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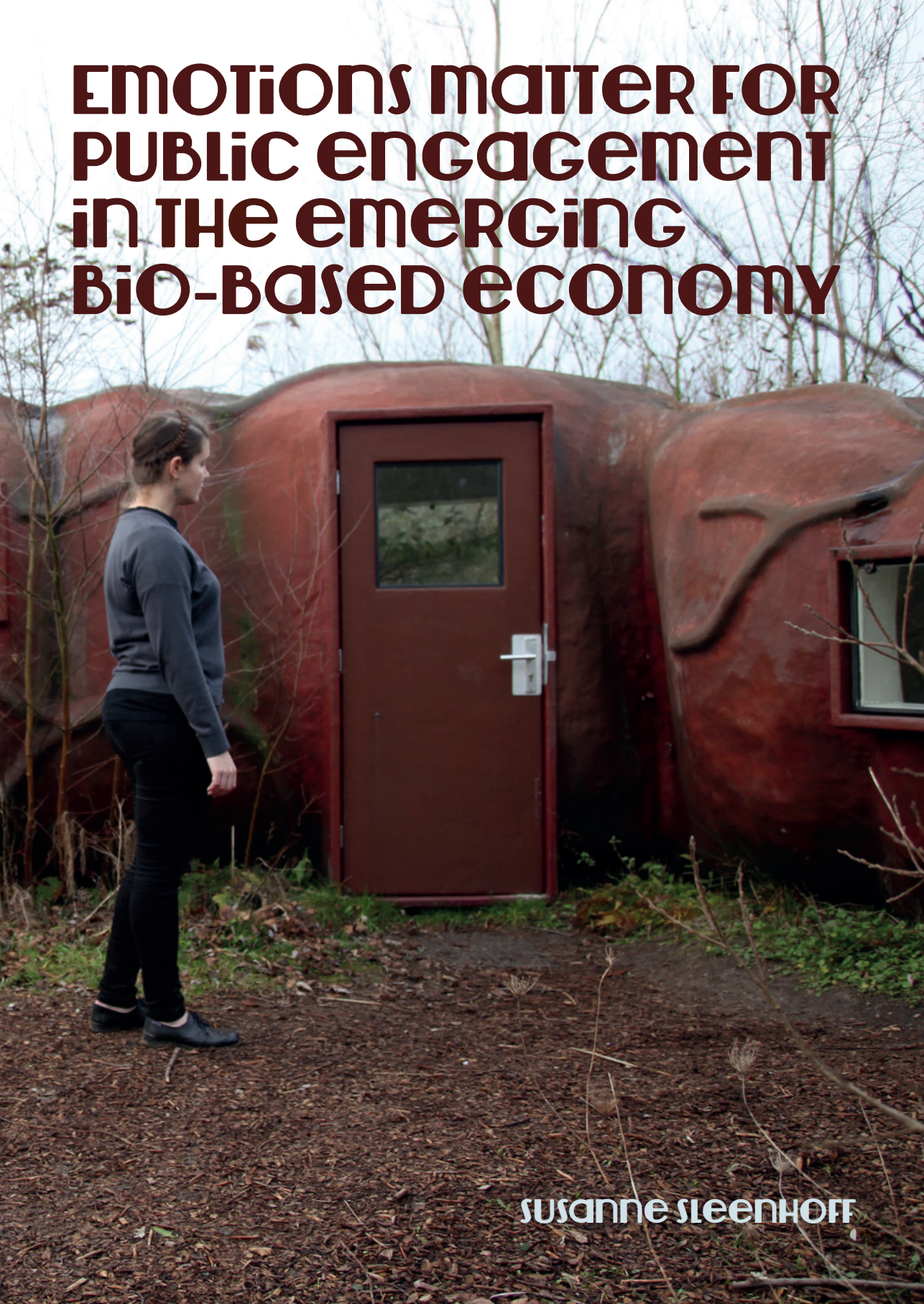

Susanne Sleenhoff

Emotions matter for public engagement in the emerging bio-based economy

Susanne Sleenhoff

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About the Cover: For the cover of this thesis I have attempted to represent the content whilst at the same time making a contribution to the whole. The photographed work is by Atelier van Lieshout. The work is called CasAnus and is on permanent display at the Verbeke Foundation. It represents a digestive tract. In that sense you could regard this artwork as a reference for one of the changes our current society will undergo in relation to a bio-based economy: our vision on waste.
Your perceptions are of a personal matter. With this picture I have tried to capture the moment when Susanne observes this artwork and a relation between her and the artwork emerges; the moment of conveyance and emotions arise.
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EMOTIONS MATTER FOR PUBLIC ENGAGEMENT IN THE EMERGING BIO-BASED ECONOMY

Proefschrift

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Susanne SLEENHOFF

doctorandus in de biologie
geboren te ‘s-Hertogenbosch

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To perseverance…

‘How often people speak of art and science as though they were two entirely different things, with no interconnection.
An artist is emotional, they think, and uses only his intuition; he sees all at once and has no need of reason.
A scientist is cold, they think, and uses only his reason; he argues carefully step by step, and needs no imagination.

That is all wrong.
The true artist is quite rational as well as imaginative and knows what he is doing; if he does not, his art suffers.
The true scientist is quite imaginative as well as rational, and sometimes leaps to solutions where reason can follow only slowly; if he does not, his science suffers.’

I. Asimov – ‘the roving mind’, 1983

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CHAPTER 1

GENERAL INTRODUCTION

'*Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do: once or twice she had peeped into the book her sister was reading, but it had no pictures or conversations in it, 'and what is the use of a book', thought Alice, 'without pictures or conversation?*'

This is the very first sentence of Alice's Adventures in Wonderland (Carroll, 1865). It paints the picture of a young girl being bored stiff because she has to sit beside her sister who is completely captured reading a book. A book without pictures and conversation, only text. This work here is not a story book, it is a thesis about a research subject. A book that contains not only text, but also pictures and conversations.

Alice feels disengaged with her sister's book due to the fact that it has no tangible connection to her own world. Following a clothed white rabbit she winds up in a world in which conventional logic does not apply. In its absurdity this Wonderland comes across as alien and sometimes even hostile. 'Why start your thesis with the first line of Alice's Adventures?' Because this thesis is about exploring how people make sense of something unfamiliar - that makes no sense, something that has no meaning, to them - based on tangible introductions. Although mind boggling, weird and strange Alice's adventures in Wonderland seem to make perfect sense to its readers. I start with the first lines of Alice as through nonsense – the absence of rationality or meaning – she constantly has to make sense of the situations she encounters in Wonderland (Huttner, 2008), a process which many members of society undergo frequently whilst living their daily lives.

Contemporary publics find themselves in a similar position as that of Alice in Wonderland when confronted with new and emerging science and technology. Biotechnology, nanotechnology, synthetic biology are all characterised by the fact that their nature cannot easily be grasped by the non-expert. As the latest Eurobarometer study (Gaskell et al., 2010) shows, this leads the public to feel alienated from science and technology and their impacts in society.

Public engagement is the central theme of this book. Public engagement in this thesis includes all kinds of mechanisms from sponsored to spontaneous initiatives ranging from a low to a high intensity of participation as described by Bucchi and Neresini (2007). More specifically this thesis focusses on the first steps of members of the public in any engagement mechanism. This is a study of how members of the public make sense of the unfamiliar and to act accordingly. Of how people's engagement with a systemic transition can be triggered whilst it is occurring. Although often disregarded or shunned from public engagement it has been argued that emotions do play an important role (Gottweis, 2005; Pidgeon & Fischhoff, 2011; Roeser,

2012b). This research is about getting to understand how people's emotions trigger their imagination (Hulme, 2011), guiding them in making sense and creating meaning out of what at first glance must seem alien. The research in this thesis focusses on the exploration and understanding of how individuals feel they can have efficacy – the way in which they trust themselves capable to be involved, enabling action in collective issues (Bandura, 1995b).

The context of this study, the transition which I will study through a looking glass, is the move of our current society to a bio-based society, in an attempt to maintain our quality of life and to manage this in such a way that is sustainable for future generations (Statistics Netherlands, 2015); a society which no longer depends on fossil resources but uses bio-renewable feed-stocks and biological processes for the production of materials and energy (Asveld, Est, & Stemerding, 2011; Langeveld, Meeusen, & Sanders, 2010; Soetaert & Vandamme, 2010). This transition takes place on many levels, affecting our economy, our culture, our institutions, our technologies, and our natural environment. And so far, this transition remains abstract and distant from people's everyday lives.

This chapter is the introduction of this thesis, describing the context, problem and formulating the research question. It starts with introducing the case of the emerging bio-based economy. Next, I argue why there is a need for broader public engagement. Subsequently, I will describe existing approaches to public engagement and introduce the value of emotion for public engagement. This section brings forward the need for further understanding of the role of emotions in communication. In the next section I introduce social representation as the theoretical bases for this thesis. Based on the described challenges the aim, the scope and the research question for this thesis are presented in section 1.5.

1.1 The emergence of a bio-based economy

The point of departure of my PhD research was to look at how the general public can be engaged with the research field of *industrial biotechnology*. Industrial or 'white' biotechnology is the use of modern biotechnological techniques, biological systems and processes for industrial production instead of (petro) chemical processes. This is industrial fermentation and bio-catalysis aided by developments in genomics and synthetic biology for adapted micro-organisms, cells or enzymes (Soetaert & Vandamme, 2010) for the industrial production of useful products. Biotechnology is applied on a large scale by industry for the production of chemicals, food and feed, fibres such as paper and textiles, and bioenergy including biofuels. This mode of production is expected to use less energy, less non-renewable input (petrochemicals) resulting in less waste and emissions, and fewer unwanted or toxic by-products (Bang, Follér, &

Buttazzoni, 2009; Burel, 2008; EuropaBio, 2008; Paula & Birrer, 2006; Schuurbiers, Osseweijer, & Kinderlerer, 2007; Soetaert & Vandamme, 2006).

Industrial biotechnology is, however, only one of the biotechnologies involved. Besides agricultural and medical biotechnology it forms part of a much bigger transition of our current economy (Enriquez, 1998; Porritt, 2013). In this transition we increasingly use biomass and other bio –techno– logical processes instead of fossil resources. A transition in which demarcations between biotechnology in industry, agriculture and healthcare, and synthetic biology get obscured as these research fields get more and more integrated. For example, plants used for primary production can be converted by enzymatic reactions into fine chemicals on an industrial scale, and become ingredients for pharmaceutical companies. The OECD defined this new economy as:

'a set of economic activities related to the invention, development, and use of biological products and processes…. Expected to improve health outcomes, boost the productivity of agriculture and industrial processes and enhance environmental sustainability.' (OECD, 2009, p. 326).

In the emerging bio-based economy biomass will become more and more of importance. Not only its production but also innovative ways in which this biomass is used, processed and converted will create new opportunities for economic development. There are several drivers for moving to a bio-based economy: 1) energy security 2) decreased energy dependence 3) and mitigation of climate change. By using non-renewable resources such as biomass it could be possible to manage our energy security and independence. Meaning that on the one hand we no longer, solely rely on big oil and energy companies as well as oil owning nations for our energy supply but that as society we are able to produce energy ourselves. And on the other hand, relying on biomass can also contribute to our energy independence, that we no longer rely on big oil companies and countries providing fossil resources and we are able to maintain a constant supply of energy. Using biomass as a resource can create a possible positive contribution to mitigating the effects of climate change.

An increased focus on the use and conversion of biomass, however, will not suffice due to Jevons' paradox or 'rebound effect'. Jevons' paradox proposes that technological progress that increases the efficiency by which a resource is used tends to increase the consumption rate of that same resource rather than decrease it. An answer to the paradox is not to focus on efficiency measures but rather to focus on ways to consume less overall (Giampietro & Mayumi, 2009). So besides biomass and the technology through which this can be converted it is also important to focus on people's behaviour in society. The integration of biotechnological research

fields and their increasing contribution and influence on the economy will have a significant bearing on public attitudes and society related to this transition and vice versa (Gijsbers, Enzing, & Vullings, 2005). Therefore, I decided to change my focus from engaging the public at large with industrial biotechnology to engagement with a bio-based economy.

The emerging bio-based economy is, similar to industrial biotechnology largely unfamiliar to members of the public. This makes their engagement far from straightforward (Berg, Hulshof, & Veen, 2013; Pesch, Sleenhoff, & Veen, 2010). Currently, most changes are made on a production and infrastructural scale by industry and government. There are only a limited number of consumer products available that have the potential to make this bio-based economy tangible in addition to comparable contemporary fossil end products. All these changes occur outside the public sphere of influence and sight at the moment.

1.2 Why engage the public at all?

To some, it is questionable why one would want to engage the public at large with such far from everyday life, industry and policy-led developments as the bio-based economy. In their line of reasoning the public has nothing to do with decision-making in science and science policy. The public is perceived to have little knowledge and expertise of what is being decided on. Most don't understand the science and policy process and are thought to only respond based on gut feelings and irrational thoughts. The public at large is considered only in the role of a consumer who purchases the end product, which will benefit the economy.

There are however three reasons why engaging the public at large is desirable: 1) instrumental imperatives, to secure peculiar ends, 2) normative imperatives, as it is the right thing to do and 3) substantive imperatives, as by engaging people one aims for getting better ends (Fiorino, 1990; Stirling, 2008). Engaging the public at large increases the openness and transparency of what is being developed and decided. Not only can this create public trust (Wynne, 2006) in the driving actors, it also facilitates that these actors can be held accountable for the development (Thorpe & Gregory, 2010): technological developments cannot and should not be black-boxed and separated from constitutive social relations whilst they are being developed.

Technologies are ambiguous in nature. It can not be decided on face value whether they are good or bad. Engaging the public also improves the quality of decision-making as different kinds of knowledge and perspectives can be evaluated and incorporated (Fiorino, 1990; Stirling, 2008). There are limits to relying on expert knowledge (Wynne, 1992, 2007) when making decisions in a transition that will affect so many different aspects of society and life. Engaging the public allows society to be included in the process in which the meaning of such development is

discussed. They can develop and express their values and concerns which should be taken into account when the direction of further development and implementation is determined (Irwin, 2001). Through public engagement the bio-based transition can also be more responsive in the way it will unfold.

The most important reason for wanting to engage the public with the bio-based economy is related to the necessity of society's behaviour change and collective action. The underlying concept – that in the long run will necessitate people to change their behaviour – is that of a sustainable economy. Economic growth deals with the increase of value of products and services produced by an economy over time. Most western economies have an economic model that relies on economic growth. However, there are two major negative side effects to economic growth: resource depletion and environmental impact (Meadows, Rome, & Associates, 1972). Some even regard continuous economic growth unsustainable (Bartlett, 2013; Hall & Day, 2009). Claims are made that with technological developments the negative impacts of economic growth on our systems ecology can be overcome (Weizsäcker von, Hargroves, Smith, Desha, & Stasinopoulos, 2009). However, it is not hard to imagine that for a viable bio-based economy an alternative model of our economy needs to be adopted (Daly, 2013; Zeemeijer, 2015), for instance a steady state or so called balance economy. Such economy is likely to dictate different values to products and services demanding a different public behaviour. Already people's personal choices influence the direction into which a bio-based economy will develop (Gijsbers et al., 2005). And as the transition slowly unfolds, society will likely be forced to make sacrifices. It will be confronted with choices, the outcome of which will affect different parts of the world as well as future generations (see chapter six of this thesis). Following the substantive imperatives this demands a broader, collective engagement of the public at large for public support, responsibility and action.

1.3 Existing approaches and value of emotions for public engagement

For long, many science communication activities were focussed on increasing public's understanding of science and technology and the possible impact of these practises on their daily lives (Irwin, 2006; Michael, 2012b). This form of communication is focussed on educating the public by providing them with scientifically sound information. The rationale behind this is that if we explain better to people why we are doing what we are doing, they will not only understand better, but also subsequently accept and support science based developments and policy. This rationale and form of communication has been used for example in cases related to the field of genetically modified food (Terlouw et al., 2002), nuclear energy (Wynne, 1992) or geoengineer-

ing (Kahan, Jenkins-Smith, Tarantola, Silva, & Braman, 2012). Despite numerous efforts in educating the public, it might have yielded some understanding, but in general this was not the case. The public remained apathetic and often more hostile to science and technology driven developments. Scientific literacy did not increase over time. This deficit-led form of science communication thus no longer suffices when active participation of the public is required (Bucchi, 2008; Bucchi & Neresini, 2007).

Interpretations of science by the public are influenced by their societal values, personal experiences and other contextual factors (Irwin & Wynne, 1996; Wynne, 1991). In order to accommodate these factors more dialogical forms of communication have been developed. These include public meetings, citizens panels and juries[1] (Rowe & Frewer, 2005). These forms of communication (Rowe & Frewer, 2005), or engagement mechanisms, intended to engage members of the public to discuss, share, reflect upon or deliberate their opinions and interpretations. Instead of being passive receivers of information, pliably responding to the choices in science and technology developments as they are made by policy and science experts, members of the public are invited to be included, share their views, opinions and knowledge, in the process in which science and its related policies are shaped. They are given the opportunity to voice their concerns, hopes, wishes and experiences.

Such engagement mechanisms, constructed to facilitate the process of engagement, raised concerns amongst scholars and engagement practitioners. At least three critiques on these public engagement mechanisms have been formulated in literature regarding: 1) the process, 2) the public and 3) the outcomes. Due to pre staging of the debate and due to pre-set agendas these mechanisms are often still infused with deficit model thinking, aiming for acceptance and consensus amongst the participants. Although these mechanisms intend to inform policy makers about public perceptions they repeatedly lack a connection with policy making and governance (Davies, 2006). And if there is such connection this is often used for managing public relations instead of true engagement (Beder, 1999). In such constructions of the public voice the representativeness of the public who participate in these mechanisms is questioned (Braun & Schultz, 2009; Michael, 2009; Rowe & Frewer, 2000). Are those people who engage and their constructed opinions representative for a bigger group of people, say society? Can the outcomes and results from an engagement process be extended to a wider audience at all? Procedural mechanisms allow for the construction of specific types of publics (Marres, 2007), foreclosing more radical forms of citizenship (Michael, 2012b; Wynne, 2007). The outcomes these processes gather are also only relevant for a given moment in time, whilst

[1] This is based on the 'flow of information' typology presented by Rowe and Frewer (2005)

the level of engagement of a given individual is very likely to change over time. The results do not say anything about changes in a participant's lifestyle or perception of the issue beyond their participation in the engagement exercise.

Most approaches towards public engagement use a very wordily and deliberative account of information focussed on the more rationalistic aspects of the issue (Hoggett & Thompson, 2002). In these approaches members of the public are invited to verbally express their points of view and share their knowledge. Such accounts are only considered 'valid' when they are supported by well-reasoned and evidence-based arguments. Such mechanistic approach to public engagement regards members of the public as singularised, calculating, decision making, cost-benefit analysts (Michael, 2012b). Michael (2012b) describes this view as too complex to also accommodate for affect and dissensus, and such mechanistic view is far from reality. As Kahan, Peters, et al. (2012) show, we often base, compare and align our opinions and behaviour to the people we want to belong to. We not only rely on our own judgement but also on those of our peer community we (want to) belong to. This behaviour addresses the core motive of identity, the almost innate sense that we want to belong to a certain group (Kahan, Peters, et al., 2012; Vugt, 2009) Or as Moscovici (1984) describes it:

'Such a cognitivist view on people is a simplification because, society is not a source of information but of meaning. People are no mechanical processors of information they receive and encounter. There is also the emotional element to consider. People also use emotions to evaluate information.'

Emotions seem to play a pivotal role in the apprehension of the issue at hand.

There is an alternative way to perceive engagement. Instead of seeing it as a process, it can be regarded as a state of connection with any given issue at a given moment in time (Lorenzoni, Nicholson-Cole, & Whitmarch, 2007). As defined by Lorenzoni et al (2007) such a state of engagement should be understood as simultaneously overlapping cognitive, affective and behavioural aspects. Engagement is not only knowing something about and having feelings towards the issue at hand, it is also a state in which individuals can develop an idea in how they are capable to take action. These engagement aspects are not linearly related to each other. Rather they comprise a complex behavioural ecology (Guagnano, Stern, & Dietz, 1995), which is influenced by experiences, feelings, past behaviour, social networks and knowledge (Blake, 1999). Although researchers attempt to model various influences on individual attitudes and behaviour (Ajzen, 1991), such an approach manages a much too individualistic and rational perspective of behaviour (Lorenzoni et al., 2007), thus not offering a sufficient basis for an alternative to the mechanistic approach to public engagement.

The mechanistic approach identifies a disparity between people's awareness and opinion towards an issue and the often limited behavioural response. This value-action gap as described by Blake (1999) is important to overcome for a successful transition to a bio-based economy. It often happens that people do not act in accordance with what is in their head and in their heart. This disparity has also been found in a study about consumer behaviour towards purchasing GMOs (Sleenhoff & Osseweijer, 2013). However, this disparity is a complex interaction between psychological, social and environmental factors. For public engagement with a bio-based economy, barriers to increase people's knowledge, interest and concern need to be overcome. Here the motivational character of emotions can play an important role in supporting people's efficacy (Bandura, 1997). But emotion-laden accounts are still often considered to be irrational, standing in the way of rational arguments. Michael (2012b) describes this as: 'The voice of the public is regarded as an added subjective, moral dimension to the objective business of determining risks or facts.' Emotions are considered to bias information processing (Kahan, Jenkins-Smith, et al., 2012; Slovic, Finucane, Peters, & MacGregor, 2007). Emotions such as fear cause the public to be blind to the opportunities of scientific developments. As such emotions are considered to be disruptive for decision-making about risks and thus they have been shunned or excluded. For a critical discussion of this position cf. Roeser, 2012b.

The people who are motivated to speak up are often those who are directly affected by an issue (Marres, 2007; Michael, 2009). And, as such they are of course more emotionally involved. Most of the time this group of people is relatively small, whilst the majority, engaged on an ad hoc basis remains silent (May, 2007). Given this emotions seem to be pivotal to engaging the public rather than blurring public understanding of science and biasing public engagement.

