to networks** of relevant actors in the field seemed important for all actor groups, as illustrated by the following:

> "[It is important to] be aware of what is happening in Vienna with […] the bio fiction festival, to discuss with those people, […] to discuss with people from Spain, to have connections with the Rathenau Institute and to also have connection with people from California because when I was there last April, I had a very interesting discussion with someone from Synberc and I made the connection with [person1], because [this man from Synberc], he was interested in […] SYNENERGENE." (I10)

As a result of gaining access, the opportunity of getting input for further **stimulating the respective national debates** was crucial. Especially CSOs who considered themselves as initiators and mediators of the debate on emerging technologies in general benefitted from having (intellectual) support, as illustrated in the following:

> "[SYNENERGENE] was a good occasion for us to have the support in the European area. In [my country] it is really so difficult … […] so, the example of what is done outside could be encouragement for our own country." (I10)

Anticipated Outcomes

Different CSOs valued the opportunity to use different engagement strategies with their respective community in order to enhance awareness concerning synthetic biology issues. Two formats have been pointed out by various stakeholder groups: interview partners from CSO contexts (even when not participating in the SYNENERGENE consortium) referred to the online-platform **SynBioWatch**[67] maintained by the Civil Society Forum of SYNENERGENE. Content is provided by various organizations aiming at giving voice to "Civil Society Perspectives on Synthetic Biology":

> "The [other] thing we're doing is about helping to gather together and give voice to civil society views and opinions on this website called SynBioWatch which acts as a portal for civil society use and we've been running webinars and that kind of thing." (I02)

The platform especially focuses on the themes of Environmental Impacts, Economic Impacts, Health & Safety, Human Genetics, Corporate Wheeling & Dealing, and Regulation & Oversight.

[67] http://www.synbiowatch.org (24.5.2017)

> From a science and research perspective, the **collaboration with the iGEM competition**[68] was regularly referred to as one of the most valuable attempts to integrate ideas about responsibility – via aspects such as safety, sustainable applications etc. right from the outset into research on synthetic biology.

Organisational practices & Resources

In general, actors' involvement depends on **available resources.** However, a certain **correspondence between project agenda and the inherent mission** of stakeholder groups seems to facilitate involvement. Engagement in participation projects such as SYNENERGENE is most beneficial for groups who are able to establish a direct link between particular activities of SYNENERGENE (e.g. public engagement) and their specific mission, i.e. their organizational task or calling, as illustrated by the following quote:

> "I think in general that advantages of the given structure of SYNENERGENE - and probably of EU funded [deliberation] projects in general - lie with organizations which see their very purpose in this kind of stakeholder and public dialogue. They will achieve success way easier than other [stakeholders]." (I09) (Translated by author)

Wherever SYNENERGENE activities were considered to be of extra effort (although of added value), the allocation of resources (e.g. in terms of time invested) turned out to become much more difficult. Hence, some actor groups (namely CSOs) were said to be more successful in using resources of the project according to their mission. In contrast, public engagement was rather considered of additional effort for other actors, e.g. representatives of industry, although they also appreciate interaction with the public. However, this seems to be usually done via other formats and to other ends than by general deliberation as an end to itself.

Barriers

Resources

Closely linked to organizational practices, a **lack of resources** was considered a restraining factor of engagement activities in general, both for organized TSOs as well as individual researchers of the DIY movement, as "[o]ne reason is the practicalities, in terms of capacity, time, etc." (I13)

While, from the DIY perspective, monetary restrictions were considered to limit research activities, some CSOs referred to a lack of time for the issue of synthetic biology in general.

[68] http://igem.org (24.5.2017)

This is because synthetic biology (compared to other issues) was not considered to be of virulent importance for their addressees (the public) yet (I14).

For the specific case of DIY biology, **institutional structures of science** and corresponding recognition policies were considered to result in according shortages of resources for research projects: since DIY biology takes place mostly outside recognized scientific organizations, common sources of funding are hardly available. Hence, participating in events of projects like SYNENERGENE may be an investment in terms of time; however, it may also enable access to networks relevant for future individual projects (I15).