Much research exists on the value, function, measurement, recognition and use of emotions. Emotion scholars from different fields such as psychology, philosophy, medicine or informatics study different aspects of emotions in their own way. Emotions have been found to be essential in decision making (Damasio, 1994). They play an important role in the formation of judgement. Emotions help us to focus and draw attention to what is important (Manstead, 2002) and they are important and guiding structures that connects us to what is meaningful in our surroundings (Oatley & Jenkins, 1996; Oatley & Johnson-Laird, 2014). Emotions can be regarded as a form of cognition and moral insight guiding and managing our thoughts, complementing deficiencies of our thinking (Frijda, 2005; Roeser, 2010b, 2012b). They help members of the public to connect and get familiar with the issues confronted with (Hoijer, 2010), emotions entice reflection to the issue at hand and motivate us for action (Roeser, 2012b). For example pictures of animals in distress – the sinking polar bear – arouse feelings of compassion. In turn this

emotion may motivate people to donate money to fight climate change. However, this knowledge and the importance and possible role of emotions is underexposed in public engagement literature and practise. As far as emotions are appealed to in public engagement they are often regarded in two different ways. Emotions are either regarded as irrational responses shrugged off because of a so-called lack of knowledge, or they are used instrumentally, purposefully addressing them to create support for a certain position cf. Roeser 2012b. In this case public engagement is no longer an open exchange: it is merely used as a public relations strategy (Beder, 1999) to raise public support.

Public engagement with a bio-based economy demands members of the public to get to know and familiarise themselves with the issue. It is necessary that they create their own apprehension of what such an economy entails – how it makes them feel and what it expects from them; which choices and sacrifices they will be asked to make. My starting point for this thesis is that emotions are important for meaningful engagement of the public. But currently we lack ways for how we can elicit and articulate these emotions so they can be taken into account in an open and honest fashion, stimulating public engagement with this unfamiliar transition.

1.4 Social representations of a bio-based economy

The bio-based developments are hidden within different, sometimes more familiar, issues that converge with a bio-based transition. Issues such as climate change and mitigation strategies, biotechnology, environmental concerns, energy security, land grabbing or neo colonialism, the use of crops for food or fuel are all at play and stir public engagement in a bio-based economy. Only if the transition becomes recognised by and familiar for the public at large, will they be able to get meaningfully involved.

In the 1960s the French social psychologist Serge Moscovici developed a social representations theory whilst studying how knowledge was reformulated by groups of people. He investigated how different groups within French society responded to the challenge of psychoanalytic ideas (Moscovici, 2008). He found that communication processes, their content and effects differed amongst the specific social groups, creating different social representations and comprehensions of the same concept. Social representations can be regarded as clusters or networks of values, ideas, beliefs, practises, attitudes, metaphors and judgements that are shared amongst members of a group. Generated through communication these representations show how people make sense of complex unfamiliar issues and how that understanding is transformed into everyday knowledge (Joffe, 2003; Moscovici, 2002). In order to get a better understanding of how members of the public engage themselves with the transition to a bio-based

economy I will frequently use Moscovici's social representations theory as a framework to understand how members of the public familiarise themselves with it.

Social representations theory is useful in exploring more meaningful public engagement, because of its orientation towards explorations of comprehensions, conceptualisations and understanding of new events or issues. Social representations are not verbal in shape per se; they are often generated by pictures and images as well. This visual anchoring and objectification facilitate comprehensions of complex issues. Especially for the bio-based transition, which is currently a very expert stakeholder driven development (Levidow, Birch, & Papaioannou, 2013), this matters. These stakeholders communicate in the vocabulary of their expertise, using much jargon. This expert level of communication can be a hurdle for members of the public to engage (Lorenzoni et al., 2007). However, representations are also captured and created by pictures or images which can be more powerful in communication and easier accessible to the public at large. In that case, members of the public do not have to process much written or spoken material. Although verbatim information processing is more precise it demands more time and effort; letters are also symbols but they need to be translated in order to be meaningful. By focussing on more visual means of communication this research will also add to the lacunae of knowledge on the use of non-verbal methods for communicating risk/benefit concepts (Frewer et al., 2015). So focussing on visual representations enhances the possibility to study how members of the public could get engaged. This is even more the case considering the fact that the theory not only allows one to look more closely into the process through which the representations are generated but also at the kinds of representations that emerge (Duveen, 2000).

1.5 Research question

This study takes on the challenge of triggering public engagement with the bio-based economy by taking a closer look at emotions and tangible connections. Firstly, a method for 'measuring' emotions of the public at large should be developed in order to identify what kind of emotions they have towards this transition. Secondly, besides people's emotions also their perceived efficacy beliefs should be assessed to get an idea of which ways they consider themselves capable in contributing to the bio-based transition. Thirdly, means to communicate more affectively should be evaluated to get a better understanding of how people's engagement emerges. The aim of my thesis is to explore the value of emotions for public engagement and to study how they can – more explicitly than before – be taken into account to trigger public action with the emerging bio-based economy. With this aim in mind I formulate the following research question:

In what way can emotions entice collective public engagement for a bio-based economy?

To answer this research question I will use the following strategy in my research: Social representations theory will be used as a theoretical framework as it allows me to explore how people create meaning when confronted with the unfamiliar. At the same time this theoretical framework allows me explicitly to study emotions as an element of communication and engagement. In addition the theory accommodates me to use images in my studies as a more affective means of engagement. For my method I will use a mixed method approach (Johnson & Onwuegbuzie, 2004) in order to answer my research question (table 1). This approach allows me to gather and combine the results of both more quantitative and qualitative methods, especially since I will integrate knowledge form different fields.

Table 1: Overview of the used methods per study in this thesis

	Study	Method	# Participants
Chapter 2	Unravelling emotional viewpoints	Q methodology	38
Chapter 3	Exploring perceived efficacy beliefs	Q methodology	39
Chapter 4	Including emotions in communication - Bio-art	Observation of visitors	197
		Semi-structured pre-interviews	48
		Semi-structured post-interviews	42
		Focus groups	20
Chapter 5	Including emotions in communication - Banquet	Narrative analysis	40
Chapter 6	Argument for including emotions	Literature review	n/a

The scope of this thesis is limited to the Dutch situation. Although the bio-based transition simultaneously takes place on a global as well as a regional scale I have confined myself to only studying the engagement of the Dutch public. This scope is chosen for several reasons. First, although some emotions are universal and experienced in the same way across cultures all over the world (Ekman, 2000), other more complex emotions show considerable differences in how they are triggered, experienced, perceived of and responded to in society. So, to be able to grasp the variations of the emotions expressed it is necessary to have an understanding of the cultural framework in which these emotions are conveyed.

Secondly, there is a very practical reason for limiting myself to studying the engagement of Dutch society which is proximity. Not only my proximity to the development of a bio-based

economy in the Netherlands allows me to have an extensive insight in the developments taking place. Also the availability of research participants made me limit the scope of this thesis to the Dutch society.

1.6 Outline of this thesis

The research question will be answered as follows. Chapter two will elaborate on the value of emotions for public engagement and explore how such emotions can be measured at a group level, using Q methodology (Stephenson, 1953). The chapter explains the purpose of this method – the elicitation or measurement of people's viewpoints – and how it was applied in this case. Part of the methodology is a sorting task in which participants are asked to rank the variables (Q sort). Normally these variables consist of written statements. However, given the public's unfamiliarity with the emerging bio-based economy I used visual representations instead. The results of the Q sorts, four different emotional representations, are subsequently presented and discussed. Finally, in this chapter I argue how emotions of a larger public can be elicited and should be taken into account for engagement.

Extending the use of Q methodology, using the same representations, chapter three explores the public's efficacy beliefs on their perceived ways for engagement with the emerging bio-based economy. The chapter looks at how members of the public believe they can make a meaningful contribution to this transition. The result of these Q sorts, five different perceived efficacy beliefs are described and discussed. In this chapter I argue that the public at large foresees different ways to engage with the emerging bio-based economy as involved stakeholders do.

Taking emotions into account in one's communication is expected to enhance public engagement (Pidgeon & Fischhoff, 2011). In chapter four I take a closer look at art as a more affective form of communication. First, I will describe the potential of art for public engagement. Secondly, based on a thematic analysis of interviews and focus groups with visitors of the D&A4G exhibition I will present two different lines of thought along which public engagement emerged.

Pulling together the found emotional views of chapter two and the different perceived efficacy beliefs of chapter three I test a more open approach for triggering public engagement with a bio-based economy in chapter five. Relying on a narrative approach I will describe the set-up, performance and experience of a banquet I organised for Delft citizens. Finally, I will reflect on this approach as a meaningful way for engagement.

In chapter 6 I will discuss and extend the argument on the importance of emotions in the communication and engagement of the public at large with a bio-based transition. I will argue

that a bio-based economy needs a bio-minded society. Subsequently I will discuss why achieving such a society is challenging and I will present means on how to initiate meaningful engagement.

Finally, chapter 7 summarises and combines the results of the different studies in this thesis. In that chapter the answer to the research question is formulated and the main conclusions of this thesis are presented and discussed. I reflect on the relevance of this thesis for a broader context and based on this reflection I will formulate recommendations for further research.

CHAPTER 2

UNRAVELLING EMOTIONAL VIEWPOINTS ON A BIO-BASED ECONOMY USING Q METHODOLOGY

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Chapter 2:

Unravelling emotional viewpoints on a bio-based economy using Q methodology

Abstract

A transition to a bio-based economy will affect society and requires collective action from a broad range of stakeholders. This includes the public, who are largely unaware of this transition. For meaningful public engagement people's emotional viewpoints play an important role. However, what the public's emotions about the transition are and how they can be taken into account is underexposed in public engagement literature and practise. This article aims to unravel the public's emotional views to the bio-based economy as a starting point for public engagement. Using Q methodology with visual representations of a bio-based economy we found four emotional viewpoints: (1) compassionate environmentalist, (2) principled optimist, (3) hopeful motorist and (4) cynical environmentalist. These provide insight into the distinct and shared ways through which members of the public connect with the transition. Implications for public engagement are discussed.

2.1 Introduction

Many scientists, industrialists and policymakers believe in the potential of industrial biotechnology for the development of a bio-based economy and for sustainable development (Paula & Birrer, 2006; Soetaert & Vandamme, 2006). For a successful transition from a petrol based to a bio-based economy it is argued that the public should be involved in the process as well (Cologne Paper, 2007; Landeweerd, Surette, & Driel, 2011; OECD, 2009; Osseweijer, Landeweerd, & Pierce, 2010; Paula & Birrer, 2006; Schuurbiers et al., 2007; Zachariasse et al., 2011) as it affects many different aspects of society and requires collective action. With a changing role for industrial biotechnology in a transforming society, people's personal choices are expected to influence the direction of development to such an economy (Gijsbers et al., 2005; Paula & Birrer, 2006). The broader implications of their actions and decisions for others and their environment need to be considered as well. Public's engagement is needed to shape the innovation agenda and strengthen social awareness in order to change unsustainable practises and to maintain economic viability.

Via various approaches to public engagement (Bucchi & Neresini, 2007; Michael, 2002) people have been invited to sharing ideas and learning about novel scientific and technological developments. These approaches often ignored the role played by emotions in how people are and can be engaged (Harvey, 2009; Hoggett & Thompson, 2002). Yet, emotions play an important role in how people engage with science and technology (Engdahl & Lidskog, 2012; Roeser, 2012b). We will argue that one needs to understand the emotional viewpoints of the public at large (Felt & Fochler, 2010) for more meaningful public engagement with the bio-based economy. This paper aims to unravel the public's emotional views towards a bio-based economy, in such a way that the complexity and diversity thereof can be captured and taken into account for further engagement.

Section two introduces the concept of a bio-based economy. The third section describes the role of emotions for public engagement. In the fourth section we explain how we performed and experiment applying Q methodology which is a semi statistical research method to study people's subjectivity (Stephenson, 1953). The fifth section presents and compares the resulting four emotional viewpoints we unravelled. In the sixth section we discuss our findings and conclude with their implications.

2.2 Public engagement with a bio-based economy

With rapid depleting fossil resources and the need to act upon climate change industries, scientists and policymakers search for alternative –more sustainable– modes of supply and production (Osseweijer, Landeweerd, et al., 2010). The concept of a bio-based economy entails the

replacement of fossil resources by biomass to produce pharmaceuticals, chemicals, fuels, materials, and energy[2]. Production is enabled by industrial biotechnologies such as biocatalysis and fermentation technologies, which are aided by developments in genomics for directed evolution or metabolic engineering of micro-organisms and cells (Soetaert & Vandamme, 2010).

The transition to a bio-based economy converges public engagement efforts with industrial biotechnology, climate change, sustainability and the environment. Much has already been written about the extent of public's awareness of the different topics, what opinions they have and how these change over time (Bauer & Gaskell, 2002; Commission, 2009, 2011b; Gaskell et al., 2010). On different ways to approach engagement (Bucchi, 2008) and its results too (Horlick-Jones, Rowe, & Walls, 2007; Lorenzoni et al., 2007; Whitmarsh, Seyfang, & O'Neill, 2011). However, the complex nature of this transition does not allow these findings to simply be added up for public engagement.

Public awareness of bio-based developments is limited (Asveld et al., 2011; Pesch et al., 2010; Velde, Verbeke, Pop, & Huylenbroeck, 2011). The complexity of industrial biotechnological processes and products (Michalopoulos, Landeweerd, Van der Werf-Kulichova, Puylaert, & Osseweijer, 2011) and people's unfamiliarity with it makes connecting to it in a tangible way difficult (Opinion leader, 2009; Osseweijer, Landeweerd, et al., 2010). The Sciencewise report (2009) concludes that despite its potential the public has negative associations with the term 'industrial biotechnology' and that they are suspicious of government and industry's motives for 'going bio-based'. On the other hand, Asveld et al (2011) expect little public disagreement about the use of industrial biotechnological processes and products. The prospect that this technology can contribute to more sustainable production that does not rely on fossil fuels and oil based products appeals to people (Gaskell et al., 2010; Opinion leader, 2009).

2.3 Emotions and public engagement

Where public engagement approaches generally rely on communicative and deliberative accounts of information focused on the rationalistic aspects of the issue (Hoggett & Thompson, 2002) different scholars have addressed the value of emotions for public engagement with complex issues such as climate change, CO2 risks, nanotechnology or nutrigenomics (Cobb & Macoubrie, 2004; Hoijer, 2010; O'Neill & Nicholson-Cole, 2009; Osseweijer, 2006; Pin, 2009). Roeser (2012b, p 1033) states: '[i]n the past, emotions were generally excluded from communication and political decision making about risky technologies […] or used instrumentally

[2] Products are listed according to the so called 'cascade-model' starting with higher valued products to lower valued products that can be derived from biomass (Verburg, 2007).

to create support for a position.' As such, emotions were considered irrational or disruptive for decision-making about risk, and a cause of bias in information processing (Kahan, 2008; Loewenstein, Weber, Hsee, & Welch, 2001; Slovic, 1999; Slovic et al., 2007). However, emotions can also be considered a form of cognition and moral insight (Frijda, 2005; Roeser, 2010b, 2012b) guiding and managing our thoughts, complementing deficiencies in our thinking and as such of value for public engagement.

Another challenge for analysing emotions is their complexity, being comprised of mental, physical and behavioural components (Manstead 2002; Scherer 2005). This complexity gives rise to much academic confusion about what is meant with an 'emotion' (Scherer, 2005) for which at least 90 definitions have been given (Kleinginna & Kleinginna, 1981). To name a few, Scherer (2005) gives a component process definition which describes emotion as: an episode of interrelated, synchronised changes in the stated of all or most of the five organismic subsystems in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism. Damasio (2004) gave a more biological definition, characterising emotions as bio-regulatory reactions that (in)directly aim at promoting the sort of physiological states that consciously secure survival regulated into the range we identify with well-being; whereas Plutchnik (1962) uses a more motivational definition stating: An emotion is a patterned bodily reaction of either destruction, reproduction, incorporation, orientation, protection, reintegration, rejection or exploration, or some combination of these, brought about by a stimulus. For this study we adopt as a working definition that emotions are private subjective, (un)conscious experiences characterised by biological reactions, outward expressions or behaviour and mental states.

Emotions have different functions. They are a natural and necessary part of decision-making, allowing people to be practically rational (Damasio, 1994). Emotions are guiding structures linking what is important to us as a person to the world of people, things and happenings (Oatley & Jenkins, 1996) providing us with meaning (Kahan, 2008) and can be viewed as socio-cultural products including values and social norms of a society (Elster, 1999; Frijda, 2005; Nussbaum, 2001). Emotions draw people's attention to situations or events that need attention (Manstead, 2002). As O'Neill & Nicholson-Cole (2009) demonstrate, fear can draw people's attention the issues of climate change but can also disengage them. Cobb & Macoubrie (2004) show that having received positive information about nanotechnology makes it more likely for people to feel hopeful about its development. As Pin (2009) shows, having a positive feeling towards nutrigenomics makes people more likely to have a favourable attitude towards it.

Supported by social representations theory (Moscovici, 2002), images have been found extremely efficient in externalising emotions that have collective meaning (Mamali, 2006).

People form social representations – of which emotions are interwoven components – by using a whole range of associations, symbols, and metaphors they share within and across social groups. Our world is much too complex to understand it by just a verbatim description of it. Images are visual social representations that have the power of what Rosa and Farr (2001) call hypostatization; they make abstract and unfamiliar phenomena more concrete. Images have the capacity to quickly convey a message, are able to condense complex issues and to engage and motivate people (Broek, Koetsenruijter, Jong, & Smit, 2010; Nicholson-Cole, 2005). As such, images have a greater intelligibility and interpretability as they can cross geological and cultural borders (Rosa & Farr, 2001). They can be a tool to communicate and trigger emotions (Hoijer, 2010; O'Neill & Hulme, 2009; Sheppard, 2005).

2.3.1 Measuring emotions

There is no 'single gold-standard' for measuring emotions, both medical and social sciences have their own approaches. Physiological approaches such as heart rate measurement or brain imaging can be used to demonstrate whether the participant is emotionally aroused or not. These approaches are limited in showing which specific emotions are at play (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000). Social science uses interviews or self-reporting schemes to measure emotions. The former suffers from participants conscious and unconscious attempts to present themselves in a certain way which creates distortions. The latter suffers from the fact that people are poor at recognising which emotions they are experiencing and with what intensity. Furthermore, these measurements are often focussed on the individual. Measurement of emotions on a public level are often done through using questionnaires for self-reporting (Cobb & Macoubrie, 2004; Klop & Severiens, 2007). The drawback of questionnaires is that the results might not reflect how the public actually feels about an issue at hand since it imposes a priori meanings (Cross, 2005) or could miss out on important aspects that surround the issue (Klop & Severiens, 2007). To measure emotions on a public level we need a method that is not focussed on the individual and that allows people to construct their own views towards the issue at hand. Q methodology is such an open approach that allows for taking divergence and complexity into account. The usage of pictures in Q methodology has been employed before (Fairweather & Swaffield, 2001; Robbins & Krueger, 2000; Størksen, Thorsen, Øverland, & Brown, 2012) and proved to be an easily understandable format producing rich and subtle interpretations of a complex phenomenon. To our knowledge, using pictures in Q to measure emotional viewpoints have never been deployed before.

2.4 Method

Q methodology was developed by William Stephenson (1953) to measure people's subjectivity in a structured and statistically interpretable way (Barry & Proops, 1999; Cross, 2005). It allows analysis of complex and diverse points of views in a population, without losing the complexity of the issue (Stirling, 2010). Q takes a holistic approach (Brown, 1996) and accommodates contradiction and ambivalence (Brown, 1997; McKeown & Thomas, 1988). Q methodology is essentially different from traditional survey research which uses Likert scales to asses viewpoints. Where a survey would allow the researcher to analyse patterns across individual traits or preferences (length, blood pressure etc), with Q methodology the researcher can establish patterns within and across individuals (Barry & Proops, 1999). Not the participants but their Q sorts – the variety of discourses around a particular issue – are the focus of Q methodology. Where in a survey the posed questions are the items of measurement and participants are the sample, in Q the participants are the items of measurement and all the Q statements are the sample (Cross 2005). Q methodology gives insight into the variety of viewpoints that exist among a population rather than a balance of viewpoints within a population (Cuppen, Breukers, Hisschemoller, & Bergsma, 2010; Farrimond & Kelly, 2011; Hobson & Niemeyer, 2012).

2.4.1 Definition of the concourse

The 'concourse' refers to 'the flow of communicability surrounding any topic' (Brown, 1993, p. 94) taken from 'the ordinary conversation, commentary, and discourse of everyday life' (Brown, 1993, p. 94). It is supposed to contain all relevant aspects of all discourses on a topic. Usually the concourse is defined by compiling a large set of verbal statements. For our concourse we extracted pictures from a wide variety of public forms of communication (leaflets, website, newspaper etc.) of Dutch stakeholders in bio-based organisations as defined in Sanders and Langeveld (2010). Furthermore we did an internet search using specific keywords related to the bio-based economy: biofuels, biomass, bio-plastic, bio-based and bio-based economy. This resulted in a collection of over 300 different pictures.

2.4.2 Selecting the Q sample

The Q sample is a smaller subset – usually 30-60 items – that represent the concourse. Removing overlapping finds resulted in hundred pictures. Next, eight colleagues, knowledgeable on the bio-based economy, were individually asked to select a set of forty pictures from the set of hundred that covered the full range of views on a bio-based economy. Once they completed their set they were asked if they felt if any particular view or picture was missing. We drafted our Q sample based on the most and least selected pictures of their compiled sorts. Based on

our colleagues additional comments this set was complemented with eight pictures to ensure it reflects the concourse on the bio-based economy. Subsequently, this set was piloted with a second group of four colleagues in order to test the procedure of sorting and to ensure that the pictures in the set were comprehensible for non-experts. The resulting set of forty-eight pictures – the Q sample – was printed on cards and randomly assigned a number for registration during the interviews.

Table 2: Demographic distribution of our P-set of 38 people and their identified emotion factors in comparison to the demographic distribution of the Dutch society (Statistics Netherlands 2011)

		CBS 2011	Our P set	Factor 1	Factor 2	Factor 3	Factor 4
Age		%	%	%	%	%	%
Low	20-40	34	42	50	38	50	0
Middle	40-65	50	48	36	50	25	67
High	65 +	16	10	14	13	25	33
Gender							
Male		50	48	36	38	75	100
Female		50	52	64	63	25	0
Level of Education							
Low		32	29	7	25	50	0
Middle		40	39	36	75	50	67
High		28	32	57	0	0	33
Household							
Single person		40	38	36	38	50	33
Multi persons		60	62	64	63	50	67
Gross Income							
Low	€ 0-20000	44	45	43	25	25	0
Middle	€ 20000-40000	34	38	43	38	50	67
High	€ 40000+	22	18	14	38	25	33

2.4.3 Selection of participants

Q requires a (small) number of specifically chosen participants (P set) who are theoretically relevant to the topic of the study (Brown, 1980). The P set should reflect the diversity of viewpoints on the issue. Currently we do not have any basis to assume that particular groups in society differ in terms of their emotional viewpoints. Therefore we aim for diversity based on demographic factors such as age, level of education, level of income, household composition and gender, matching the average demographic of Dutch society (Statistics Netherlands, 2011) (Table 2) although we are aware this new economy develops at a global scale. We narrowed the age range to include only adults as they are the ones making choices relevant for a bio-based economy (e.g. in their shopping or mode of transport). Individuals working in bio-based

related branches were also excluded as we are interested in the viewpoints of those who are not professionally involved. A marketing research company invited 40 people to participate based on our criteria.

2.4.4 The Q interview

In a Q interview, the respondent sorts the items on a scale that represents significance or salience (Brown, 1980, p. 198). Typically, the items are sorted according to a forced, bell-shaped distribution. After sorting, respondents are asked to explain their sorting. This qualitative data is used in the next step for interpretation of the quantitative factors. 38 people participated in the study in a face to face interview setting in October 2011. They received a step by step instruction to complete their Q sorting task based on (Exel & Graaf, 2005) including a definition of the subject of study. Participants were asked to rank the pictures on a scale from the ones that gave them the most positive feeling (+4) to the ones that gave them the most negative feeling (-4). By doing so, participants evaluated the pictures in relation to other pictures and revealed their subjective viewpoint (N. W. Smith, 2001). Once the sorting task was completed the participants were asked to elaborate on what particular feeling the pictures in columns -4 and +4 aroused and why. The sorting process provides us with an holistic emotional perspective whereas the interview data allowed us to unravel participants emotions more discretely.

2.4.5 Q analysis

A typical Q analysis firstly involves factor analysis. The correlations between the Q sorts are calculated, representing the level of (dis)agreement between individual sorts. The resulting correlation matrix is then factor analysed, identifying the number of natural groupings of Q sorts. These groups can subsequently be interpreted as distinct, shared emotional viewpoints on the bio-based economy. PQ method 2.20a (Schmolck, 2011) was used to perform the factor analysis. Principal Component Analysis (PCA) was used for factor extraction (table 3) and factors were rotated using Varimax, both common procedures in Q methodology. Factor arrays were calculated for composing an idealised Q sort (factor array) for each factor (table 4). Correlations between different factor solutions were calculated for construction of a factor diagram representing the hierarchical structure of our data (based on Goldberg, 2006) (see figure 1). This visualisation helped in choosing the optimal factor solution for interpretation and description of the different factors. It showed that the data contained at least three stable factors across different factor solutions. Based on close inspection of the content of all factors in the four-, five- and six-factor solutions – taking into account the factors eigenvalues, the number of single

significant loadings of participants onto a factor – and the interview data, the four-factor solution was selected. In total 29 respondents significantly loaded on a factor.

The four factors explained between 8 and 21% of the explained variance in Q sorts, and collectively 56%[3]. The found factors are converted to viewpoints by interpreting them. Based on its *characterising* pictures, those with the highest and lowest ranks (-4, -3, 3 or 4), and its *distinguishing* pictures, those that differ significantly between factors, together with the qualitative data from the interviews the emotional viewpoint is unravelled and described.

[3] In Q, the explained variance is not considered a relevant measure, since one is not interested in the question how many people in a population hold a viewpoint. Rather, Q is developed to show how that various viewpoints exist within a population, and what the similarities and differences between the viewpoints are.

Table 3: Correlation coefficients of the Q sorts for the four found factors. Defining variables for each factor in bold[4]

Respondent	Factor			
	1	2	3	4
1	**0,70**	0,12	0,13	0,33
2	**0,59**	0,37	-0,13	0,28
3	**0,50**	0,03	0,19	-0,33
4	**0,70**	0,31	0,27	0,11
5	**0,39**	-0,09	0,16	-0,13
6	**0,70**	0,01	-0,21	0,23
7	**0,50**	0,23	0,09	0,17
8	**0,54**	-0,04	0,14	0,30
9	**0,81**	0,09	0,26	0,12
10	**0,77**	0,21	0,29	0,07
11	**0,66**	0,48	0,20	0,13
12	**0,58**	0,10	0,40	0,30
13	**0,62**	0,16	0,49	0,10
14	**0,59**	-0,12	0,47	0,05
15	-0,04	**0,53**	-0,15	-0,06
16	0,00	**0,69**	0,12	-0,08
17	0,54	**0,73**	0,11	0,02
18	0,40	**0,51**	0,18	-0,21
19	0,10	**0,60**	0,43	0,29
20	0,12	**0,56**	0,44	0,28
21	-0,01	**0,57**	0,19	0,45
22	0,38	**0,62**	0,37	0,31
23	0,02	0,30	**0,61**	-0,14
24	0,26	0,14	**0,66**	0,07
25	0,30	-0,01	**0,79**	0,09
26	0,42	0,23	**0,57**	0,14
27	0,18	0,06	0,07	**0,57**
28	-0,04	-0,05	0,36	**0,56**
29	0,14	0,00	-0,04	**0,44**
30	0,45	0,45	0,21	0,09
31	0,51	0,45	0,26	0,03
32	0,38	0,56	0,37	0,30
33	0,44	0,46	0,51	0,09
34	0,39	0,33	0,47	0,11
35	0,52	0,29	0,04	0,56
36	0,48	0,40	0,12	0,40
37	-0,13	0,39	0,46	0,33
38	0,21	0,07	0,48	0,45
% expl.Var.	**21**	**14**	**13**	**8**

[4] A respondent defines (or loads) a factor if: the respondent correlates statistically significant with that factor; the loading of a respondent on a factor should exceed the multiplier for the statistical significance level (p=0.01) divided by the square root of the number of statements, in this case: 2.58*1/√48=0.37 (See McKeown & Thomas 1988)

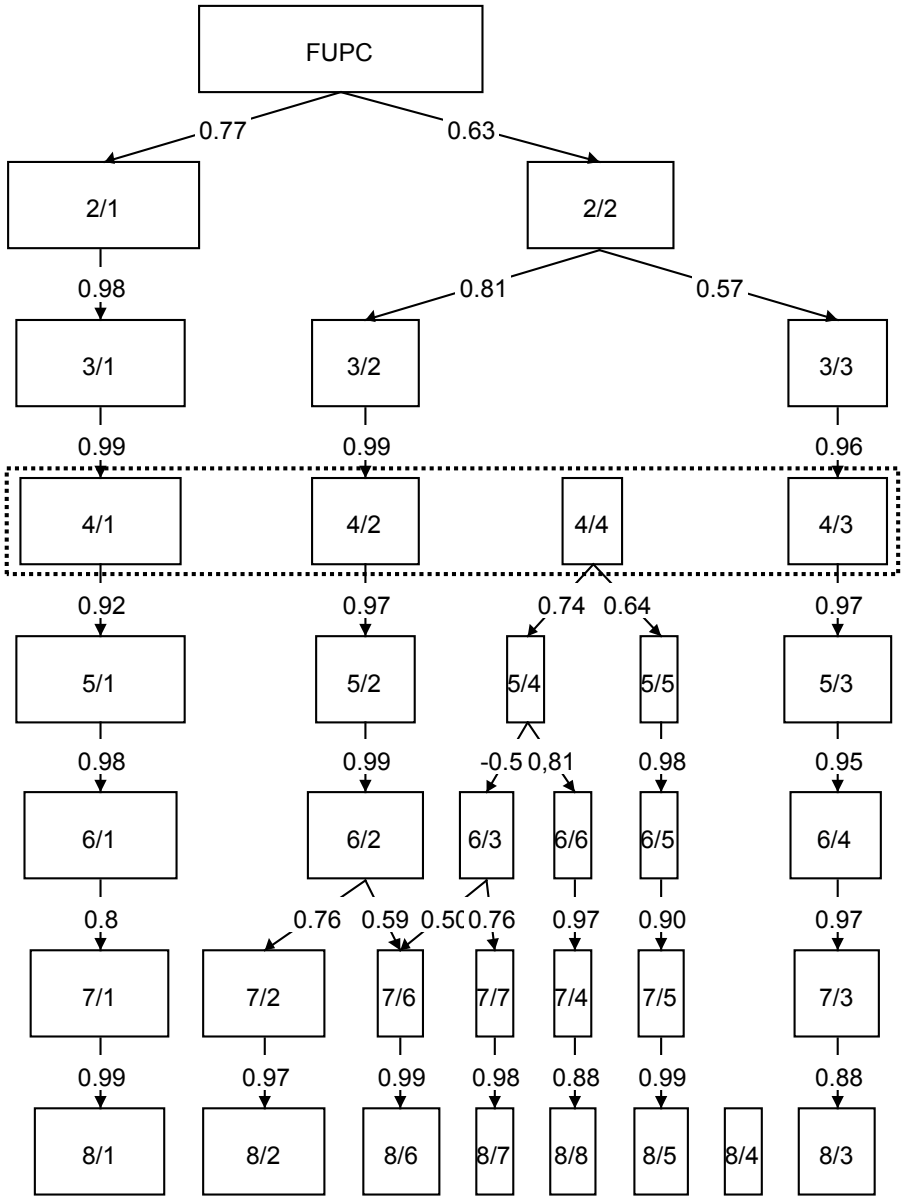

Figure 1: factor diagram showing the hierarchical factor structure (Goldstein 2006) in our dataset. Each row of the diagram shows the factor solution for the data (from separate analyses of the data) from one factor at the top to eight at the bottom. The boxes in each row represent individual factors, and the width of the boxes their percentage explained variance. The arrows between the boxes indicate the most important correlations between the different factor solutions and the numbers the corresponding correlation coefficient. The dotted box shows the optimal factor solution.

Table 4: Factor arrays of the emotion sorts per factor[5]. See appendix A for the pictures.

No.	Picture	Factors			
		1	2	3	4
1	bio-based economy in Europe	2†	0	0	1
2	infographic about Carbon Cycle with the use of biomass	0	0	1	4†
3	infographic of ethanol production from biomass	1	-1	1	0
4	corn cob with hunger gauge	-2*	0	-1	-1
5	tree shaped as light bulb	4	4†	0*	2
6	chemical formulas	-1	-3*	-2	0
7	infographic about Carbon Cycle using biomass for heat and power	0	1	1	-1
8	degradable plastic bag	3	0	0	3
9	bio-based cycle	0	-1	-1	0
10	composting logo	2	-1*	2	1
11	bioplastic logo	3†	0	1	1
12	bio-power plug	2	3†	1	0
13	refuelling with biodiesel	1	2	1	-1†
14	algae farm	1	0	2*	1
15	algae flasks ‡	-1	-2	0	0
16	factory	-1	-2*	-1	-4*
17	Dutch limits to biomass cartoon	-2†	0	-1	2*
18	cartoon of Western looking man who takes away food from an African looking child	-4	-4	-4	-3*
19	green dreams; harvesting sugar cane	-3†	-1†	3	1
20	mechanised harvesting	-2	-2	-1	-1
21	oil drums coverd with rape seed field image	0	1	2	0
22	a rapeseed field against a blue sky with a 'grown for biofuel sign grown for biofuel	1†	2*	4	4
23	rooting oil tank	-1*	1	-2*	1
24	gasoline pump in a wheat field	-1†	2*	3	3
25	a traffic jam with a sunflower covered nozzle	2†	3	3	-1†
26	biodiesel filling stations	0	0	-1	0
27	a Mercedes on biodiesel	0	1	0	-2†
28	cartoon of plant growing various bio-based products	-2	0	-2	0
29	composition of filled scientific glassware, with corn cobs and bio-plastic pellets	-1	2†	0	-1
30	a car that is being refuelled with wheat	-1	4†	0	-2†
31	public protest of Greenpeace against biodiesel	-1†	-3	-3	1†
32	a water filled bio-plastic cup	4	3	-1†	2*
33	infographic of things a micro-organism can produce from biomass	1*	0*	2*	-2†
34	scheme of manufacturing with biomass to recycling ‡	0	1	1	2
35	an Erlenmeyer with shoot	2	2	2	-1†
36	algae close-up	0†	2†	-2	-1
37	clouds with CO2	-2	1†	-2	3†
38	polar bear on melting ice flow	-4†	-3	-2	0†
39	recycling and reuse of a plastic bag from biomass	3*	1	0	2
40	biobased plastic with family	2†	-1	0	0
41	fuelling car with vegetable oil process	1	-2	0	-2
42	a dirt road with on the left a scourged field and on the right a green field	-2*	-2†	-3	-4
43	an Orang-utan with a nozzle pointed to its head	-3	-1†	-3	-3
44	composition from wood chips to biodiesel	1*	-1	-1	-2
45	a display of bioethanol from maize	0	1	4†	-3†
46	people working in biomass factory	0	-2†	2	1
47	overview of types of biomass	1	-1†	1	2
48	a mock-up of Mucha's autumn which takes off its green mask	-3	-4	-4	-2†

[5] Statements with the highest factor scores (-4, -3, 3 or 4) are called characterising statements of that factor. Statements with a factor score that differs significantly between factors are called distinguishing statements for that factor (* $p<0.05$; † $p<0.01$). Statements that are not distinguishing between any of the identified factors are called consensus statements (‡ $p>0.01$).

2.5 Results

Below we describe each factor based on the interpretation the analysis of the factor data and quotes from the respondents. The name of each factor captures and summarises each viewpoint.

Factor 1: Compassionate environmentalist

Table 3 shows 14 participants loaded on this factor, these are mainly younger aged, higher educated participants (table 2). The top of table 5 shows the characterising pictures for factor 1 that gave participants the most positive (+4 and +3) and negative (-4 and -3) feelings with their accompanying rank, card number and description. Pictures marked with an * were found to be distinguishing for this factor. Descriptions of other distinguishing pictures[6] can be found in the factor array overview (table 4). Participants with this emotional viewpoint focus on taking care for their environment. They describe positive feelings of hope, happiness and affection which are related to their living environment and actions they can do to take care about it. Negative feelings they expressed were anger, sympathy and fear related to negative impacts onto their wider environment and the fact they feel there is little they can do to take care of it.

Compassionate environmentalists get 'good feelings' from the cards on ranks +3 and +4, as they associate this with actions of recycling, the use of bioplastics and production of green energy. *'This [5] suggests pure, green energy which doesn't affect the environment*[7] *'. 'This [11] is reassuring, with good plastics we retain the planet for our children.'* The cards represent things the participants associated with this factor feel they can do in their closer-to-home environment. These actions enable them to take better care of their own environment. *'There should be more of this [8], you know you are doing the right thing.'* The distinguishing pictures of a father with a child (40) and the nozzle (25) emphasise that participants with this viewpoint care for their environment. The distinguishing picture of Europe (1) strengthens participants wish for everybody taking action, to do something for the environment by and within Europe. *'This [1] makes me hopeful, I think it is very important that every person, province, country and continent, so everybody on earth should do its best to be as environmentally friendly as possible.'* The pictures that gave negative feelings are associated with possible negative consequences of climate change as well as possible negative consequences that accompany a transition to a bio-based economy. The possibility that such economy will create clear-cut landscapes, scourge and pol-

[6] Pictures not shown

[7] Text in italic represents quotes from the interviews from the members associated with the factor connected to the aforementioned cards. In our translation we stayed as close as possible to their original statements.

lute the social and natural environment occur farther from their personal environment. Participants have a desire for change but at the same time worry about the potentially adverse impacts of a bio-based economy. *'There is a dark side to the beautiful idea of a bio-based economy.' 'The earth is being polluted.' 'I feel pity for the animals, they quickly become the victim of the obtuseness of man.'* Distinguishing pictures (42, 17 & 4) emphasise participants' concern about the consequences of this development.

Factor 2: Principled optimist

Table 3 shows that eight participants loaded on this factor and table 2 indicates that these are mainly lower to middle educated participants with a higher income. The bottom half of table 5 shows the pictures for factor 2 that gave participants the most positive and negative feelings with their accompanying rank, card number and description. Principled optimists focus on the mode of production. Positive emotions that participants with this emotional viewpoint describe are feelings of enthusiasm, happiness and optimism. Their feelings are linked to the idea that, with a bio-based economy, nature will ensure future supply of fuel and products. Negative emotions they expressed were concern, anger and frustration which are related to factories. Factories where biomass is processed do not seem to be part of their views on a bio-based economy. Although principal optimists find ways to provide for the future aspiring they don't want to go bio-based at all costs.

The pictures that gave the most positive feeling for this factor represent bio-energy, biofuel and bioplastic. In the interviews participants associated with this factor mention the production of biofuels and products made from bio plastic. *'Free fuel, you drive on plants that grow alongside the road.' 'Nature provides!'* Participants like the idea that their way of life can be sustained by using biomass as a resource. *This [25] indicates we no longer have to drill for crude oil.'* Positively distinguishing pictures 22, 36, 29 & 24 emphasise participants' elevated interest in the conversion of biomass for fuel. *'Happy, if it appears that in the future it is possible to generate fuel in a natural way.'* The pictures that gave the most negative feeling represent participants' concern that nature and other people will suffer from this development and their frustration about the possible price society has to pay. '*There is already so much hunger in the world and if we visualise a bio-based economy like this [18] nobody will like it.*' *'This [18] gives me a feeling of pursuit for profit'.* Principled optimists don't seem to realise that there is an industrial aspect behind a bio-based economy. '*Factories destroy everything and are hugely polluting'.* Negatively distinguishing pictures of factory settings (16 & 46) where biomass is converted emphasised this. *'Mass production is usually unhealthy.' 'Machines in scourged landscapes never give me a good feeling of what happens there'.*

Table 5: Most characterising pictures – that gave the most positive and negative feeling – for factor 1 and 2 with their accompanying rank and card nr and description. Card nr with an * are also distinguishing pictures for this factor (see table 4).

Factor 1					
Rank	**4**	**4**	**3**	**3**	**3**
Card nr	5	32	39*	8	11*
Picture					
Description	A tree shaped light bulb	A water filled bio plastic cup	Recycling and reuse of a plastic bag from biomass	A 100% degradable plastic bag	A bio plastic logo
Rank	**-4**	**-4**	**-3**	**-3**	**-3**
Card nr	38*	18	48	19*	43
Picture					
Description	A Polar bear on a melting ice flow	Cartoon of a Western looking man taking away a corn cob form an African looking child	A mock-up of Mucha's autumn which takes off its green mask	A man in protective clothing standing next to an almost destroyed field	An Orang-utan with a nozzle pointed to its head
Factor 2					
Rank	**4**	**4**	**3**	**3**	**3**
Card nr	5*	30*	12*	25	32
Picture					
Description	A tree shaped light bulb	A car that is refuelled with plants along the road	A plug connection in a tree	A traffic jam with a sunflower covered nozzle	A water filled bio plastic cup
Rank	**-4**	**-4**	**-3**	**-3**	**-3**
Card nr	18	48	38	6*	31
Picture					
Description	Cartoon of a Western looking man taking away a corn cob form an African looking child	A mock-up of Mucha's autumn which takes off its green mask	A Polar bear on a melting ice flow	Chemical formulas	Public protest against biodiesel production

Factor 3: Hopeful motorists

Table 3 shows that four participants loaded on this factor. These were mainly low to middle educated males with a middle income (table 2). The top of table 6 shows the pictures for factor 3 that gave participants the most positive and negative feeling with their accompanying rank, card number and description. Hopeful motorists focus on the production and use of biofuels for transport. Positive emotions that participants with this emotional viewpoint describe are feelings of hope and reassurance connected to the prospect that with biofuels they can continue driving their car and it is a less polluting alternative for fossil fuel. Negative expressed emotions were despair and loathing, which are linked to the negative consequences of biofuels and the possibility that could force them to give up driving a car. On the one hand they hope they can maintain to drive as they do but they despair that this will not be the case because of the negative consequences of biofuels.

The pictures that gave hopeful motorists the most positive feelings show that the growth of biomass for the production of biofuels is most salient to these participants: *'A huge, healthy looking field specifically grown for the production of biofuels.' 'If that would be possible.'* The positively distinguishing pictures for this viewpoint emphasise the production of fuels. The corncob, the algae farm and micro-organism demonstrate different generations of biofuels (45, 14 & 33). '*Reassuring: we can continue driving.' 'A clear idea of how much ethanol a corncob could produce.'* The pictures that gave participants with this viewpoint the most negative feelings represent the negative consequences of the production of biofuels and driving a car. In the interviews they mention: *'This [18] is a wrong setting of priorities, this looks like stealing instead of exchanging.'* Distinguishing picture 23 also emphasises participants' focus on the production of biofuels. The participants are aware of the negative polluting consequences of conventional fuels.

Table 6: Most characterising pictures – that gave the most positive and negative feeling – for factor 3 and 4 with their accompanying rank and card nr and description. Card nr with an * are also distinguishing pictures for this factor (see table 4).