Resistance to changing worldview about topic or new ways of working

While the aim of SYNENERGENE was to provide an open frame for debate, **integration** of different world views still remains difficult. Different framings do not only apply to synthetic biology itself, but relate to a variety of issues addressing broader questions of how society should be organized with regard to new technologies and innovation. These include, among others, the purpose and usefulness of concepts such as RRI in relation to dynamics of commercialization of synthetic biology and the question of whether synthetic biology can be interpreted as meaningful contribution to a sustainable lifestyle at all. This is illustrated by a comment of one of our interviewees:

> "[There] is a clash between different world views where people look at these innovations and the promises of synthetic biology. […] If you look at what we […] have been doing in the SYNENERGENE project, it's all about anticipation, about reflection, [or] attempts at inclusion (although these attempts are still quite limited), but the most important issue is the issue of responsiveness. […] [T]o what extent are we able, by these activities of anticipation, reflection and inclusion, to make a difference in the way that innovations will develop in the future? And to what extent are we able to make a difference in the global market forces that are also part of the game? This is something that makes it understandable from [some] CSOs' point of view: their position, why they are so sceptical about the aims of responsible research and innovation." (I13)

While projects like SYNENERGENE put up such issues for discussion, the expectation of resolving "clashes of worldviews" may be regarded as too high. Nevertheless deliberation projects may contribute to further clarify these worldviews.

Lessons learned from this case study

SYNENERGENE was a project explicitly dedicated to promote the RRI agenda by inviting different actors to actively engage with synthetic biology at an early stage in the innovation process ('upstream engagement'). The project aimed at involving stakeholders such as CSOs and industry not only in the form of participants of single events, but rather at engaging with these actor groups from the outset providing for (relatively) long-term engagement. Two lessons can be drawn from the analysis:

First, deliberation projects like SYNENERGENE provide a necessary openness of a debate to allow for a wider framing of synthetic biology crucial for this kind of multi-stakeholder involvement. Vice versa, inviting a broad variety of stakeholders ensures a deliberation on various aspects of synthetic biology without sticking to one particular frame of debate too much. Flexibility of project structures (e.g. in terms of formats, addressees and issues) supports this attempt. However, whether the project lives up to this idea of openness lay within the responsibility of the event organizers themselves. Due to its **openness,** network building is accomplished, enabling a formal as well as informal exchange of different perspectives on synthetic biology.

Second, taking into account **different needs and expectations** of stakeholder groups is crucial as illustrated by the activities of the different SYNENERGENE Open Fora. While the Civil Society Forum or the Media Forum seem to serve the inherent need of public communication of their addressees (e.g. CSOs or journalists/science communicators), other formats of exchange seem to be more suitable for other actor groups. Formats such as the Business Forum seem not to have gained momentum as expected, although there was certain interest in the issues discussed (e.g. bioeconomy). When looking for appropriate engagement formats regarding synthetic biology, these different interests take off. Therefore, the challenge of such deliberation projects lies within the suitability of issues as well as finding modes of exchange which serve different interests in equal shares.

2.3.4 Domain Synthesis

- In general, the question of *perception of issue* and of *framing* the debate poses a major challenge to engagement between societal actors on various levels. In all the

activities described here, the way the debate was framed influenced the willingness of TSOs and CSOs to engage with other societal actors.

- Especially in the debate around Ecover products, the discussion on concrete synthetic biology applications was criticized as it was discussed *how to use them*, rather than discuss *whether to use them at all*.

- Similarly to the Ecover case study, in the case study of the SBLC the way in which the council had been set up and issues were debated was criticized as contributing to a general commercialization agenda and therefore to restrict the opportunity of critical CSOs to make their arguments heard.

- However, as such *resistance to change worldview* takes place, these pre-set ways of thinking are difficult to change and the integration of different framings poses a major challenge to engagement since these ways are rooted in different understandings of the technical issues, priority setting and values.

- The *lack of resources* for CSOs for issues that were perceived as 'not so pressing' (e.g. synthetic biology) was a regularly mentioned topic throughout all cases: Regarding a lack of resources, especially small TSOs have to calculate well where to engage in order to live up to their mission. Therefore, for campaigning CSOs, the issue of synthetic biology seemed too far away to (already) invest in stimulating the debate as other issues, e.g. regarding the environment, seemed more pressing.

- For engagement, a c*orrespondence between the (process) agenda and the inherent mission* of the TSO facilitates the allocation of resources as TSOs usually are not able to cover all issues on their agenda equally well. Thus, priority setting in relation to resources poses a challenge to inherent engagement, especially in the (sometimes perceived as futuristic) field of synthetic biology.

- In order to avoid perceptions of dialogues as being tokenized or engagement activities as being simple 'tick-box' exercises, *organizational challenges* of processes have to be taken into account.