Factor 3					
Rank	**4**	**4**	**3**	**3**	**3**
Card nr	22	45*	25	24	19
Picture					
Description	A rapeseed field against a blue sky with a 'grown for biofuel sign'	A display of bioethanol form maize	A traffic jam with a sunflower covered nozzle	A gasoline pump in a wheat field	A man harvesting sugar cane with the text green dreams
Rank	**-4**	**-4**	**-3**	**-3**	**-3**
Card nr	18	48	42	43	31
Picture					
Description	Cartoon of a Western looking man taking away a corn cob form an African looking child	A mock-up of Mucha's autumn which takes off its green mask	A dirt road with on the left a scourged field and on the right a green field	An Orang-utan with a nozzle pointed to its head	Public protest against biodiesel production
Factor 4					
Rank	**4**	**4**	**3**	**3**	**3**
Card nr	22	2*	37*	24	8
Picture					
Description	A rapeseed field against a blue sky with a 'grown for biofuel sign'	Infographic about the Carbon-cycle with the use of biomass	A bright clean sky with CO_2 as text in it	A gasoline pump in a wheat field	A 100% bio-degradable plastic bag
Rank	**-4**	**-4**	**-3**	**-3**	**-3**
Card nr	42	16*	43	18*	45*
Picture					
Description	A dirt road with on the left a scourged field and on the right a green field	A biomass processing factory	An Orang-utan with a nozzle pointed to its head	Cartoon of a Western looking man taking away a corn cob form an African looking child	A display of bioethanol form maize

Factor 4: Cynical environmentalist

Table 3 shows three participants loaded on this factor who were mainly middle to older aged, middle to higher educated males with an above average income (table 2). Table 6 shows pictures for factor 4 that gave participants the most positive and negative feeling with their accompanying rank, card number and description. Cynical environmentalists focus on the independence of non-renewable resources and they distrust stakeholders involved in a bio-based economy. Positive emotions that participants within this viewpoint express are feelings of interestedness and happiness, which are connected with their idea that within a bio-based economy, society will become independent of non-renewable resources. Cynicals' negative feelings of disgust and rage arise from a perceived inefficacy to act against and distrust in industrial and governmental stakeholders involved in the bio-based economy.

Cynical environmentalists welcome the opportunity to become independent of non-renewable resources and the shift towards renewable resources and recycling. '*I see a huge field for bio-oil instead of fossil fuel.' 'How does it work, how can it replace fossil fuel?'* The pictures that gave participants the most negative feelings are associated with not anticipated and undesirable consequences of a bio-based economy. The idea that this new economy also uses factories and mass scale production methods which will affect animal and social welfare disgusts Cynical environmentalists and makes them feel powerless. *'I feel nothing I can do will matter, I have to resign in this.'* The distinguishing pictures (30, 27, 33 & 48) emphasise that Cynical environmentalists' disgust emanates from feelings of distrust of stakeholders who are engaged with a bio-based economy, such as industry and government. *'A big fat polluting Mercedes on biodiesel, a chutzpah!'* They suspect these stakeholders go bio-based to uplift their polluting and self-interested practises.

2.5.1 Comparing emotional viewpoints

In comparing the emotional viewpoints commonalities and differences can be found. See figure 2 for a visual overview of the different views. It shows that although the environment is important for participants with a Compassionate as well as those with a Cynical viewpoint, the distinction between the two is caused by the latter's distrusts of industry's motives for going bio-based. The Compassionate Environmentalists seem to have more confidence in both government and industry to do the right thing. They care for the environment and hope that with collective action the planet can be retained.

Principled Optimists' have a more positive outlook than Cynical Environmentalists. Both Optimists' and Cynical's positive feelings are connected to the idea that with this development society no longer depends on finite resources. For both viewpoints new ways of production are

salient but Optimists negative feelings are more focused on the mode of production and its effects and the Cynicals focus on who is producing and their motives for going bio-based. A difference between the 'Principled optimist' viewpoint and the 'Compassionate Environmentalist' viewpoint is that the former viewpoint embraces the production of bio-fuels and the latter does not. Optimists are more focused on modes of production while Compassionates focus more on the environment.

Although both Hopeful Motorists' and Principled Optimists include biofuels in their viewpoint they differ in that for the former this is their main focus while for the latter this is just one element in their viewpoint. Motorists' feelings of loathing are connected with the negative effects of the development of biofuels. Principled Optimists also have negative feelings of concern, frustration and anger towards the effects of using biomass although these extend beyond the use of biomass for the production of biofuels. The use of biomass as a resource for independence is also important in the Cynical and Hopeful viewpoint. The latter is, however, mainly focused on the use and production of biofuels from biomass whereas the former is focused on a wider use of biomass for society to become independent of non-renewable resources.

Figure 2: Visual overview of the four different emotional views on a bio-based economy. Picture by: Total Shot Productions.

6. Discussion & conclusion

Contributing to a richer account for emotions in public engagement, the aim of this study was to unravel emotional viewpoints on a bio-based economy of the public at large. We have applied Q methodology with pictures and found four emotional viewpoints. These provide insight into the distinct and shared ways through which members of the public connect with a bio-based economy. The results show that participants don't have single black or white feelings but rather demonstrate complex arrays of emotions towards this subject. Even though members of the public express similar emotions they are triggered by different aspects of a bio-based economy.

Earlier studies on social representations of climate change (Smith & Joffe 2013; Hoijer 2010) concluded that emotions play an important role in making the issue recognisable and comprehensible. This present study shows how emotions help members of the public to understand what a bio-based economy is. By sorting the pictures according to their feelings participants constructed their own social representation of a bio-based economy. As these emotion based conceptualisations help members of the public focus, entice reflection and motivate for action they are a starting point for public engagement.

This study extends findings from Berg et al. (2013) on public perceptions towards a bio-based economy. They suggest that public's representations of a bio-based economy are non-existent. However, our study has shown that connected to their emotional views members of the public do have different representations of a bio-based economy. So instead of approaching civic society as a blank slate, stakeholders would do well to take these representations and connected emotional views into account. Identification of other perspectives for engagement has been shown to be an important step for engagement with complex issues (Cuppen, 2012). Specially as members of the public conform their viewpoints based on those that dominate amongst their peers rather than what they are being told by an expert (Kahan, 2010; Kahan, Peters, et al., 2012).

The emotional views have further implications for public engagement with the development of a bio-based economy. Our results indicate commonalities in the demographic backgrounds of the participants per factor suggesting that there are particular groups within society based on their emotions. These may facilitate a group specific engagement process as they may predict which emotions are likely to appeal to which group. But despite these shared backgrounds our results did not provide further insight in other characteristics such as car ownership, or view on nature defining these social groups and associated emotional views *ex-ante*. This would require further study. Nevertheless, we did find four distinct emotional viewpoints to consider for public engagement. And since people's emotions play an important role in the choices they make and how they are motivated to engage (Pidgeon & Fischhoff,

2011; Roeser, 2012b), our results imply that just as there are different emotional viewpoints amongst Dutch members of the public, there will be different actions taken amongst them. This suggests that collective action should not require everybody to be engaged in the same action but rather that all actions aid to achieve a collective goal.

In this study we only looked at the affective aspects of public's engagement with a bio-based economy. Since emotions also have a motivational aspect and engagement implies a form of action (Lezaun & Soneryd, 2007) it would be interesting to investigate in more detail how an emotional viewpoint motivates members of the public. Especially since a bio-based economy requires collective action and decisions made by the members of the public influence the direction of its development.

Instead of omitting emotions and underestimating the role images can play in engagement (N. Smith & Joffe, 2013; Wibeck, 2012) with a bio-based economy this study rose up to the challenge. Having used bio-based stakeholders' pictures for sorting, the study also adds to literature on how members of the public compose representations of a bio-based economy based on the representations of stakeholders (Bauer & Gaskell, 1999). Based on the pictures, participants were able to construct their own view of how they feel and conceptualise this economy. This was also mentioned by some of the participants during their Q interview. Ranking pictures provided them with an opportunity to learn what a bio-based economy encompasses and to formulate their own emotional viewpoint towards it. So, Q methodology not only created insight in their different emotional viewpoints towards a bio-based economy, but through the Q sort participants actually started to engage with the issue.

CHAPTER 3

HOW PEOPLE FEEL THEIR ENGAGEMENT CAN HAVE EFFICACY FOR A BIO-BASED SOCIETY

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Chapter 3:

How People Feel their Engagement can have Efficacy for a Bio-based Society

Abstract

Up till now, the transition to a bio-based economy mainly involves expert stakeholders. However, the actions required are of a collective scale necessitating public engagement for support and action. Such engagement is only successful if members of the public believe their participation holds efficacy. This belief is closely linked to their personal representation of the issue. We report findings from our Q methodology workshop that explored public's efficacy beliefs on their perceived ways for engagement with a bio-based economy. Participants were provided with stakeholders' visual representations depicting a concourse of the transition to a bio-based economy for Q sorting. We found five efficacy beliefs. These beliefs differ in differ in the size in which they perceive the context of their engagement corresponding with the differences between personal and collective efficacy. These results indicate that members of the public foresee distinct and shared ways and levels in how they can engage with the transition to a bio-based society that do not always concur with stakeholders' views.

3.1 Introduction

Our economy is in transition, from being fossil fuel based to bio-based (Commission, 2012; OECD, 2009). This bio-based economy uses bio-renewable materials and bio(techno)logical processes for the production of chemicals and materials such as medicines and plastics, and energy for transport and other usages (Langeveld et al., 2010). Many scientists, policymakers, industrialists, and non-governmental organisations (NGOs) believe in the potential of industrial biotechnology for a bio-based economy and the development of a more sustainable society (Bang et al., 2009; Commission, 2012; Paula & Birrer, 2006; Soetaert & Vandamme, 2010). This transition is likely to significantly affect developments that deal with sustainability, mobility, food-and-, energy security, governance, public health, safety, logistics and social and industrial infrastructure (Langeveld et al., 2010) and their growing global interdependence. The changes involved put pressure on people's sense of control over their living environment and way of life. With their personal choices and forms of participation, the public is expected to influence the direction of development of this transition (Gijsbers et al., 2005; Paula & Birrer, 2006). The complex nature and scale of a bio-based economy and its associated developments require collective action necessitating public engagement (Sleenhoff, Landeweerd, & Osseweijer, 2015).

Public awareness of the bio-based transition is limited (Asveld et al., 2011; Pesch et al., 2010). Berg et al. (2013) even claim that public representations of a bio-based economy are currently non-existent. Up till now mainly (non-) governmental, scientific, technical, biomass providing and processing stakeholders are involved in developing the transition. These stakeholders have different and sometimes conflicting narratives and values about bio-based developments which complicate public engagement (Cuppen et al., 2010). However, Sleenhoff, Cuppen, and Osseweijer (2015) have shown that despite the complex nature of the transition and the public's limited awareness they do construct their own representations of a bio-based economy based on stakeholders' visualisations (see chapter 2).

Any attempt to engage the public with the bio-based transition will confront the public with stakeholder representations. O'Neill, Boykoff, Niemeyer, and Day (2013) found that for climate change such representations not only play an important role in denoting the importance of the represented issue, but also they play an important role in how capable the public feels they are to contribute to the issue. This connects to what Macnaghten and Jacobs (1997) described: 'public engagement will be more successful if their feelings of being able and capable to do something is developed at the same time as their awareness.' Or as Wynne (1991, p. 118) put it: 'those who do or develop the motivation often show great alacrity at seeking out sources and assimilating science.' The capacity to stimulate awareness and efficacy at the same time can be found in visual representations.

One needs to study in what way stakeholder representations engage the public; not merely in terms of 'negative/positive' but also in terms of facilitating collective support and action or obstructing this. Adding to the unravelled emotions people have towards the transition to a bio-based economy (Sleenhoff, Cuppen, et al., 2015) this paper focusses on their perceived efficacy for engagement. We will explore the ways in which the public believes it can contribute to a bio-based economy. This insight should help to advance efforts for meaningful public engagement for collective action. In this paper we describe which different efficacy beliefs we found amongst the public at large towards a bio-based economy. We approached this without taking an actual position towards the transition to a bio-based economy, focussing on processes of engagement and collective action rather than on justification of this transition as such, and without seeking to deliver tools and instruments for public legitimation of this transition. We do, however, take the position that a morally and democratically justified transition to a bio-based economy needs an open dialogue in society.

This paper is built up in the following way: section two introduces ways for meaningful public engagement with a bio-based economy. The third section describes how social representations influence public engagement. In the fourth section we discuss the necessity for developing the public's efficacy belief for public engagement while they are developing their own representations. In the fifth section we describe how we elicited the different efficacy beliefs using stakeholders representations for sorting in a Q methodology workshop. The results are presented in the sixth section. In the seventh section we discuss our findings and conclude with implications for collective public engagement with a bio-based economy in the final section.

3.2 Meaningful public engagement with a bio-based economy

The master narrative of a 'knowledge based bioeconomy' for Europe promotes industrial research and development for opening up new markets for the exploitation of renewable and sustainable resources (Birch, Levidow, & Papaioannou, 2010; Levidow et al., 2013). Up till now, scientists, industrialists and policymakers are the predominant stakeholders involved besides farmers and NGOs. They call for an open and informed dialogue that includes the public at large during the development of this bio-based economy (such as Commission, 2011a, p. 74; Commission, 2012, pp. 8, 13, 27). Through such open dialogue stakeholders anticipate the lifting of the perceived problem of a public deficit of knowledge, a well-known problem in public engagement and science policy literature (Irwin, 2014; Stilgoe, Lock, & Wilsdon, 2014; Sturgis, 2014). However, this is a very institutionally driven, instrumental approach to engagement which often does not lead to more meaningful engagement of the public. Quite the opposite; where

stakeholders expect to increase the legitimacy of their actions through such activities eliciting public opinion, they rather quench the public voice (Cooke & Kothari, 2001; Wynne, 2006).

Public engagement can offer means to deal with the tensions between values of science for the economy and democracy by opening up social choices (Stirling, 2012). Taking emotions into account has been suggested to enhance public engagement with complex issues (Osseweijer, 2006; Pidgeon & Fischhoff, 2011; Roeser, 2012b). As integral part of our decision-making, reflection, perceptions and behaviour, emotions provide people with cues on how to evaluate information and its presenters and act accordingly (Hoijer, 2010; Kahan, 2010; Nussbaum, 2001). Emotions entice reflection which will influence people's choices as they not only have to take into account the effect of their choices on their personal life but also on their wider community or future generations.

When emotions are taken into account for public engagement then different social representations of a bio-based economy emerge (Sleenhoff, Cuppen, et al., 2015). These representations show that the public at large have different conceptions of a bio-based economy, which do not necessarily reconcile with the master narrative of a knowledge based bio-economy. These representations give insight in how the transition to a bio-based economy has become more concrete and tangible for members of the public; how they envision such a new economy (Wynne, 2014). Being aware of these different public narratives of a bio-based economy should facilitate opening up dialogue with policymakers as they make public views explicit. In their evaluation of public engagement initiatives within Europe Felt and Wynne (2007) also stress the importance of considering and reflecting on such different narratives as they represent people's different perspectives.

3.3 Visual social representations of a bio-based economy

Social representations are shared understandings, beliefs and practises of unfamiliar phenomena by individuals in social groups. They can be regarded as networks of ideas, metaphors and images that include emotions, attitudes and judgements (Moscovici, 2002). Social representations are generated through communication and show how people make sense of complex unfamiliar issues and how that understanding is transformed into everyday knowledge (Joffe, 2003; Moscovici, 2002).

Images or visual social representations are extremely powerful in making the abstract and unfamiliar more concrete (Rosa & Farr, 2001). They have also been found efficient in collective meaning making since they externalise emotions (Mamali, 2006). Such representations have the capacity to quickly convey messages, condensing complex issues as well as the capacity to engage and motivate people (Nicholson-Cole, 2005). And since they can cross

cultural and geological barriers such visual representations have greater intelligibility and interpretability (Rosa & Farr, 2001).

By the process of communication through various media and occasions about bio-based developments and expansions, relevant stakeholders cluster themselves into social groups with shared views and social representations thereof. In their public communication they make ample use of photographs, pictures, info graphics, cartoons, metaphors and other forms of visual representations to illustrate and support their messages. By doing so, they create specific social representations of a bio-based economy that can be regarded as identifying characteristics of those groups. The images indicate how stakeholders understand and give meaning to this development, and these representations are also taken up in public understanding. Analysis of such stakeholder representations can help in bridging the gap between the public and the technical and scientific developments associated with a bio-based economy as they transform this complex phenomenon into hybrid forms which draw on both science and the public's everyday life world (Bauer & Gaskell, 1999).

3.4 Collective engagement for a bio-based society

The development of a bio-based economy will dictate changes to society which will likely affect various aspects of our daily life. Which actions and behaviour changes are necessary, desired and accepted from the perspective of sustainable development and the extent to which members of the public can and are willing to act is up for debate. This requires public engagement which means effort, ranging from the processing of information to the production of an opinion or taking action. In order for members of the public to exert themselves, contributing to the transition, they need to feel confident and capable to do so. So, identifying meaningful ways in which they can respond is important (Ballard, 2005; Gehrke, 2014; Lorenzoni et al., 2007).

Results of a study on the impact of climate change imagery for public engagement showed that such representations play an important role in promoting feelings of efficacy besides increasing the saliency of the issue. Also the emotions attached or evoked by such images have been found to influence people's level of engagement (O'Neill and Nicholson-Cole, 2009). Considering these findings with regard to the transition to a bio-based economy stakeholders would be wise to consider the messages their imagery communicates and the type of responses it will generate.

Promoting awareness alone does not lead to meaningful engagement of the public (Irwin, 2006; Irwin, Jensen, & Jones, 2013; Jaspal, Nerlich, & Cinnirella, 2013). Their efficacy beliefs have to be developed simultaneously (Macnaghten & Jacobs, 1997) giving perspectives and facilitating members of the public to develop ways through which they want to engage with

the transition. What they buy, how they choose to travel, how they vote, how they recycle their waste, and even their level of acceptance of technology and governance will influence the development and structure of a bio-based economy. Thus if one does not provide members of the public with a sense of being capable to change and affect their own situation or the wider world, attempting public engagement is futile.

Despite the difference between the various master narratives about the bio-economy they all point out that some form of collective action, including that of the public at large, is required (Levidow et al., 2013). When people have an idea of how they can take action, making meaningful contributions, they have been found to be more inclined to learn new skills and adopt alternative behaviours (Ballard, 2005). Motivations and actions are partly guided by their beliefs of personal efficacy (Bandura, 1995a, 1997). These beliefs have been found key for individual and collective behaviour (Bandura, 2000).

Efficacy beliefs influence how people think, how they will act, what goals they set for themselves and their commitment to achieve them (Bandura, 1995a). For collective public engagement with a bio-based economy members of the public need to be empowered in ways they can contribute. Therefore they need to be able to develop and *share* their own narratives, establishing their own relations with, and representations of the bio-based transition and belief for collective action. Stakeholder representations form an important and powerful connection to how people will build a shared believe in how they can make a meaningful contribution.

Gaining insight in how people consider themselves capable to contribute to the transition can enhance the required collective action. Research in this requires an open method that allows people to construct their own perspectives of the issue at hand. Q methodology is such method that takes divergence and complexity into account. Besides, through Q sorting people start to engage with the issue at hand. The sorting process offers an opportunity to learn what a bio-based economy encompasses.

3.5 Method

Q methodology is a method used for studying people's subjectivity in a structured and statistically interpretable way (Barry & Proops, 1999; Cross, 2005) developed by William Stephenson (1953). His methodology follows a holistic approach (Brown, 1996) for the analysis of complex and diverse viewpoints, opinions, beliefs or attitudes in a population without losing the complexity of the issue (Stirling, 2010). Q methodology gives insight into the variety of viewpoints that exist among a population rather than the prevalence of viewpoints within a population (Cuppen et al., 2010). These viewpoints are unravelled through the process of Q sorts. Participants are asked to rank a number of items which together represent all the relevant aspects

of all discourses on a topic ('concourse'[8]). By doing so, participants evaluate the items in relation to other items revealing their subjective viewpoint (N. W. Smith, 2001). Based on their expressed similarities and differences in Q sorts, shared viewpoints amongst participants can be identified (Brown, 1997; McKeown & Thomas, 1988). Normally, textual statements are used as items for sorting. However, visual images are used increasingly (Fairweather & Swaffield, 2001; O'Neill, Boykoff, Niemeyer, & Day, 2013; Sleenhoff, Cuppen, et al., 2015) as they have proved to produce rich and subtle interpretations of complex phenomena and our world is too complex to understand by just a word by word description.

This study draws upon the image sorting Q methodology described by Sleenhoff, Cuppen, et al. (2015). For our Q sorts we collected pictures used in public communication by bio-based stakeholders as defined in Sanders and Langeveld (2010) supplemented with pictures which were retrieved by searching the internet using specific keywords. This resulted in a series of over 300 different pictures. Having removed overlapping finds the remaining pictures (100) were individually refined by eight colleagues who are knowledgeable on the bio-based economy. Each colleague was asked to select forty pictures that according to their view represented the full range of views on a bio-based economy. They were also asked if they felt if any particular view was missing. Based on their most and least selected pictures complemented with their suggestions we compiled a set of forty-eight pictures[9]. Pilot testing our set affirmed the used pictures were comprehensible and our procedure for sorting was understandable and easy to follow.

Participants were recruited by a marketing research company so together they resemble the average demographic of Dutch society (Statistics Netherlands, 2011). As we did not have any basis to assume that particular groups within society differ in level of being able to do something or their perception of being able to do something (efficacy beliefs) with regards to a bio-based economy, we aimed for a diversity amongst our participants based on demographic factors such as age, level of education, level of income, household composition and gender (Table 7). We included only adults for participation as they are currently the ones who make choices relevant for a bio-based economy (e.g. in their shopping or mode of transport) and excluded individuals who work in bio-based related branches (as we were of course interested in the engagement of those who are not professionally involved).

[8] The social representations we use for our concourse have similar and overlapping characteristics with discourses and narratives which can also be used for Q sorting.

[9] A complete overview of the pictures can be found in Appendix A

Table 7: Demographic distribution of our P-set of 39 people and their identified emotion factors in comparison to the demographic distribution of the Dutch society (Statistics Netherlands, 2011)

		CBS 2011	Our P set	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Age		%	%	%	%	%	%	%
Low	20-40	34	42	86	55	67	0	20
Middle	40-65	50	48	14	27	33	67	80
High	65 +	16	10	0	18	0	33	0
Gender								
Male		50	48	43	64	0	67	80
Female		50	52	57	36	100	33	20
Level of Education								
Low		32	29	29	9	50	0	40
Middle		40	39	43	55	33	100	20
High		28	32	29	36	17	0	40
Household								
Single		40	38	43	27	67	0	60
Multi		60	62	57	73	33	100	40
Gross Income								
Low	€ 0-20000	44	45	29	45	50	33	40
Middle	€ 20000-40000	34	38	71	27	33	33	40
High	€ 40000 +	22	18	0	27	17	33	20

In a face to face interview setting, thirty-nine participants were provided with our set of forty-eight randomly numbered colour printed images, a sorting grid and a step-by-step instruction guide (based on Exel & Graaf, 2005). For unravelling the perceived efficacy of the participants they were asked to rank the pictures on a scale from the ones that made them feel most enabled (+4) to those that made them feel least enabled (-4) to act. Having completed the sort, participants were interviewed and invited to elaborate on their sortings focussing on the extreme ranked pictures. They were asked to describe the kind of action they perceived themselves (dis)enabled of performing and why. Participants were asked to record their own sort on a score sheet, so we gathered both quantitative as well as qualitative data.

Table 8: Correlation coefficients of Q sorts for the five perceived efficacy factors[10].

Respondent	Factor				
	1	2	3	4	5
1	**0,67**	0,06	0,01	0,35	0,11
2	**-0,57**	-0,08	0,13	0,09	-0,37
3	**0,69**	0,05	0,03	-0,08	0,01
4	**0,57**	0,08	0,28	0,33	0,10
5	**-0,55**	0,22	0,06	0,32	0,25
6	**0,61**	0,16	0,23	0,22	0,35
7	**0,52**	0,33	0,13	0,32	-0,15
8	-0,11	**0,56**	0,27	0,10	-0,27
9	-0,09	**0,76**	-0,26	-0,08	0,17
10	0,23	**0,64**	-0,07	-0,08	0,29
11	-0,17	**0,57**	-0,27	-0,04	0,13
12	-0,04	**0,58**	-0,54	-0,05	-0,01
13	0,31	**0,63**	-0,05	0,20	0,34
14	-0,02	**0,64**	0,15	-0,02	-0,10
15	0,03	**0,53**	0,26	0,32	0,09
16	0,38	**0,66**	-0,29	-0,02	0,15
17	0,09	**0,65**	0,26	0,39	0,31
18	0,21	**0,65**	-0,03	0,06	-0,02
19	0,11	0,22	**0,60**	0,11	0,42
20	-0,34	-0,24	**-0,67**	0,14	-0,23
21	-0,13	0,32	**-0,66**	0,07	-0,13
22	-0,35	0,08	**-0,55**	-0,16	-0,08
23	0,19	-0,13	**0,49**	0,29	-0,14
24	-0,23	-0,03	**0,67**	0,01	0,04
25	-0,10	0,12	0,25	**0,82**	-0,14
26	0,29	0,08	-0,18	**0,47**	0,06
27	0,01	0,00	-0,16	**0,78**	0,18
28	0,09	-0,09	0,19	0,19	**0,65**
29	-0,16	0,27	0,04	-0,04	**0,68**
30	0,16	-0,08	0,14	0,26	**0,35**
31	0,06	0,26	-0,14	-0,20	**0,67**
32	0,18	0,04	0,38	0,32	**0,58**
33	0,48	0,34	0,16	0,21	0,41
34	0,34	0,45	0,09	-0,24	0,41
35	0,17	-0,27	0,29	0,34	0,18
36	0,28	0,42	-0,37	0,12	0,17
37	0,46	0,13	0,32	0,51	0,14
38	0,39	-0,02	0,21	0,31	0,47
39	-0,38	0,33	0,56	0,03	0,27
% expl.Var.	**11**	**14**	**11**	**8**	**9**

[10] A respondent defines (or loads) a factor if: the respondent correlates statistically significant with that factor; the loading of a respondent on a factor should exceed the multiplier for the statistical significance level (p=0.01) divided by the square root of the number of statements, in this case: 2.58*1/√48=0.37 (See McKeown & Thomas 1988)

3.6 Results

The Q sorts were analysed using factor analysis on the correlation matrix calculated from the participants' Q sorts. This procedure identifies the number of natural groupings of Q sorts, based on the degree to which these sorts are similar or dissimilar to one another. Together with the interview data these number of groupings can be interpreted as distinct views. We used PQ method 2.20[11] for the factor analysis applying Principle Component Analysis for the factor extraction and varimax for the factor rotation (see table 8). These are common procedures with Q methodology. For the composition of idealised Q sorts for each factor, factor arrays were calculated (see table 9). To decide on the number of factors to extract from the Q sorts we used Goldberg's (2006) method for visualising the hierarchical structure of our data set (Figure 3). It showed that the data contained at least three factors. Based on a close inspection of the different factor solutions – taking into account which of the participants loaded on a factor defining that factor and the interview data – we selected the five factor solution for their perceived efficacy beliefs. In total 32 participants loaded onto a factor. These five factors explained between the 9 and 14% of the explained variance in Q sorts and collectively 53%. By interpreting these factors through an iterative process between the distribution of the pictures, the loaders and their interview data they are converted into efficacy viewpoints.

[11] Software and manual can be downloaded from http://schmolck.userweb.mwn.de/qmethod/downpqwin.htm

Table 9: Factor array of the perceived efficacy belief sorts per factor [12] See Appendix A for the pictures.

No.	Picture	Factors				
		1	2	3	4	5
1	bio-based economy in Europe	0	-1	1	-1	0
2	infographic about Carbon Cycle with the use of biomass	-1	1	2	-1	-1
3	infographic of ethanol production from biomass	-1	-1	1	-1	1
4	corn cob with hunger gauge	1*	1*	-2	-1	-3
5	tree shaped as light bulb	2	2	2	1	3
6	chemical formulas	-1	-4*	1	-2	1
7	infographic about Carbon Cycle using biomass for heat and power	-1	-1	3†	0	-2
8	degradable plastic bag	2	3	3	0†	2
9	bio-based cycle	0	-1	1	1	0
10	composting logo	2	2	2	0†	2
11	bioplastic logo	2	2	1	-1†	4
12	bio-power plug	2	2	1*	4	4
13	refuelling with biodiesel	4	1†	-2†	4	3
14	algae farm	-2	-1	1	0	-2
15	algae flasks	0	-4†	0	0	0
16	factory	-2	-3	-1	-4	0
17	Dutch limits to biomass cartoon	-1	-1	-3†	0	0
18	cartoon of Western looking man who takes away food from an African looking child	1†	3†	-4	-3*	-4
19	green dreams; harvesting sugar cane	-3	0	-2	1	0
20	mechanised harvesting	-2	-3	-2	-3	-2
21	oil drums coverd with rape seed field image	0	0	2†	-2†	0
22	a rapeseed field against a blue sky with a 'grown for biofuel sign grown for biofuel	0	0	4	3	-4†
23	rooting oil tank	2†	-1	-1	-4†	-1
24	gasoline pump in a wheat field	1*	0	0	3*	-2*
25	a traffic jam with a sunflower covered nozzle	3	1	-1	2	1
26	biodiesel filling stations	3*	1	-1	1	-1
27	a Mercedes on biodiesel	3†	0	-1	1*	-2*
28	cartoon of plant growing various bio-based products	-2*	1	-1	2	1
29	composition of filled scientific glassware, with corn cobs and bio-plastic pellets	-2	-2*	0*	1*	-1
30	a car that is being refuelled with wheat	4†	0	1	2*	-1
31	public protest of Greenpeace against biodiesel	1†	2†	-2	-2	0
32	a water filled bio-plastic cup	1	1	2	-1†	3
33	infographic of things a micro-organism can produce from biomass	0	0	2†	0	-1
34	scheme of manufacturing with biomass to recycling	0	0	3†	-2*	1
35	an Erlenmeyer with shoot	-3	-2	0	1	-2
36	algae close-up	0	-2	0	0	0
37	clouds with CO2	-4†	3	-1†	1	2
38	polar bear on melting ice flow	-4	4†	-4	2†	-3†
39	recycling and reuse of a plastic bag from biomass	1	2	4	0	1
40	biobased plastic with family	0	1	0	-3	2
41	fuelling car with vegetable oil process	1	0	-1	-1	1
42	a dirt road with on the left a scourged field and on the right a green field	0	0	-3	-2	0
43	an Orang-utan with a nozzle pointed to its head	-2	4†	-2	-1	1†
44	composition from wood chips to biodiesel	-3	-2	0†	2	2
45	a display of bioethanol from maize	-1	-2	0	3†	-1
46	people working in biomass factory	-1	-3	0	0	-3
47	overview of types of biomass	1	-1	0	1	2
48	a mock-up of Mucha's autumn which takes off its green mask	-1	-2	-3	-3	-1

[12] Statements with the highest factor scores (-4, -3, 3 or 4) are called characterising statements or that factor. Statements with a factor score that differs significantly between factors from other factors are called distinguishing statements for that factor (* $p<0.05$; † $p<0.01$).

3.6.1 *To what kind of engagement do participants consider themselves capable?*

The five factors that resulted from the factor analysis were interpreted as five different efficacy beliefs on how participants see themselves capable of engaging with a bio-based economy in a relevant manner. The characterising pictures – those with the highest and lowest scores – and the pictures that distinguish most between factors are useful in interpreting a factor. Together with the interview data of the participants that significantly loaded onto a factor, we interpreted each factor. Below we describe each viewpoint and in figure 4 you can find a visual representation of all the described perceived efficacy beliefs.

Efficacy belief 1: Conscious shopping by…

Table 8 shows seven participants loaded on this factor. These are mainly younger participants with a lower to middle level income (see table 7). Two participants have a negative correlation coefficient making this a bi-polar factor. This means that the participants with a negative correlation coefficient hold an opposite perspective to what is represented by this factor based on the positive correlating participants. Therefore we present a twofold description for this factor.

a) Conscious shopping by Consumption

Participant quote: 'I can help improving things by making conscious choices. This [biofuels] reminds me that even by fuelling up my car I can help our planet.'

These participants are willing to engage with a bio-based economy because they consider themselves capable of several personal actions through which they perceive they may positively contribute to a cleaner and more sustainable society. Their actions are mainly guided towards more sustainable consumption. They want to make efforts in the use of biofuels, green energy and bio plastics but also consider action for recycling without the loss of current consumption or major behaviour change. The food versus fuel discussion, and the possible unfair treatments of people living in developing countries involved, is of less importance for their engagement and no reason for them to reduce their consumption pattern. *Consuming* participants are aware of the possible negative consequences connected to biofuels development, however, they still consider it an improvement. The more complex and wider issues connected to a cleaner and sustainable society such as deforestation, air pollution, inequity or reducing the greenhouse effect, are discouraging for these participants. They feel that despite their individual contributions they will not halt or limit these developments.

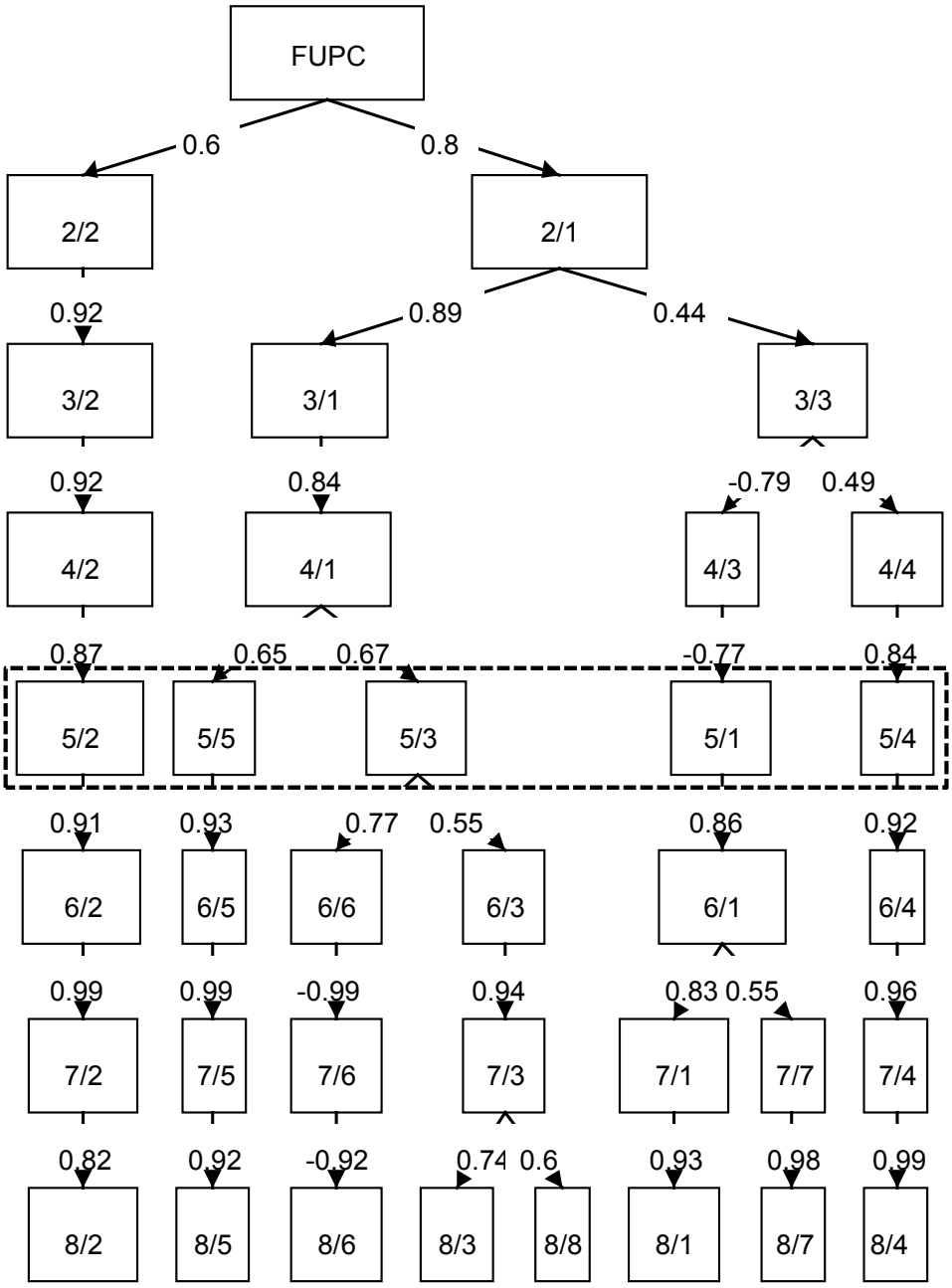

Figure 3: Factor diagram showing the hierarchical structure (Goldberg 2006) of the efficacy dataset. Each row of the diagram shows the factor solution for the data, (from separate analyses of the data) from one factor at the top to eight at the bottom. The boxes in each row represent individual factors, and the width of the boxes their percentage explained variance. The arrows between the boxes indicate the most important correlations between the different factor solutions and the numbers the corresponding correlation coefficient.

b) Conscious shopping by Sacrifice

Participant quote: 'Society is unable to take a step back; we say we agree with being more efficient and using less but we don't act upon it.'

These participants are willing to engage with a bio-based economy because they feel this development will positively contribute to solving complex issues such as the reduction of carbon emissions and more sustainable sources of energy. They also consider themselves capable of several personal actions through which they perceive they may positively contribute to a cleaner and more sustainable society. However, their actions are mainly guided towards more conscious consumption, reducing their consumption pattern. These *sacrificing* participants think that they can make a difference with their personal actions by consuming less or paying more for specific products. At the same time they are discouraged from engaging with the transition because they believe that people will not be able and willing to downsize their consumption pattern to make a difference. They do not think that society is willing to drive smaller, more compact and economically friendly cars, use biofuels or eat less or no meat.

Efficacy belief 2: Saving the world despite the technical terms

Participant quote: 'These protesting people against the forest & climate disaster due to the production of biodiesel make me feel I have to become a member of Greenpeace too'.

Table 8 shows eleven participants loaded on this factor. These are mainly middle to higher educated male participants (table 7). These participants are prepared to engage with the bio-based economy because of the anticipated negative consequences of its development such as the destruction of nature, unfair treatment of people from developing countries and an increase of greenhouse gas emissions. By taking personal actions such as protesting, donating money, purchasing environmentally friendly products, or collecting frying oil for recycling, they consider themselves able to avert these negative consequences. Concurrently these *saving the world* participants are discouraged to engage with a bio-based economy because of the technical and chemical aspects involved in its establishment. They consider such bio-based processes and innovations as the work of experts that work in industry and factories. They feel unable and powerless to influence or have control over them. Participants claim they lack sufficient understanding thereof to be able to make a meaningful contribution.

Efficacy belief 3: Recycle to…

Factor three is also a bi-polar factor. There are three people who have positive correlation coefficients for this factor and three who have negative correlation coefficients (table 8). All significantly loading participants are women who are mainly low educated and have a single household (table 7).

a) Recycle to be like nature

Participant quote: 'Even if we close the loops in our processes we will be unable to prevent destruction'.

These participants are eager to engage with the bio-based economy because of its cyclic character. They are attracted by the idea that this new approach to the economy is part of a natural process in which loops are being closed. The conversion of biomass into different sorts of energy and products enhances the success of their personal contributions. They consider recycling as something that everybody should be able to do, for closing their own loops. On the other hand, the *to be like nature participants* feel that with recycling they are not able to avert negative consequences such as the destruction of nature and stealing food and the living environment of other people and animals.

b) Recycle to prevent disaster

Participant quote: 'We should alert other people to more environmentally friendly behaviour such as recycling too'.

For these participants the negative aspects of a bio-based economy trigger them to recycle. They believe that if we all make more conscious decisions we can avert the negative consequences. They are even willing to encourage others to do the same. They feel that recycling is one of the things they can do to help avert the further destruction and pollution of our environment. For them the extra emphasis on the closing of product loops and recycling is unnecessary. They feel it should be something that is natural to everybody to do. *Preventing disaster* participants are discouraged to engage because they question how they can be sure about the nature and environmental friendliness of the products they use and recycle. They feel they lack sufficient information to make well informed decisions.

Efficacy belief 4: Filling my car with the 'right' fuel
Participant quote: 'I can reduce the use of fossil fuels by making the conscious choice for using bio-fuels. I am the one who determines where I fuel up my car'.

Table 8 shows three participants loaded on this factor. These are all middle educated, having a more person household, middle to older aged participants (table 7). These participants are willing to engage with a bio-based economy because of the production of biofuels. They feel capable to carefully select the type of fuel they use, reducing their fossil - non-renewable - fuel consumption. They believe that by choosing wisely they contribute to preventing further pollution of the environment and rapid depletion of fossil fuels. The outlook that even a bio-based economy, with biofuels, could still pollute the environment is demoralising for them as they perceive this to be a practice they cannot influence.

Efficacy belief 5: System limits personal contribution
Participant quote: 'Noting I do will make a difference, money and economy play the major part here'.

Table 8 shows five participants loaded on this factor. These are mainly middle aged, single living males that have received either lower or higher education (table 7). This behavioural perspective is focused on the system people inhabit. A participant's inclination to engage or not is connected to the extent they feel they have control over the system or not. *System limits* participants feel able to contribute to the bio-based economy by making small changes in their behaviour such as buying bio-plastics, reducing their personal energy consumption, driving on biofuels and paying attention to the amount of packaging of the products they purchase. With their personal actions participants perceive they can positively contribute to the transition to a bio-based economy. On the other hand they feel unable to contribute to the development of a bio-based economy due to the scale of its development and the occurrence beyond their sphere of influence. They do not belief voting for specific political parties would make a difference.

Figure 4: Visual overview of the different perceived efficacy beliefs towards a bio-based economy. Picture by: Total Shot Productions

3.7 Discussion

The hierarchical factor structure (figure 3) and the factor interpretations show that participants with a 'saving the world' efficacy belief immediately stand out. These participants' belief in being able to engage with a bio-based economy is triggered by representations of the negative consequences of a bio-based economy. Such representations have been found to arouse negative feelings of unfairness, inequality and frustrations because of cruel acts against animals and nature (Sleenhoff, Cuppen, et al., 2015). Because of these negative feelings these participants are spurred into action. Here they differ from the other factors where such representations made participants feel unable to make a meaningful contribution.

Our empirical results seem to partially contradict findings of O'Neill and Nicholson-Cole (2009), Hoijer (2010) and Moser and Dilling (2004) who argued that using or addressing negative emotions for engagement is more likely to disengage or make the public indifferent towards the issue. Moser and Dilling (2007) claim that negative emotional appeals can only be effective when there are sufficient supportive conditions that enable individuals to engage in a desired way, which reinforces their self-identity. Our approach allowed for participants to formulate what their desired way to engage was. Through sorting the images, participants constructed a context they could relate to and in turn, this created a perspective for them on how to act.

With the transition to a bio-based economy different issues of industrial biotechnology, sustainability, climate change and the environment melt together for public engagement. This can explain the two sided negative emotional response of the 'saving the world' participants. They are frustrated about how this transition deals with the environment and its sustainability aspects, enhancing their perceived efficacy. On the other hand, the 'saving the world participants' felt unable to engage with the transition because of its more technical aspects and their perceived lack of knowledge thereof. Here the supportive conditions for their engagement were missing.

The 'saving the world' belief also adds empirical evidence for Roeser's (2012b) point about the necessity of emotions for practical and moral decision-making with regard to issues of risky technologies or climate change. The participants that significantly load onto this factor show how experiencing moral emotions – which are considered as a form of cognition or insight – can trigger moral considerations such as fairness and equality which in turn can motivate people to engage. These participants reported that they considered themselves more inclined to participating in demonstrations, donating money to NGOs and buying more environmentally friendly products.