- Issues such as invitation policy and feedback mechanisms were mentioned regularly by TSO members as indicators of a sincere and genuine dialogue. Issues such as timely invitations to events, giving time and providing mechanisms for feedback in actions and taking up input as one perspective in discussions were mentioned as being crucial in order to show interest.

3. Input for the WP5 Conference: Challenges and Solutions

We used the themes developed through the analysis procedure (described in Section One) as a way to consider the central challenges to engaging with TSOs and FSOs. Table 4 lists the "top five" challenges, as they emerged by research domain. They are not listed from the most to least significant challenge, but to show the similarities and differences by domain. We have also specified whether a particular sub-code was dominant within this theme.

Table 4: Central Challenges by Research Domain

Food & Health	**Nanotechnology**	**Synthetic Biology**
Research Infrastructure (innovation processes & lack of resources)	Research Infrastructure (lack of resources)	Research Infrastructure (lack of resources)
Perception of Others (perceived fixed categorisations of stakeholder groups)	Perception of Others (perceived fixed categorisations of stakeholder groups)	Perception of Others (perceived fixed categorisations of stakeholder groups)
Worldview	Anticipated Outcomes	Worldview
Organisational Culture	Perception of Topic	Organisational Culture
Momentum for Change	Values System	Values System

We briefly discuss the five challenges that were cited most frequently across all three research domains, and provide policy and practice options (PPOs) which could act as possible solutions to these challenges. The viability of these options will be discussed as part of the WP5 conference in June 2017.

3.1.1 Challenge One: Research Infrastructure

There is a lack of resources to enable researchers to engage with TSOs and other stakeholder groups, and a lack of resources for TSOs to engage with researchers.

A lack of money and time were cited as key reasons why engagement did not happen across all cases and research domains.

Policy and Practice Options:

1. **Require funding agencies to stipulate that a condition of funding is for part of the budget to be used for stakeholder engagement.** The host institution would be required to present outcomes of all funded projects to wider society, which places emphasis on core resources rather than on individual scientists (who may not be interested in engagement).

2. **Treat social and technological innovations as equally important.** Clear evaluation criteria should be set for both types of innovation, including regular reporting about the resources allocated to each.

3. **Mandate that research funding agencies must transparently and openly engage with societal actors.** This can be done through the development of an "Independent Commissioning of Research Board" involving all major stakeholders, whose members are routinely rotated. Engagement would happen using transparent mechanisms to select and recruit such organisations to participate in research.

3.1.2 Challenge Two: Perception of Others

Both researchers and TSOs hold preconceived ideas about particular stakeholder groups that make them reluctant to engage with those groups.

The stereotypes held by researchers and TSOs often make researchers reluctant to engage with TSOs, and can make TSOs hesitant to engage with researchers or industry stakeholders.

Policy and Practice Options:

1. **Provide opportunities to build understanding and trust across different sectors.** Opportunities such as secondments, exchanges between organisations, training TSOs

about research goals and language, and team-building activities within organisations (not necessarily on the controversial topic) enable collaboration with the aim of softening pre-conceptions of others and enhancing the culture of engagement.

2. **Support the development of cross-sector groups and communities that have a common vision and purpose.** Establishing multiple communities with common interests and values that cut across sectors can ensure that such communities have equal access to decision-making powers.

3. **Move away from the paradigm of "consensus building" by respecting the roles and positions of different interest groups like TSOs.** It needs to be acknowledged that some TSOs, particularly those concerned with a single issue, will not change their position on a topic. Rather than spending large amounts of time trying to reach consensus, those driving the engagement could transparently and respectfully acknowledge the different perspectives present and then move forward with the engagement.

3.1.3 Challenge Three: Anticipated Outcomes and Worldview

Different and often conflicting worldviews held by TSOs and other stakeholders can lead to incompatible ideas about possible solutions to societal challenges.

Worldviews about the role of innovation in solving problems may vary. Worldviews also differ in regard to whether responsibility lies with individuals, organisations, or broader society. These perspectives, in turn, influence which innovations are prioritised and implemented.

Policy and Practice Options:

1. **Increase transparency about the engagement process and its outcomes by reaching advance agreements about decision-making procedures and rules of engagement.** Provide clarity regarding the purpose of the engagement and how outcomes will be used in future policy/funding decisions. What are its objectives, how will it be

measured a success, who will be involved, and how will decisions be made? What happens after the project? How will results be acted upon for the benefit of wider society? As part of this, it is crucial to emphasise that not all participant perspectives will be taken on board; engagement is usually done to provide advice to researchers and research funders, and it is up to their discretion about which perspectives they incorporate into either process.