The hierarchical factor structure (figure 3) and the factor interpretations further show a distinction between the 'recycle to' and 'system limits' efficacy beliefs on the one hand and the

'conscious shopping' and 'filling my car' on the other. Participants with one of these four efficacy beliefs consider themselves capable through more positive representations whilst more negative representations make them feel less capable or even incapable of contributing to a bio-based economy[13]. Despite this commonality across beliefs, participants differ in the size in which they perceive the context of their engagement.

Participants with a 'Conscious Shopper' and 'Filling my car' belief regard their level of engagement as the personal actions they can undertake and control. They are more focused on the different means through which they can take personal responsibility on an individual level. In contrast participants with a 'recycle to' and 'system limits' belief tend to regard their efficacy more on the systems level they inhabit. They perceive their engagement on a society or economic level which is a higher aggregation level than that of the former two beliefs. These participants' efficacy beliefs are more focused on the changing context of the transition and to what extent their behaviour can influence that development.

The difference between the two distinct lines of efficacy beliefs seems to correspond with the differences between personal and collective efficacy (Bandura, 1995a, 2000). Where personal efficacy is about the belief in one's own capabilities to organise and execute the course of actions towards a desired outcome, collective efficacy concerns a group's shared belief in collective power to produce desired results. These beliefs will influence the types of future participants seek to achieve, how much time and effort they are willing to invest and to what extent they will interact with others to coordinate their activities for collective action.

These five senses of efficacy have further implications for meaningful collective public engagement as personal efficacy is a strong indicator for concurrent and future behaviour (Milne, Sheeran, & Orbell, 2000). Our results indicate that there are commonalities in the demographic backgrounds of the participants per factor. This suggest that particular groups within society could be identified based on their demographic background. However, as Cormick and Romanach (2014) argue, segmentations of the public based on their values towards science and technology provide greater insight in how they engage then on those based on demographics. Identifying people based on their behaviour is also problematic since our results show that participants name similar actions they consider themselves capable of. However, they differ in their motivations for doing so. Meaningful public engagement can not only be determined by the way people act. The emotions people have towards the transition (Sleenhoff, Cuppen, et al., 2015) and other personal and social characteristics will also influence their engagement (Lorenzoni et al., 2007).

[13] The distinction between positive and negative representations is based on the results of Sleenhoff et al 2015

Prior to exploring participants' efficacy beliefs we also unravelled their emotional views, since taking emotions into account is expected to enhance public engagement (Pidgeon & Fischhoff, 2011; Roeser, 2012b). In this earlier study we found four emotional views amongst our participants: compassionate environmentalists, principled optimists, hopeful motorists and cynical environmentalists (Sleenhoff, Cuppen, et al., 2015). As emotions underlie motivation and behaviour, connections between the different beliefs are expected to be found. However, we were not able to determine a significant correlation between people's emotional views and their perceived efficacy beliefs. Nevertheless, from the descriptions of the different emotional views and efficacy beliefs it is apparent that there are connections between them. For instance, participants with a 'saving the world' belief have been found to have either a 'compassionate', 'principled' or 'cynical' view. For these participants their concerns towards the environment, and fairness connected to their envisioned bio-based economy, are likely instigating their belief for this action. However, a more detailed discussion of possible correlations between participants emotional views and efficacy beliefs fall beyond the scope of this paper. More research is needed to more closely look into how the link between these two aspects for people's engagement is forged.

3.8 Conclusion

This paper shows what efficacy beliefs participants develop through the interaction with stakeholders' representations of a bio-based economy. The aim of this study was to explore in what way such representations would engage the public. We applied Q methodology using stakeholders' visual representations and found five efficacy beliefs. These create insight in how, besides the public's awareness they believe themselves (in)capable of making a meaningful contribution to the transition. The different efficacy beliefs show that the public connects with this transition in distinct and shared ways. It also shows how their contributions could add to more collective action and support for a bio-based economy through purchasing and recycling behaviour.

Taking into consideration the current results, current practises of public engagement with a bio-based economy and stakeholders interpretation thereof show a discrepancy. Stakeholders mainly want to engage the public for two reasons: their support is perceived to be necessary to their role as consumer (Zachariasse et al., 2011); and they need to be aligned to legitimise the current shaping of the bio-based economy (Cologne Paper, 2007, p. 13; Commission, 2012). However, our results show that members of the public foresee different ways and levels in how they should engage with the transition. These public ways to engage do not always concur with how stakeholders perceive they will engage, for instance when members of the public want to make a meaningful contribution by consuming less. And our results also indicate the public

wants to engage in ways that are not welcomed by the predominant stakeholders of industry, policymakers and scientists, by voicing their concerns through supporting public protests or donating money supporting such initiatives. The representations and approaches that members of the public build based on stakeholders representations do not obviously match with stakeholders' vision and approach to a bio-based economy.

Our findings call for further discussion about in what way members of the public should be engaged with the transition to a bio-based economy. In what way can interaction for meaningful engagement between members of the public and stakeholders be created? Another interesting subject for further study would be to see if people actually engage with the transition as they would do based on their found efficacy and whether that contribution is meaningful. Further work is necessary to examine the relation between peoples' emotional views towards a bio-based economy and perceived efficacy belief.

This research was conducted in response to the call for more meaningful collective action and support that includes the public, with regard to the transition to a bio-based economy (Sleenhoff, Landeweerd, et al., 2015). We have shown that people believe there are different ways to engage with this transition, based on stakeholders visual representations of a bio-based economy. Stakeholders should be more aware of the implications and effect of their own representations for public engagement, because it is most likely members of the public will encounter these representations when they start familiarising themselves with its development. This analysis also sheds light on the methodological uses of how visual social representations engage the public by developing different modes of efficacy towards a bio-based economy alongside their personal representations. This should be taken into account for meaningful public engagement and different forms of collective action for a more bio-based economy.

Chapter 4

Unexpected Encounters: Public Engagement with a Bio-based Economy via Bio-art

Chapter 4: Unexpected encounters; public engagement with a bio-based economy via bio-art

Abstract

For a bio-based economy meaningful engagement that includes emotions, is needed as the actions required are of a collective scale. Taking emotions into account is expected to enhance public engagement. However, how such emotions can be included without them being used merely instrumentally is less straightforward. Art is a more affective form of communication which in its performance can extend the provision of factual information enabling observers to get a feel of what future perspectives could look like. This article aims to explore the potential of bio-art as more affective form of communication for public engagement. Using observations, interviews and focus groups amongst visitors of a bio-art exhibition we have found two thematic lines of thought which illustrate how their engagement evolves. These themes provide insight how and with what engagement amongst visitors emerges by observing bio-art. Implications for using art for public engagement are discussed.

4.1 Introduction

The transition to a bio-based economy is complex as it will require substantial changes in our present oil dependent society. This asks for public engagement. Driven by increasing sustainability, energy security and geopolitical factors, governments worldwide support innovation and development for bio-based alternatives. This transition is likely to affect different aspects of society such as the way we move things and ourselves, food- and-, energy security, governance, public well-being, safety, and social and industrial infrastructure (Langeveld et al., 2010). Therefore collective support and responsibility that includes the public is essential. Acquiring broad engagement is often difficult as members of the public are largely unaware of these developments (Berg et al., 2013), and lack a sense of urgency since they are not (yet) personally emotionally involved with the possible effects. To enhance public engagement with complex issues several scholars suggested to take emotions more seriously into account (Pidgeon & Fischhoff, 2011; Roeser, 2012b). Emotions are a basic part of our decision-making process, thinking, perceptions and behaviour. Emotions guide people on how to evaluate information and where it comes from, and how to act accordingly (Hoijer, 2010; Kahan, 2010; Nussbaum, 2001). We argue that, for meaningful engagement of the public with a bio-based economy more affective forms of communication are needed. Forms of communication that intuitively engage people with the prospects of this transition and in doing so facilitate in the creation of tangible associations. This would aid members of the public to become aware of what a transition to a bio-based economy will mean and help them in their efficacy to envision how this new economy would look like and what part they could play. By perceiving public engagement as emergent (Horst & Michael, 2011; Michael, 2002) – engagement which arises during interaction – members of the public can establish their own role.

In this paper we suggest and demonstrate that art can play an important role to create affective engagement. Engagement with art combines the rational, the emotional, the imaginative and the intuitive (Wyman, 2004) ensuing more affective forms of communication. Several authors have shown that performing arts - such as theatre - give insight in how these facilitate public engagement through performed narrative (Bush & Rothenberg, 2012; Cox, Kazubowski-Houston, & Nisker, 2009; Nisker, Martin, Bluhm, & Daar, 2006; Rothenberg & Bush, 2012). Although many have written about the use of imagery for public engagement (Dobos, Orthia, & Lamberts, 2014; Nicholson-Cole, 2005; O'Neill & Hulme, 2009; O'Neill et al., 2013; Sheppard, 2005; Sleenhoff, Cuppen, et al., 2015), little has been published about the potential of the visual arts. While there is no active, spoken narrative, visual art can still trigger a relation between spectators and what he or she is observing. We will explore the potential of bio-art as a more affective form of communication and question how and with what spectators are engaged during

the interaction with art. Importantly, we do not attempt to provide for a tool to steer the opinion of the public vis-a-vis the transition to a bio-based economy through bio-art. Instead, we elucidate how bio-art, in its ambiguous nature, and its potential to drill into the absurd, may trigger public engagement, as a pivot between mere public awareness, and towards public opinion formation.

The next section discusses the value of emotions for public engagement and the potential of art as a way to trigger communication. In section three we elaborate on our subject for engagement – the bio-based economy – and introduce our empirical case study: The Designer and Artists for Genomics Awards (D&A4G) exhibition. Section four explains our method and how we applied it. The results are presented in the fifth section: two lines of thought along which visitors engagement establishes itself.

4.2 The value of emotion for public engagement

For long, emotions were perceived as irrational states or cause of bias for decision-making (Kahan, 2008; Loewenstein et al., 2001; Slovic, 1999) negatively influencing people's rational thoughts and behaviour. They have been excluded from engagement practises to avoid the idea that people are manipulated to adhere to a certain position (Lorenzoni et al., 2007; Sheppard, 2005). Experienced emotions by the public were also often ignored or even excluded from public engagement as such responses were perceived as irrational prioritising rational discourse (Engdahl & Lidskog, 2012; Harvey, 2009; Lezaun & Soneryd, 2007).

Although emotions can stir public opinion and cloud judgement, just as we can be deceived by our other senses, they are also guiding structures to relate to what is important in our lives (Oatley & Jenkins, 1996). Instead of a disruptive force in people's thoughts, emotions can be considered as a form of cognition and insight (Roeser, 2010a, 2010b) that allow people to make practical decisions when faced with moral dilemmas (Damasio, 1994). They facilitate people in familiarising themselves with new or incomprehensible phenomena (Hoijer, 2010; Sleenhoff, Cuppen, et al., 2015). As such, emotions help us to give meaning to the world in which we live and can be regarded as judgements of our values (Kahan, 2008; Nussbaum, 2001).

Including emotions for public engagement requires approaches that trigger people's imaginative and empathetic capacities and that admit their subsequent responses. These capacities help people to create a picture or mental image of the issues that require their engagement and develop the associated feelings of what the issue signifies, not only for them but also for other people. Using narratives has been suggested to achieve this (Harvey, 2009; Hulme, 2011; Roeser, 2012a). Different forms of narrative, such as, theatre, fiction, films, songs,

art (although several modern art movements refuse the narrative in favour of the abstract and conceptual) or other types of performances facilitate such capacities by invoking emotions.

The attainment of the engagement depends on individuals' willingness to get involved. Public engagement is relational (Horst & Michael, 2011). Thorpe & Gregory (2010) described this relation as a form of cognitive, interpretative, affective and social work through which science, or in our case a bio-based economy, is produced as material artefacts and cultural meanings. As such public engagement can be regarded as a starting point for further questioning and study of emerging issues since the event of communication continuously scrutinises the interaction, stimulating reflection. Lezaun and Soneryd (2007) defined the sociality of public engagement by its degree of eventfulness, referring to the extent to which participants are moved and mobilised through the event. This can result in unanticipated actions and contingencies.

4.3 The potential of art for affective engagement

According to (Nussbaum, 2009) the arts cultivate capacities of judgement and sensitivity that can and should be expressed in the choices a citizen makes. The importance of story-making and story-telling alongside the enterprise of science, is also stressed by Hulme (2011), as that is how people make sense. Narratives can capture the emotions of the moment described and are an important part of the cultural fabric (Felt & Wynne, 2007). In its performance, art can extend the provision of factual information by enabling one to feel what the articulated future perspective could imply (Joffe, 2008).

Horst (2011) created an art installation to experiment with public engagement for the improvement of scientific knowledge production. Horst's experiment opened up engagement to its visitors (Horst & Michael, 2011). The encounter with the artwork becomes an opportunity in which emotions are triggered and can be vented (Veen, Sleenhoff, & Klop, 2010). Such encounters serve in empowering public, science and their relationship. But emotions are the point of origin of engagement rather than being an instrument to steer engagement. Nevertheless, Horst concluded that she became more reticent with the explicit inclusion of emotions in the installations because of their communicative power. In her experience emotions seem hard to dose satisfactorily.

Emotions are an integral part of works of art. However, art cultivates different types of emotions. Art can convey different forms of emotion. Compared to what Scherer (2004, 2005) refers to as basic (utilitarian) emotions, which are always transactional, aesthetic emotion's appraisal is intrinsic to what the person sees, hears or experiences, based on forms and relations. Aesthetic emotions such as surprise, fascination or wonder are often triggered by

listening to music, or watching visual or performing art. Such aesthetic emotions are not triggered by a person's concerns of the relevance of a perception to his bodily needs, social values, or current goals or plans, nor with how well he or she can cope with the situation. Rather it is an emotion where the appreciation of the intrinsic qualities of a piece of visual art or a piece of music is of paramount importance. These emotions are experienced within the body but do not change the behavioural readiness (Frijda, 2005); 'the appraisal of goal relevance and coping potential is absent or much less pronounced (Scherer, 2005, p. 706).' They are diffusely reactive based on a more comprehensive appraisal including efferent reactions such as goosebumps or wet eyes. Moral emotions are functional in how people position themselves towards an issue. They include feelings such as pride, shame, and indignation. Thus art as narrative employs affective forms of communication, combining emotions and imagination.

4.4. The bio-based economy and the Designers and Artist for Genomics Award

The complexity of the bio-based transition and people's unfamiliarity with it makes it difficult to create tangible narratives that enable members of the public to engage (Opinion leader, 2009). Public engagement is therefore limited (Asveld et al., 2011; Berg et al., 2013; Pesch et al., 2010). With the current transition to a bio-based economy, the mitigation of climate change, and geopolitical dependency on fossil fuel producing countries there is a search for techno-knowledge fixes to resolve these (Birch et al., 2010; Levidow et al., 2013). The dominant narrative of a bio-based economy tells about the replacement of fossil resources for the production of pharmaceuticals, chemicals, fuels, materials, and energy[14] by biomass. Life sciences and industrial biotechnology is expected to facilitate the utilisation of biomass through biocatalysis and fermentation technologies, aided by developments in genomics and synthetic biology for adapted micro-organisms and cells (Soetaert & Vandamme, 2010). Bio-based industry relies on (renewable) feedstocks. This creates other narratives related to pressure on environmental governance, and people's choices in food and energy uses which also requires public's engagement. Therefore a bio-based economy has intertwined industry and environment. Alternative narratives of a bio-based economy (apart from alternative technological routes) focus on the development of more sustainable rural communities, mobilising local knowledge and enhancing local capabilities (Levidow et al., 2013; Schmid, Padel, & Levidow, 2012). Still, the public is largely unaware of the slowly unfolding transition. Members of the public have difficulties in recognising that used technologies have different application areas, and they seem

[14] Products are listed according to their place in the so called 'cascade-model' starting with higher valued products to lower valued products at the end that can be derived from biomass (Verburg, 2007).

to misunderstand the role that life sciences, industrial biotechnology and genomics could play on an economic and subsequent social level (Opinion leader, 2009; Osseweijer, Landeweerd, et al., 2010). All narratives emphasise the need for collective action (Levidow et al., 2013) including civic society; a bio-based economy needs a bio-minded society (Sleenhoff, Landeweerd, et al., 2015). Felt and Wynne (2007) proposed a 'regime of collective experimentation' which produces new creative interactions among many diverse participants and expertise. Their proposed regime attempts to move away from more narrowly defined forms of innovations, recognising the more socially distributed and collective forms of public engagement. Public engagement via art is promising as such novel experimental regime.

Bio-art is considered an art practise where bio-artists work either with live tissue, bacteria, living organisms, and living processes in the making of artworks or they use more conventional means (e.g. paint or photography) to represent aspects of life or biotechnology (Hanssen, Sleenhoff, & Stolk, 2006; Mitchell, 2010; Sleenhoff, 2005; Zwijnenberg, 2012). Just as with a bio-based economy, biological materials, processes and principles are used in the artist's creative process. Notwithstanding its physical make up, bio-art holds potential as an intermediary for the engagement between art, life sciences and society. As bio-artist of the first hour Eduardo Kac (2005b) stated:

'the domain of art is symbolic, […] art can contribute to reveal the cultural implications of the revolution on the way and offer different ways of thinking about and with biotechnology.'

Bio-art can be flexible enough to attract different entities – science and society – and for each entity to be perceived in a different way. On the other hand it is robust enough to hold its own identity as artefact. It can function as a 'double boundary object' (Star & Griesemer, 1989), namely in the configuration between science and art and one between science and society (Hanssen et al., 2006; Sleenhoff, Montalti, & Osseweijer, 2012). In this capacity, it can articulate social, cultural and moral and scientific dilemmas carried along by emergent life sciences and technology in a bio-based economy. Bio-art makes these dilemma's visible and tangible. However, besides 'bio-art's potential to offer a critical and philosophical perspective that is beyond its stated goals; it is free to explore the creative potential of tools and fields of knowledge unconstrained by their own self-imposed limits' (Kac, 2005a, p. 233). This is an important notion when we look at the communicative aspects of bio-art. In its performance it should never be regarded as the 'maid of the science it uses' (Stelling, 2011; Zwijnenberg, 2012). However, for bio-art to retain an autonomous voice it should refrain from any tendencies to self-domestication in its attempts to nourish good relations with the sciences involved.

4.4.1 The Designers & Artists for Genomics Awards

The D&A4G award highlights and explores the exciting and novel possibilities between design, artistic practice and life sciences. Instigated by the Netherlands Genomics Initiative and supported by its centres of excellence the initiative aims to stimulate collaboration between designers and artists with the most prestigious Life Science research institutes in the Netherlands, to delve into the world of bio-art, and produce new work. From 15 June 2011 to 8 January 2012 the first three winning installations of the 2010 D&A4G awards were on display in the *Naturalis Biodiversity Centre*, in Leiden, The Netherlands. The artworks were presented alongside other museum installations such as the stuffed first transgenic bovine, Herman the Bull which is a Dutch biotechnology icon and a highlight for many of the museum visitors. Visitors could watch and familiarise themselves with three bio-artworks: *Microscopic Opera, System Synthetic* and *2.9g 329m/s.* This exhibition offered the opportunity to study the emergent engagement with its visitors.

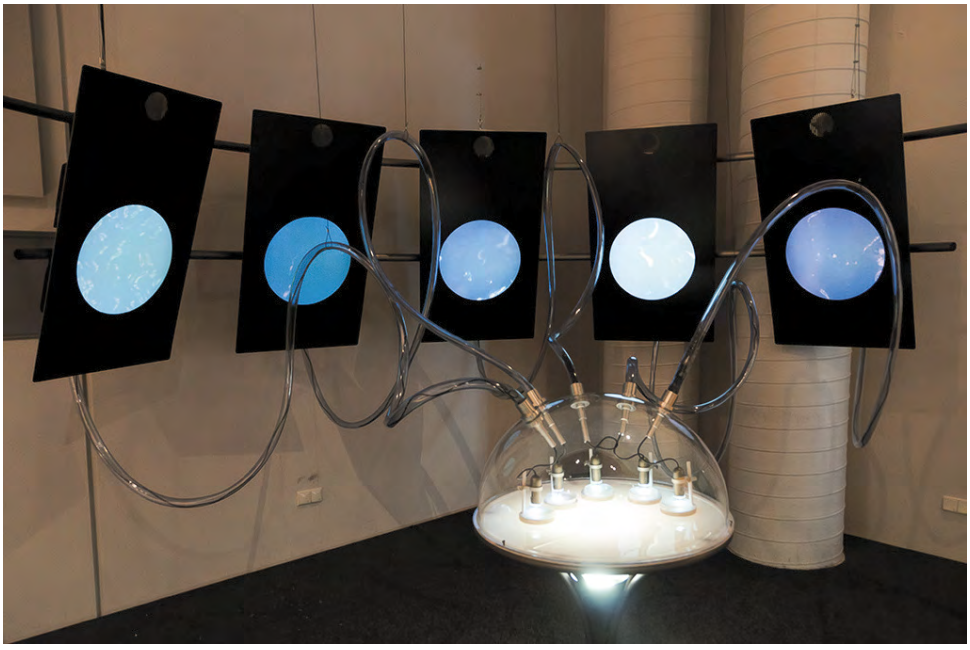

Figure 5: Set-up of *Microscopic Opera* at the Naturalis museum in 2011. Photo by: Ed Jansen

Microscopic Opera (See figure 5) was created by Mathijs Munnink in collaboration with the Netherlands Consortium for Systems Biology. This consortium implements systems biology as a powerful scientific approach to overcome the increasing complexity in the three research areas of biomedical research, agricultural biotechnology and microbial biotechnology. The artwork is comprised of a futuristic sphere topped pedestal which contained five Petri dishes

filled with nematodes in agar. Each set of nematodes has its own mutation which influences the way it moves. Each Petri dish lies underneath a digital microscope that is connected to a monitor. Five monitors are suspended in a semi-circle behind the pedestal, one for each dish, projecting what is going on in the Petri dishes. The different movements of the worms are linked to different opera like sounds. Depending on the movement beneath the microscope the worms together create an opera (Munnink, 2011).

System Synthetic (See figure 6) was created by Maurizio Montalti in collaboration with the Kluyver Centre for Genomics of Industrial Fermentation. This centre employs microbial genomics to improve micro-organisms for use in industrial fermentation processes. Starting from renewable feed stocks, fermentation is used for the production of food products and ingredients, beverages, pharmaceutical compounds, nutraceuticals, and fine and bulk chemicals. The art-work is comprised of a glass display containing an installation of chemistry glasswork in which a yeast and a filamentous fungi convert plastic to bioethanol. The installation is composed of a shredder, a bioreactor, a fermenter, and a distillation unit. Via a button visitors could activate the bioreactor. Next to the chemical installation the display contains an installation of several Erlenmeyer flasks connected together by tubes with plastic chips, cloudy fluid and clear fluid. Furthermore, the display shows a plastic model of the envisaged organism that can convert plastic to biofuels (Montalti, 2011).

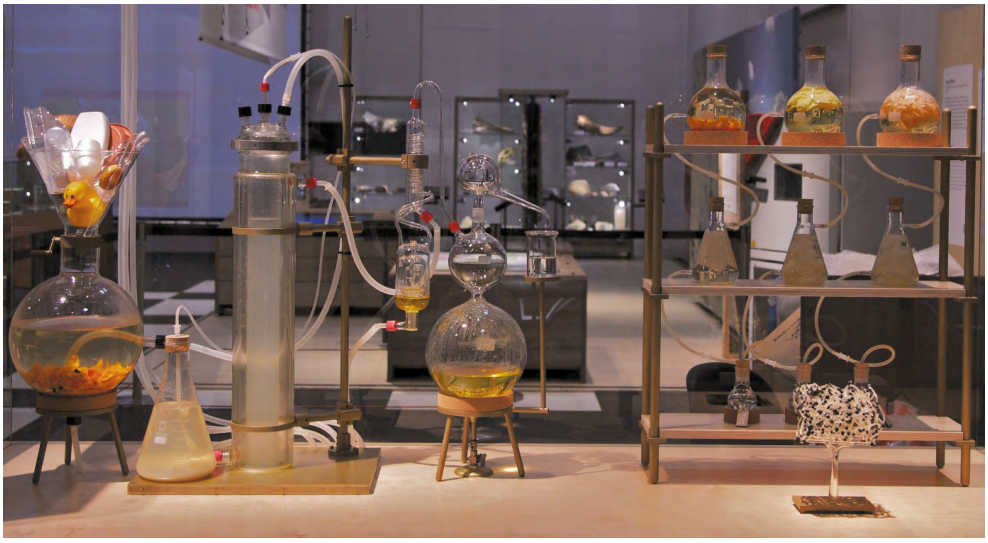

Figure 6: Set-up of Systems Synthetic at the Naturalis museum in 2011. Photo by: Maurizio Montalti

2,9g 329m/s[15] was created by Jalila Essaidi in collaboration with the Forensic Genomics Consortium Netherlands. This consortium aims to substantially improve routine forensic genetic research by developing techniques for dedicated crime cases to increase the crime solving rate. The artwork consisted of three parts. First, a sample of pieces of stretched human skin that are stitched together which are interwoven with transgenic spider silk hang in a wired cube from the ceiling (See figure 7). Secondly, a looping film which shows footage of ballistic tests onto different pieces of skin including this bullet proof sample. And finally a small incubator containing two growing samples of tissue culture on a frame of spider silk (Essaïdi, 2012).

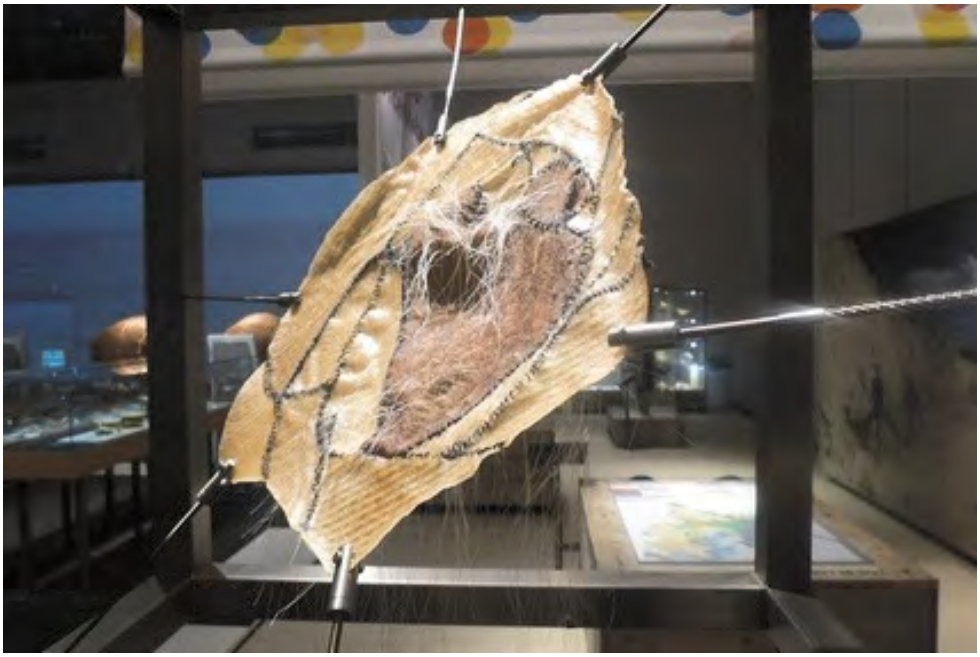

Figure 7: Close-up of the bullet proof skin at the Naturalis museum in 2011. Photo by: www.we-make-money-not-art.com

4.5 Method

Studying emergent engagement demands a more 'idiotic methodology' (Michael, 2012a). By idiotic[16] Michael refers to the incommensurable criteria of what is meaningful, which functionally disrupts the event. This methodology departs from the idea that social events – the engagement

[15] 2.6g 329m/s is the name of the Bulletproof Skin Artwork by Jalila Essaidi. 2.6g 329m/s is also the performance standard for bulletproof vests, the maximum weight and velocity of a .22 calibre Long Rifle bullet from which a Type 1 bulletproof vest should protect you

[16] For a more detailed and elaborate explanation of the idiot see (Horst & Michael, 2011; Michael, 2012a, 2012b)

– are ontologically open and in-process. The emergence of such absurd objects allows for a re-evaluation of the event in which they emerged, 'what are we busy doing?' (Michael, 2012b). Absurd artworks don't necessarily make sense. This can trigger 'idiotic' behaviour of visitors that might not make sense to the researcher. Any use of such absurd encounters, focusses on the particularities of the often complex circumstances. This yields background material and visitors personal stories which enable us to access their experience, and their attribution of meaning. It is the vary lack of definite and intended meaning of art that enables this.

4.5.1 Participant selection

For our study we used two sets of participants. The first set consisted of natural groups of museum visitors and the second set is comprised of focus group participants recruited by a marketing research company. We made a reconnaissance of the familiarity of visitors with the life science and their applications, by inviting visitors to share their views. Since the informal setting of these interviews was crucial this meant that interviewing one visitor triggered comments from other visitors forming so called natural groups. We documented 48 natural groups. We refer to these natural groups as pre-visitors. Similarly we invited comments post-visit (post-visitors). Here we documented 42 of such natural groups (Adams, 1980). The participants comprised a wide variety in age, educational level, and were visiting with and without children. The marketing research company recruited focus group participants based on gender, age and educational level (see table 10) to facilitate discussion amongst the participants with the provision that they had not visited the museum within the last half year. We organised four focus groups with four to six participants each.

Table 10: Focus groups included in the Naturalis study

Group nr	Participants	Age range	Educational background	Interview date
1	4 (all women)	20-40	middel-high	25-nov-11
2	6 (3 men, 3 women)	40-65	middel-high	25-nov-11
3	6 (3 men, 3 women)	20-40	lower-middle	2-dec-11
4	4 (1 man, 3 women)	40-65	lower-middle	2-dec-11

4.5.2 Data collection – Interviews

According to Michael (2002, 2012b) examining the relational aspects of public engagement asks for an alternative sensitivity of the researcher. When assessing engagement contingent events and more distal resources should also be included. Therefore we also gathered observations of natural groups of visitors' behaviour while they visited the exhibition in addition to the direct

interaction with volunteering visitors. Via direct observations we first studied how visitors interacted with the artworks and each other without interference and independent of their willingness to participate. Only if approached by visitors the researcher would identify herself and clarify her presence.

A series of 48 semi-structured pre-visit interviews were held following an interview guide (see appendix B). The semi-structured nature of the interviews safeguarded that all visitors were asked the same questions. Visitors were posed open questions so they could answer and elaborate in their own words. They were encouraged to be as detailed in their answers as possible. The interview guide included questions related to their representation, feelings and perceived efficacy towards the life sciences which was the basis and connecting element between the artworks and the bio-based economy. A second series of 42 semi-structured post-visit interviews were held with natural groups of visitors following an extended interview guide. This second interview guide included additional questions related to visitors impressions and experience with the artworks allowing us to explore the effect of visitors interaction with the artworks on how they got engaged and with what.

4.5.3 Focus groups

A focus group is a group interview in which a small number of participants discuss a given topic lead by a moderator (Barbour & Kitzinger, 1998). This form of interview and discussion and spontaneously raised issues by participants helps the researcher to discover unanticipated aspects of the topic. To connect the answers given by the visitors in the separate pre- and post-interviews, we conducted a series of four focus groups including a visit to the D&A4G exhibition. Each focus group used the same semi-structured pre- and post- questions as during the museum interviews (see appendix C). Participants were encouraged to share their thoughts and experiences. Each focus group meeting lasted two hours, including a visit to the exhibition. During the visit to the exhibition participants were invited to write down their impressions, reflections, feelings and questions which were used for input in the post-visit discussion. All discussions were held in Dutch and recorded with consent of the participants.

4.5.4 Data analysis

The data gathered was qualitative: participants observations, pre- and post- interviews and focus group discussions. The interviews and focus group discussions were recorded, transcribed ad verbatim and analysed using the qualitative analysing software package NVIVO (QSR International Pty Ltd., 2010). Coding was done from two different positions: deductive and inductive. The post-visit data was first deductively coded based on the artworks as they were

addressed by visitors in their interview. This provided a first distribution of the data for the initial classification of all the gathered material. Subsequent labelling was inductive permitting an open outlook on the way in which participants engaged and with what. During the open coding, labels and sub-labels were created for each new theme mentioned by the visitors.

Finally, the data were thematically analysed (Joffe, 2011) to explore found patterns within the data. This analysis provides for a systematic exploration of how visitors' engagement emerged (Horst & Michael, 2011), how associations are interconnected and how they structure people's thinking. The complete qualitative analysis was reviewed by three peer researchers and disagreements were discussed until consensus was reached about the labelling and interpretation of the transcripts.

4.6 Results

Overall, we found no salient differences in the responses between the interviewed visitors and the focus group participants. Hence, we treated the answers given by the interviewed pre- and post-visitors commensurable to those of the focus group participants.

4.6.1 Baseline engagement of visitors

When asked about the life sciences pre-visitors would spontaneously mention various topics to which they associate this development. Results show that the topics most mentioned included the use of life sciences for the production of food (63% of the pre-interviews) and various applications of life science in medicine (60 % of the pre-interviews). Other topics mentioned were human enhancement (27% of the pre-interviews) and the production of transgenic animals (29% of the pre-interviews). Only 6 % of the pre-visitors mentioned the production of biofuels.

When visitors elaborated on their interpretation of the life sciences they often spoke about the afore mentioned topics in terms of impact. For instance they would discuss the use of genetic modification for food production in the context of an increased population growth on the one hand and the depletion of natural resources and biodiversity loss on the other. However, talking about impact visitors thought this would still be a long way off. They perceived that this development would most likely affect future generations and not themselves.

In their responses many visitors displayed mixed feelings about the life sciences. They expressed feelings of hope for scientific developments and associated technologies to solve societal problems. They admired these technologies especially for being able to develop new ways of producing from new materials. At the same time they doubted the extent to which the frontier of science is pushed or passed. Two questions were raised by almost all visitors: 'How far can we go?' and 'who controls this development?' Behind these questions seems to lie the fear for a

coercion to (human) perfection. Visitors recognised their own emotional ambiguity towards the discussed topics in their elaborations.

The results of the pre-visit interviews and focus groups provide a baseline for visitors initial engagement with the bio-based economy and its accompanying processes. It provides insight in how people think about the associated technologies involved, what emotions they have towards their use and impact. The following section will report the core themata of managed vs wild and useful vs useless that underscore the most prevalent themes that appear in post-visitors replies. Such themata are non- or unconsciously revealing how visitors' engagement emerges. The post-interviews focussed on the experience of the exhibition as a whole.

4.6.2 Managed vs Wild

The most prevalent theme in our post-visit data are underlined by a managed versus wild dyad. This is apparent in most visitors' responses in a variety ways. The visitors see 'managed' (or managing) as how the new technologies can help society in solving problems and in structuring chaos. Participants recognise the possibilities that are opened up by this bio-based transition and its accompanying technologies and at the same time they question who manages this development. With this bio-based transition visitors foresee that it is possible to manage life. They anticipate how human life can be fixed or improved with the help of life sciences. That it is possible to better, faster and easier cure people and environments. They accept this could be achieved by better treatments, or more personalised medicines. Other applications imagined included human enhancement or functional use of waste for material production. At the same time the visitors are afraid for this development and where it might be heading. They voiced their concern over the management of this transition. Who is in charge? Who decides how far one can go? How far can the boundaries of science be pushed? Simultaneously, they recognise that this bio-based development opens up a whole range of options. With the drive to perfection they wonder to what extent they are willing and capable to take responsibility over such options.

Some visitors recognise their own responsibility in making changes to behaviour in daily life: in this case choosing to reuse utensils (shopping bags) and taking a position as responsible citizen towards military innovations. They expect to contribute to the direction into which this transition develops. Here visitors also take a step further in their thinking, imagining that the recycling of humans and human body parts would be a thing we should also organise. They raise questions over the perceived extent to which such new technological possibilities will solve a problem. Visitors believe people should first manage themselves and their own behaviour in relation to the problem rather than reaching to technology for a solution.

The other use of 'managed' in visitors thinking can be found in how they are marvelled about how the organic/life and inorganic/artificial aspects of the artworks are combined. They wonder out loud how the artist has come up with the idea what is on display; how he or she has managed to further develop, create and build their idea. They admire their creativity. At the same time they compare the artist's creative process of inventing new solutions for managing societies problems with that of scientists. They don't think scientist are similarly creative to come up with solutions. According to the visitors, scientists are not equipped to such out-of-the-box-thinking for managing societies problems.

By contrast to representations of how this development is 'managed', 'wild' becomes apparent through visitors descriptions of them being marvelled by nature. In their encounter visitors reminisced how nature is far ahead of us. The fact that the visitors could observe microscopic animals with their own eyes enthused them to look further. The installation made the invisible visible. The installation visualising the process of degrading plastic made them understand it. The installation of the skin made them wonder at the strength of spider silk.

Another representation of wild is connected to visitors thoughts about what would happen if one would have indeed developed a new life form and that would run wild and out of control. Visitors' associations often were about evil geniuses and science. They also included associations over breaches of safety standards and resulting disasters. The visitors acknowledged that doing so, always contains a risk of things going wrong without us knowing what the consequences will be. However, 'Nature is always in balance' some concluded. So in the end nature will solve our mistakes, possibly at our expense.

4.6.3 Useful vs useless

The useful/useless dyad also plays a prominent role in the emergence of our visitors engagement. The anticipated purpose of what the visitors observed underscores many of their thoughts. Specially the idea of solving the problem of the plastic soup in the ocean was mentioned often by the visitors as very useful.

All visitors were aware that plastics have a strong negative environmental impact. It takes a long time for plastic to deteriorate, we use it a lot and we leave it everywhere. The thought that with the visualised process something could be done about the enormous heap of plastic waste stirred most visitors positively. Making something out of plastic added to visitors enthusiasm for the idea. Transforming plastics into biofuel was considered equally useful and revolutionary, contributing to solving global problems.

The use of plastic waste matched with visitors daily practise of separating plastic from their normal waste. Although they were aware that their collected plastic waste is used for

making fleece or road posts they much more appreciated the prospect of turning that waste into fuel. One visitor would even go as far as to ask where he could buy such installation so he could put it up in his garage so he could add the fuel directly to his own car.

Uselessness was also important for the visitors encounters. When visitors could not grasp the purpose of the artworks they would become less attracted to them. Understanding the impact and intention of the artwork makes it more enjoyable. Visitors would question what they were seeing and how they were expected to relate to that. If people could not relate to the artwork they were less willing to participate in the interview. The opera was an exception to this rule. Although most visitors expressed not to have understood the artwork they did find it a very stunning piece of work to look at and listen to.

Uselessness was also experienced by visitors in how they would talk about the anticipated feasibility of doing research in relation to the amount of money that is being spent. Visitors spoke about the time it takes for results of scientific research to make it to the market. They also contemplated the sheer amount of money that goes into these endeavours with an acerb undertone. They are aware that once there is a result on the market all investors want is a return on their investment. They also see the downside of these investors' expectations namely innovation steers towards the rich rather than the needy. In their eyes this makes the whole enterprise of research useless.

4.7 Discussion

The two major dyads found in our data give insight in how visitors of the D&A4G exhibition became engaged and with what. The found dyad 'managed vs wild' is consistent with visitors prior feelings of hope, enthusiasm, doubt and fear towards the use of life sciences. Post visitors were also hopeful about the potential of a bio-based economy in resolving societal issues, and at the same time they are concerned about stretching the boundaries of science and technological advances. Observing artworks does not alter visitors' emotions but stimulates them to reflect more concretely to the issues that are represented. Through the observation they are enticed to think about what is signified and what it means for them.

In the found dyad managed vs wild the thematum 'managed' shows that, stimulated by the observation of the artwork, visitors got the idea that with a bio-based economy environmental and societal problems can be fixed. Our environment can be cleaned, or our people can be repaired, cured or improved. This aligns with Birch et al. (2010) who identified techno-knowledge fixes to solve issues of depletion of fossil fuels, mitigation strategies for climate change and the increased focus on more sustainable production. At the same time visitors

came to realise that they can and have a role to play, enhancing their efficacy. This also becomes apparent in the usefulness thematum.

The managed vs wild dyad provided insight in how visitors were marvelled by about the combination of natural life with the artificial. This line underscores how a relation is created through observation and interaction with the artwork and how engagement is allowed to emerge (Horst & Michael, 2011). At one level the artworks made visitors reflect on the role and the creativity of scientists, at another level they contemplate on how nature is ahead of use. The intertwinement of industry and environment, that is a central property of a bio-based economy, is also a key for deeper engagement.

The useful vs useless dyad also emerges in how visitors talk about life science before they have seen the artworks. Pre visitors talk about this technology in terms of its (expected) impact onto society and economy. However, post visitors go much further in envisioning the usefulness and expected impact. This shows how through the interaction with the artworks people's imaginative and emphatic capacities are stimulated.

The usefulness thematum also shows how artworks in their capacity of double boundary object function specifically with regard to the boundary configuration between science and society (Hanssen et al., 2006; Sleenhoff et al., 2012). They are able to raise various moral, cultural, social and scientific issues and have visitors reflect on these. Through the artwork the impact of the current and anticipated development related to a bio-based economy is visualised and visitors can establish their own relation towards it.

The visitors first response to the artwork often also carried along aesthetic emotions of surprise, wonder, amazement or disgust. Such emotions seem to function as a precursor for more basic or moral emotions. These aesthetic emotions draw people's attention, helping them to focus, which is followed by a further exploration of what is observed. As such these emotions aid people in familiarising themselves with what is in front of them (Hoijer, 2010).

4.8 Conclusions

This chapter demonstrated how visitors engagement is shaped and furthered by interacting with bio-art. The aim of this study was to explore the potential of bio-art for public engagement with a bio-based economy by taking emotions into account. We conducted interviews and focus groups during a bio-art exhibition for capturing visitors impressions and responses thereof and found that visitors engaged with the implications of the bio-based transitions rather than the application of the technologies involved. As such using bio-art for public engagement falls within Felt and Wynne's (2007) regime of 'collective experimentation' contributing to a more open and collective form of innovation shaping a bio-based economy.

We gained insight in how bio-art engaged its spectators. Through the established emotional connection – which is often aesthetic at first – the artworks raised questions which enticed visitors' moral reflection and which can motivate them to consider their personal responsibility. Bio-art's potential for enhancing public engagement lies in its open, affective and eventful approach to communication (Horst & Michael, 2011; Lezaun & Soneryd, 2007) and its ambiguous nature. By moving the visitors – touching their emotions – a starting point for dialogue and collective action is created. At the same time 'using' bio-art is a less predictable, less controllable and less steerable form for engaging people, as the manner in which people engage depends on their personal context.

Our findings invite further discussion on how emotions can be taken into account for public engagement and the value thereof. An area of research interest would be to study if a similar engagement can be achieved through other forms of art (Harvey, 2009) or visual representations (Dobos et al., 2014) and what would be required to reach a certain level of engagement. Further work can also study how visitors' engagement may lead to collective action in bio-basing economy. It would also be interesting to develop visual tools for participants to express themselves. This may form the basis for an 'idiotic' methodology for engagement (Michael, 2012a). Another fruitful enquiry would be to investigate the extent of visitors engagement.

This study was designed to study how emotions can be taken into account for public engagement (Pidgeon & Fischhoff, 2011; Roeser, 2012b) with a bio-based economy for more collective action. This article lifts a tip of the curtain of how emotions can be included for public engagement with a bio-based economy in a non-instrumental way. We have demonstrated that bio-art holds potential for public engagement by taking emotions into account. However, this type of engagement is not as controllable or predictable as traditional approached to engagement: How people get engaged and with what with depends on people's personal context. Stakeholders should not be afraid to engage in such spontaneous and emotionally initiated dialogue. These forms of engagement entice reflection and personal responsibility. Instead of regarding emotional responses as an endpoint for further conversation they should be considered as the starting point.