2. **Develop better ways to measure the impact of funded research on society, as well as in academia and industry.** Scientific impact is an important indicator of the value of science, but societal engagement should also be a vehicle to contribute to, and better understand, the full impact of innovation as well. Suggested criteria to measure impact would be openly discussed and shared with the participants of societal engagement, including TSOs.

3. **Develop a mandate within existing funding programmes to explore and acknowledge non-technological options to address societal challenges.** This recognises that science and technology are not always the only means to address a given issue. There should be consideration of non-technological options in research funding proposals, or a justification for why these non-technological options have not been included (i.e., they have already been explored through wider stakeholder engagement).

3.1.4 Challenge Four: Organisational Culture

The organisational cultures of TSOs, research funders, and research institutions can limit which projects they want to become involved in, and how they want to engage with others or be engaged with.

The organisational culture can act to confine the organisation to a narrow range of issues. This 'culture' can include resource constraints, such as time or budget, or pressure from shareholders to focus only on certain topics and debates. Different departments within an organisation can also have conflicting, yet well-established, relationships with each other that can act as a barrier. For instance, research funders are known for operating within the

narrow confines of their organisational culture. This culture is the result of historical trends and economic realities and it is not conducive to open debate that may shift the traditional roles/domains of operation.

Policy and Practice Options:

1. **Enrol 'key individuals' who are already carrying out societal engagement and working interdisciplinarily in government-sponsored programmes that are designed to help promote a culture of sharing and engagement within organisations.** Partnering with other key individuals would help them to create intra-organisational momentum for change together, and break down preconceived ideas about working outside of one's discipline. As part of this process, organisations also have an obligation to re-think their structures and the way they evaluate the success of projects and people.

2. **Develop external "ethics oversight" advisory bodies at all research funding levels that include philosophers and ethicists.** These advisory bodies, like the EU-level "European Group on Ethics in Science and New Technologies", will regularly oversee and advise research funders about setting funding agendas. They will enable societal concerns to be embedded within the research process and research funding.

3. **Provide grants that TSOs can apply for to fund engagement activities with research.** Access to grants would give "key individuals" the resources to engage and change organisational cultures, going beyond the resources provided within the organisation itself.

3.1.5 Challenge Five: Values System

The values system that drives innovation processes is overwhelmingly focused on economics and wealth creation.

Innovation processes currently favour individual success and the free market, rather than societal good or responsibility. These processes require expansion and a systemic shift to

include other values, such as flexibility, inclusion, fairness, empathy, altruism, trust, reflexivity, and transparency.

Policy and Practice Options:

1. **Research funders, including TSOs (e.g., Bill & Melinda Gates Foundation) and industry, need to lead by example and develop a system to ensure transparent research programming and agenda-setting.** Examples of this include: regularly maintaining a database of relevant Third Sector Organisations; developing portals or crowd-sourcing mechanisms to obtain societal views and opinions on issues of concern to the various stakeholders (within specific domains), which could shape research and innovation; developing a decision-making tree that specifies the criteria for the selection of the core issues and allocation of funding.

2. **Make ethics and philosophy an integral part of science education across education levels.** Consistently framing science within ethics and philosophy will help to develop a generation of European citizens who are not only science-literate, but confident about contributing to the debate about the long term ethical consequences of innovation.

3. **Re-align the science and innovation policy agenda away from economics and towards a societal agenda.** This will enable science to be seen not only as a “vehicle for economic growth”, but also as a “vehicle for public good”.

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5. Appendices

5.1 Appendix 1: Sub-codes and definitions emerging from the interview data

Sub-Codes for Barriers & Incentives	Sub-Code Definitions
Anticipated outcomes (barrier or incentive)	i.e., development of a new software tool (in my case: Deliberation Aid); information exchange; greater openness; gaining new perspectives through inter/transdisciplinarity; no time for dissemination; expected output not possible to implement for certain target groups
Resistance to changing worldview on the topic or new ways of working (barrier)	Not able to change how an individual or organisation understands or frames an issue; trying to work with others whose practice hasn't caught up with new theoretical frameworks; commercialization or funding agenda excludes critical voices; unable to reach compromise on ideas when different SH have a set agenda
Resistance to changing worldview about engagement (barrier)	Entrenched ways of working; not convinced of the benefits of collaborating with others, including publics; difficult for TSOs to campaign, therefore not their priority; RRI principles do (not) give a lot of guidance to doing engagement; engagement process perceived to be biased etc.
Adaptability of worldview (incentive)	Willingness to take on new ideas and ways of working; being able to raise awareness about an issue
Conflict between stakeholders (barrier)	i.e., debate within cellular ag science about whether to genetically modify cells, affects whether environmental TSOs want to engage; TSOs 'hijack' research topic
Accessible communication (barrier or incentive)	Ability to communicate accessibly for all audiences
Institutional Practices (barrier or incentive)	i.e., business as usual; habit that it is unusual to involve TSOs in certain committees; priority-setting within organisations; organisational mission limits opportunities to do things differently; institutions are being internally reorganised; missing incentives to engage/participate in engagement; RRI reduced to tick-boxing; TSOs only allocated a subsidiary role in industry-focused projects; TSOs gain more from engagement with EU projects and feel frustrated by national-level projects
Permitted discourse (barrier or incentive)	i.e., academics not feeling like they have the ability to ask certain questions or engage in certain ways, so bring artists on board to take on those tasks; enabling informative debate; free space for ideas without too many limits; space for open, cross-organisation discussions
Academic culture (barrier or incentive)	i.e. the ways funding and evaluation policy impacts how academics work, what they publish

Timelines (barrier)	i.e., academics work to slower timeframes than most stakeholder groups; because effort is too high for stakeholder on single projects, outsourcing of engagement/networking to individual projects/ missing synergies with other projects; no follow-up because of other priorities
Role of individuals/Key players/Change-makers (incentive or barrier)	i.e., individuals driving institutional change and/or engagement initiatives; changes in personal/professional life of individuals; no one feels in charge for initiating certain debates (e.g. PE) within process
'Critical Mass' required for change (incentive or barrier)	Gaining momentum for change with enough key players to support it; engagement enabling systemic change
Perceived fixed categorizations of stakeholder groups (barrier)	i.e., academics not understanding what TSOs/FSOs do or how they can engage in research; believing all artists do the same thing and can easily work together; TSOs or other stakeholders are unwilling to engage because of the organisations/funders involved; reservations about working with certain types of organisations
Imagined publics (barrier)	Stakeholders assume they know about the role of the public, how they perceive an issue, and what they can contribute to research or debate
Perception of an issue, research domain, or innovation (barrier or incentive)	i.e., an interest in nanotechnology makes them more likely to participate in engagement; don't want to get involved because nano not 'hip' anymore; whether BMI is a good way to measure health
Innovation Processes (barrier or incentive)	Whether funding for innovation processes is primarily top-down or bottom-up; lack of continuity between projects or within organisations; regulation of innovation end-product varies greatly by region
Resources to participate in engagement (barrier)	i.e., lack of time (e.g. not part of the job) or money (e.g. for covering travel expenses)
Engagement procedures (incentive or barrier)	i.e., engagement participants are enthusiastic, but also missing participants who wouldn't obviously see themselves as connected to the topic – missing valuable outside opinions; invitation policy (too late, chaotic, etc.); who was invited; collaborators asked too late to contribute to report; manageability of process restricts no. of participants; structural difficulties of formats (e.g. Open Forums in one project which did not work the way they were intended); etc.; payment/stipend/other incentive to participate
Broader Social/ Cultural/ Political/Economic Influences (barrier or incentive)	i.e., participants struggle to integrate new epistemology with dominant cultural values or traditional ways of working; shifting priorities in response to changing political climate (Brexit, Trump), can also influence willingness for participation

Flexibility (barrier or incentive)	Ability to modify engagement activities and output formats as the project evolves creatively
Other Values (barrier or incentive)	Values that are embedded and encouraged within an organisational environment (gaining new perspectives, inclusion, fairness, etc.) and which impact whether an organisation is open or closed to engagement; individual values that drive or inhibit change
Empathy and altruism (incentive or barrier)	
Trust (incentive or barrier)	
Reflexivity (incentive or barrier)	i.e., can reflect on career/training and see how it could be improved in line with new thinking; working interdisciplinarily to be able to reflect on biases, etc. in work
Transparency (incentive or barrier)	Being open about research/business practices
Reputation (barrier or incentive)	i.e., businesses gain social credit or funding by including RRI in their projects or institutional mandate
Access to network (incentive)	Participation enables easy outreach; networking opportunities; regular conversation and networking allows for discussion that is otherwise not possible; knowledge transfer