Chapter 5

Bio-based banquet: putting research into practice

Organised: 13 November 2013 in the Hypokunst supermarket in Delft, The Netherlands

Chapter 5: Bio-Based Banquet: putting research into practice

Abstract

Different emotional views and perceptions of efficacy have been found amongst the Dutch public at large for their engagement with the transition to a bio-based economy. Emotions have been acknowledged as an important aspect of engagement. However, how to include these in public engagement practice is still unclear. Living up to the challenge a case study was carried out to combine the insights from my research and to put them into practice. A design for public engagement was made and consequently organised in the form of a special banquet for citizens from Delft attempting to engage them in a more *a*ffective way with a bio-based economy.

5.1 Introduction

So far mainly scientists, industries, companies, some NGOs and governments are engaged with a bio-based transition of our economy (Soetaert & Vandamme, 2010). To the public at large this development occurs unnoticed (Asveld et al., 2011; Pesch et al., 2010) whilst they influence its direction with the everyday choices they make about their food, mode of transportation or energy usage. As will be argued in the sixth chapter of this thesis, engaging the wider public with this transition is important (Sleenhoff, Landeweerd, et al., 2015), since economic viability and political legitimacy are no sufficient drivers for this transition and its impact on society. The choices and actions required for a bio-based economy are of a collective scale, necessitating collective support and effort. Public's engagement can give insight to the answers to the question: What changes should be made, and are we able and willing to make for a bio-based economy? However, acquiring this engagement is not straightforward to achieve.

Emotions are important factors for engagement, and they should not be disregarded. Emotions have been described as important for people in how they connect with other people, with objects and with happenings. Emotions help focus our attention, help us familiarise with the unfamiliar. They entice moral reflection and motivate people to action. For enhancing engagement of the public at large with complex issues, such as the transition to a bio-based economy, it has been therefore suggested to take emotions into account, using a more affective approach (Pidgeon & Fischhoff, 2011; Roeser, 2012b). Members of the Dutch public create various different representations of a bio-based economy based on what they feel and the extend they can contribute to it. Since I found different emotional views and perceptions of efficacy amongst the Dutch public (Sleenhoff, Cuppen, et al., 2015; Sleenhoff & Osseweijer, 2015) I wanted this event to contain and address as many different aspects of a bio-based economy as possible. By doing so I attempted to nourish my guests' engagement, so they can create their own representation of what a bio-based economy means for them.

In the context of the CSG Centre for Life Sciences 'Shaking Science' month (CSG Centre for Society and the Life Sciences, 2010) I decided to put my PhD research into practice by organising a banquet for citizens of Delft. On the 13th of November 2012 there was a bio-based banquet on the menu for a small group of Delft citizens. They were invited for an evening that was organised around the topic of a sustainable or greener economy, which would address the question: 'what does this development mean for me as a citizen of Delft?' This evening was an impact activity of my PhD research into the value of emotions for public engagement with a bio-based economy.

In this chapter I will explain what I did, and reflect on the event. This chapter uses a different form of reporting than the previous chapters. It will be anecdotal in nature, relying on a

narrative approach (Polkinghorne, 1995; Sandelowski, 1991) in describing what we can learn from this event. Narrative analysis is a qualitative research approach that relies on reconstructing the narrative of the event as a whole – the big picture – of what took place.

Narratives are not about objective reality, they portray and illustrate in the form of statements what is considered to be significant amongst certain social groups (Allen & Giampietro, 2006) and as such provide us with more reflective insights that are additional to mere factual data. People tell each other stories to share experiences and to create meaning out of what happened. Using a narrative approach can be more informative for measuring people's (change of) opinions. Another advantage of a narrative approach is that the emotions and subjectivity of the moments described can be more easily captured (Felt & Wynne, 2007). These moments are the elements that are filtered out when a more formal scientific form of reporting is used (Sikes & Gale, 2006). For this account I have used my field notes, videos that were made during the event, the responses I received from my guests – orally and by email – and photographs of the event.

5.2 The way to the heart is through the stomach

Food is emotion. We experience very strong emotions towards what we eat i.e. the things we are confronted with on our plates. For instance, when we question if our food is still safe to eat, the disgust we feel when we don't like the thing that lies on our plate, or the longing one can experience for a tiny bit of chocolate. The ritual of eating that surrounds the special occasions in people's lives is also strongly connected to specific emotions or feelings. Take for example the family Christmas dinner or Easter brunch, the birthday cake, or the typical slice of cake and coffee after a funeral (a drink that in Dutch is often referred to as a *mug of consolation*).

In relation to the bio-based economy, food also stirs emotions, as it is a contested issue to use food for other purposes then feeding people (Landeweerd et al., 2011). Do we want to use food as a resource for the production of fuel once crude oil runs out or becomes less easily available? Where do we grow enough biomass for both food and other purposes so people in developing countries don't have to suffer from famine? These are a few of the issues that necessitate public engagement. With the development of a bio-based economy different bigger issues align: the use of biotechnology, not only for the production of crops but also for the conversion of these crops; mitigation strategies against climate change to ensure a more sustainable and healthy planet for generations to come; the environment, to live in a world that we all want to live in and be able and free to our own choices (Asveld, Ganzefles, Osseweijer, & Landeweerd, 2014; Gijsbers et al., 2005; Landeweerd et al., 2011; Sleenhoff, Landeweerd, et al., 2015). Whilst the bio-based transition further unfolds these issues get more and more

entwined. The result is that what we fear on the one hand might be necessary on the other hand. What we hope to be possible might make us despair if it proves to be impossible. By sharing something that often brings people together, food, I attempted to affectively engage citizens of Delft.

5.3 Banquet guests

Attempting to engage the public at large we invited a broad range of people from various societal groups living and active within Delft's society to join the banquet. We invited people from the city council, the Delft entrepreneurs association, members of different service organisations (aka, Rotary Club), local members of the Dutch Women's Institute, members of various sustainable or transition organisations, topped off with interested Delft citizens.

The thought behind inviting our banquet guests were twofold. Firstly, by specifically inviting our guest we tried to avoid having a table filled with the usual bio-based subjects of already engaged members of society. Secondly, by inviting people from different social networks, we hope to have invited people who were more likely to share their experience within their network, thereby spreading public engagement with a bio-based economy to a larger audience.

5.4 The Banquet table

The banquet took place in the HypoSupermarket in the city centre of Delft. This supermarket is a very creative venue where many lectures and public debates were being organised by foundation TOP[17]. This foundation wants to raise discussion about issues in their societal context, connecting technology with culture whenever possible. The venue also functioned as meeting point, a window and gallery for art from many different disciplines.

Surrounded by an atmosphere of innovation, technology and creativity, all guests were seated at one long table. Some of the table parts were made from hogweed, and the menus were printed on paper that was made from vegetable waste. We did this to make the bio-based economy tangible for our guests. Through the design we wanted to show them its versatility as well; that this new economy is not only about food, but also about using non-food and waste for the production of things. Moreover, small cards with provocative questions and statements were distributed on the table to engage guests into conversation and to consider their own role with regard to bio-based developments, albeit passive or active. For instance, 'how many different

[17] http://www.topdelftdesign.nl/home-top/

waste streams do you collect at home?' Or 'when industry produces more sustainably I don't have to change my personal behaviour'. The setting was enhanced by music from Zero Sharp.

5.5 The Banquet

The three chefs of Gastrovan were asked to prepare the meal. Gastrovan (Gastrovan, 2013) is a pop-up restaurant with a kitchen built within an old camper van. With their driving restaurant, the chefs prepare local, seasonal & organic food wherever they park the van and for everybody who would like to discover the taste of the land.

The menu was as follows: an appetizer of a mealworm filled carrot cocktail. This dish addressed the issue of eating insects and larvae as an alternative protein source. The mealworms were supplemented with shrimps, which we consider normal to eat. The worms and shrimps look quite alike although the former has a different, more crunchy mouth feel. Compared to meat, insects are much easier and cheaper to produce as it can be done with low-tech and a low capital investment. Insect production emits fewer greenhouse gasses than most livestock and does not require land clearing to increase production (Huis et al., 2013)

The starter was spelt risotto with goose ham, served on cut logs as plates. Spelt is an older almost forgotten grain which is currently hyped by a lot of organisations as it does not produce as much gluten when it is used for making bread. Growing spelt is more environmentally friendly as it requires less fertiliser than wheat and the crop has a natural resistance to diseases.

The ham came from geese that were hunted on a farm in the Biesland polder, which is in close vicinity of Delft. Goose is not a popular bird to eat, despite that so many of the birds stay in the Netherlands during the winter that they are considered an infestation. Wild geese can be a problem for a lot of farmers. The geese graze barren and foul their pastures having a negative economic impact. Hunting them on a larger scale is up for a moral debate as the effect of killing geese to reduce the population seems to have a minimal effect and their meat is not in demand by consumers. However, they could be an alternative local and seasonal meat source. This was presented on a wooden cookie which served as a plate. These cookies can be either reused, composted or used for building a campfire.

The main course was a locally produced bread bowl, filled with a stove of pumpkin, mushrooms and lentils. The bread bowls ensured that in principle plates are unnecessary as the bowl can contain the stew. However, plates were used for serving the dish as it allows the waitresses to carry more plates in one walk. The course was comprised of all seasonal produce in November. This dish also showed that you can have a very nice main course without meat.

For dessert the chefs prepared a beetroot filled millefeuille on a chocolate plate. The way this dish was served created no waste, you could eat everything (except your cutlery). Beetroot is also a commonly available crop in the Netherlands. Using beetroot for the filling resulted in using no milk for making the crème. With these menu items the chefs ensured that during dinner issues such as the use of alternative protein sources, eating meat or not, the kind of meat that was served, the use of seasonal, regional and sustainable produce, less dishes and waste were brought to the table in different ways.

5.6 Food for thought

Besides enticing our banquet guests' taste buds their other senses were not forgotten. Three speakers provided *food for thought*. The first speaker was Eric Roos from the Bioprocess Pilot Facility (BPF), secondly, Nina Haase from the World Wildlife Fund (WWF) and finally Eduardo van den Berg from Pharmafilter. They represented different engaged stakeholders in the transition to a bio-based economy, addressed different aspects and connected issues of bio-based production process in relation to Delft as a region.

Eric Roos, who was the director of the BPF at the time of the Banquet, explained the usefulness and necessity of having a pilot facility at the DSM campus in Delft. With this facility new sustainable production processes that have been proven to work at a lab scale can be tested and optimised at industrial scale. These production processes form the basis of converting biomass into new bio-based products. The city of Delft, with its knowledge and development facilities (IOW, the Delft University of Technology & the Biotech campus), is uniquely situated for the pilot facility. DSM is one of the biggest employers in Delft. And the city lies between the harbour of Rotterdam as central hub for biorenewable resources and The Hague, where national laws and regulations are being created and ratified.

Nina Haase works as a Communications Manager for the Market Transformation Initiative of the WWF. By engaging in dialogue with big international companies within this initiative the WWF attempts to make production chains more sustainable. In a video she showed how much water goes into making a single cappuccino. Surprisingly, in contrast to what you would expect, most water is used for the production of the coffee beans, instead of the disposable cup. By making the former process more efficient, more coffee can be produced with less water. The idea behind the initiative is that by making products that consumers use on a daily basis more sustainable, making sustainable choices becomes easier. By introducing a certification system the WWF wants to enhance this choice. In that way, every consumer can reduce its ecological footprint. 'The challenge is to be smarter about how we produce and what we buy and sell' was her message.

Figure 8: Photo report of the bio-based banquet. Photos by IAMIVAN

During dessert the director of Pharmafilter *Eduardo van den Berg,* talked about poo and pee as that was how, in the end, we all would dispose ourselves of the lovely meal we just ate. He spoke about the development of *Pharmafilter* which was pilot tested at the 'Reinier de Graaf Gasthuis', the local hospital in Delft. This is not only a new product but at the same time a completely new system and practice by which the hospital can work more efficient, cheaper and hygienic. He demonstrated to the guests how through fermentation, energy can be produced and hormones and drug residues are removed from the hospital's waste water. By using bio-plastic bedpans and urinals which are made from potato peels instead of metal the handling therefoe has become more hygienic. The new design of the bedpan makes it easier to use for both patient and nursing staff, saving time and money.

5.6 Responses

What we report here are observations made during the banquet and personal responses I received from my guests. The communal feeling of sharing and making the banquet a special evening started at the beginning of the event. I personally welcomed all my guests. Some immediately told me that they came by public transport or by bike as this evening was about a greener economy. Other guests would come in and give me a sample of their homemade or Fairtrade products they would produce or sell themselves. And other guests would come in with flyers about their own enterprises or initiatives that they wished to share with me and the other guests. They all stated to be very curious about the banquet and what the evening would bring.

In general, the guests responded spontaneously, curiously and critical to the food, the talks and discussions and each other. Although some of the guests came in pairs most of them came alone. There was no allocated table setting so my guests could choose their own seat. This created a balanced dispersion of my guests along the table where no-one sat left alone without a dinner and discussion partner.

The appetiser stirred my guests. There was a lot of nervous laughter at the beginning when the chefs introduced the course. Although presented alongside a similar, more common ingredient, my guests were not eagerly inclined to consume the cocktail. They peered at each other to have a good look of who would be the first, most daring, guest who started eating. The thought of eating insects disgusted most guests. One of the small cards that were distributed over the length of the table posed the question of 'meat or another protein source?' This raised a lot of discussion amongst my guest. Whether they would eat it or not, if it was safe to eat and what it tasted like? In the end every guest at least tasted the cocktail with the insects and only a few glasses returned to the kitchen almost untouched.

One of the guests commented that the use of the wooden cookies as alternative plates might not be as safe as anticipated. He remarked that the repeated use of such an untreated piece of wood could become a source for salmonella. So, he recommended to use the plates once and then use them for building a campfire. The fact that part of the tables were made from hogweed was a surprise for many of my guests. All guests were familiar with the invasive plant that burns your skin as you touch it and that you can find alongside many roads. The maker of the tables explained how he would harvest the plants at night – as (sun)light is what sets off the irritated reaction of the burning hairs of the plant – and converted the stems into table tops. One of the chefs told the guests that young hogweed sprouts can even been eaten. You can prepare and eat them similar to asparagus. The use of local produce was appreciated by many of the guests. They made enquiries with the chefs of Gastro-van about where they could get many of the ingredients used themselves.

Although the talk of Eric Roos was very technical in nature for most guests, they were very enthused to learn what was going on at the DSM site. They appreciated that much effort was put into bridging the innovation ravine for more sustainable production processes. On the other hand they questioned to what extent such facilities and the costs should be funded by public money. They considered this a risk you have as an entrepreneur. The question was raised why society should contribute to decreasing this risk?

Nina Haasse's talk was received with much surprise. My guests did not realise that most of the water for producing Cappuccino would go into the production of the beans. They expected most water would go into the production of either the cup or the milk (incl the growth of the cow). They appreciated WWF's efforts to make production chains more sustainable. On the other hand they commented that besides producers consumers have to take their own responsibility for making more sustainable choices. Although most guests acknowledged that making sustainable choices is often a difficult choice to make as there are so many different aspect one has to take into account. Still they thought that the other side of consuming, i.e. consuming less or reusing products should not be forgotten.

Eduardo van den Berg's talk was received with disgust as he started talking about faeces and waste when not all guests had finished their dessert. However, once he shared his story about the idea and building of the Pharmafilter all were silent and listening with great attention and growing appreciation. One of the guests happened to work as a nurse in a hospital in Rotterdam and she exclaimed why not all hospitals would have such a system in place. Since Pharmafilter is a company that has to make money, this system comes with a price. However, my guest argued that she felt that all hospitals had a moral responsibility towards their own employees of providing a safe working environment and that this new system

could contribute to that. She continued, that such system – although it will cost money to install it – will make a big contribution to reducing healthcare costs in general. In this she was supported by my other guests who had similar thoughts and feelings. Overall my guests were amazed about this concept of the filter and proud that this was first tested in Delft. *"These are the things by which we want Delft to be put onto the map and the direction we would like our economy to prosper in".*

My guests were enthused and pleasantly surprised with the experience of the whole evening. The ladies of the Women Institute were much surprised about the whole event and very much appreciated the invitation. Although they accepted it at first very hesitantly they were pleased to have come and have learned so much about a bio-based economy. My guests from one of the service clubs hailed the fact that it was a banquet comprised of delicious local and organic produce. Other guests sent emails which stated: '*With great pleasure I look back at the Bio-Based Banquet. Besides the very tasty food I have gotten a good vision of the ongoing bio-based developments.'* Or '*It was an inspiring evening in all its aspects and definitely worth repeating.'*

5.7 Reflection

The banquet was organised as an impact event for my research project. It aimed to invite citizens of Delft to familiarise themselves with the development of a bio-based economy in a more emotional way by making the developments tangible. These tangible connections, and my guests emotions were the starting point for a lot of talk and discussion amongst them. Based on my research results I wanted to create an opportunity by which public engagement with a bio-based economy could emerge rather than that such engagement was created or forced upon people (Horst & Michael, 2011). What this new economy encompasses was something that the guests should discover and decide on themselves during the evening.

By representing the conduct of the event anecdotally I have been able relay the course of the evening as and how my guests got engaged with the bio-based economy as a whole. Through their statements and reactions I was permitted to also relaying their emotional and verbal responses rather than just their opinions. This method allowed me to narrate what moved my guests and what was eventful and meaningful for them. It enabled me to capture the emergence of their engagement and its essence.

With the banquet I managed to reach my guests in different ways. In different forms the bio-based economy became (literally) tangible for my guests during the event. Through the design of the furniture, the menu and the talks they could familiarise themselves with this unfamiliar bio-based economy. The banquet allowed me to address all my guests senses. This

enticed them to create their own representation of what this economy might eventually look like and what it all meant to them. By eating and tasting, touching, listening and talking about food; about what you can do with the food besides eating, what the implications and alternatives are I offered my guest a way to connect with a bio-based economy.

With the scenario for the evening I managed to move my guests and to get them thinking about the development of a bio-based economy at the same time. With the emphasis on what happens within this transition on a local and global scale and opportunities for what they can do in these situations I managed to engage the compassionate environmentalists (see chapter 1 for an explanation of these and the other unravelled emotional viewpoints). By showing my guests how things were made, the banquet on a small scale, but also through industrial processes on a larger scale I attempted to engage the principled optimists. Even more so by the presentation of Nina Haase which showed that this development should also be fair and just. By presenting my guest the different levels onto which the bio-based economy manifests itself and by bringing my guests in direct contact with people from industries and companies I attempted to engage the cynical environmentalist by reducing their distrust to these parties.

My guests' disgust at eating insects as a possible protein resource showed me the importance of strong emotions for their engagement. Although the insects were masked and presented with similar looking more normal ingredients, some of my guests gagged at the idea of eating this. However, once it became apparent that for some people in developing countries this is their main protein source, that farming insects provides them with an income and this way of farming is more sustainable than producing meat, this made them think and reflect on this. This moment in the event demonstrated the importance of emotions of drawing focus and enticing reflection.

The banquet also demonstrated the importance of opening opportunities for people to make a difference themselves. This became apparent by the sheer enthusiasm of my guests by learning from the chefs where the various ingredients of their dinner came from and how they could achieve making similar dishes themselves. The story of Pharmafilter is a great example of how, by making small changes in nurses daily practice, they can help by making a huge difference for the recycling and treatment of their patients and the hospital they work in.

It appeared fruitful to invite people from different societal organisations instead of using self-signup or inviting experts. All my guests function in a network of other people so they know how to make contact with people they don't know. Besides, by inviting non-bio-based experts the chance of the occurrence of a 'them versus us' discussion could be avoided. Except for my speakers none of the guests had an idea of what a bio-based economy was about. And still they listened, wanted further explanations and asked very critical questions. The open and

sometimes chaotic setting in the performance of the banquet contributed to an open atmosphere which allowed all my guests to be themselves. This attitude allowed me to get a better grasp of how my guests conceptualised their bio-based economy.

The fact that most people operate in a network enhanced many of the discussions as sometimes they would talk for themselves and sometimes they would represent a whole community they represent. The fact that my guests all represent a certain network allows for a further dispersion of their experience of the banquet and their newly gained knowledge in those same networks. This might prove to be a sound way for further engagement of the public at large. For further study it would be interesting to look into the way in which the experience of the event is shared and dispersed within the network.

With regard to public awareness over bio-based products and the triggers for meaningful engagement several useful observations can be made. In the first place the WWF example of the production of a cappuccino showed that there seems to be a need for attention to communication about water usage in production processes. In this sense the banquet, if representative, may indicate that availability of water is still taken for granted within the Dutch society. In contrast to the knowledge on the cultivation and processing of coffee beans of which my guests had far less knowledge. Secondly, the enthusiasm over Pharmafilter demonstrated that engagement might best be triggered by providing a context of application that people can relate to in their daily life. Thirdly, the guests were divided by the attribution of responsibilities over responsible production: should industry or government be responsible for choosing more sustainable products or processes or should it be the consumers who make this choice for themselves. Since a banquet may not be sufficiently representative for opinions and attitudes held by society as whole the conclusions that one may derive from such event should be regarded as an invitation for further research rather than conclusive. The results and responses of my guests however do indicate how emotions and feelings socially contribute to understanding and that the event as such is useful for initiating engagement.

CHAPTER 6

BIO-BASING SOCIETY BY INCLUDING EMOTIONS

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Chapter 6: Bio-basing Society by Including Emotions

Abstract

A bio-based economy needs a bio-minded society since the required actions are of a collective scale. Engagement of civic society is crucial but disregarded by some of the advocates of the bio-based turn. Connecting society to this complex transition is difficult and so far insufficient. Technocratic one-directional communication strategies that aim to nurture public trust and support for the transition to a bio-based economy often backfire. Besides, 'tamed', institutionalised public participation approaches to legitimise policies may frustrate the public rather than facilitate engagement. What is needed is an approach that engages the public as active citizens, in an open-ended process. This pre-conditional 'state of engagement' can only exist when the public feels it holds a stake and has a voice. Initiating such engagement is not possible through rational, deliberative processes without emotions. In this paper we consider and explore the value of emotions for strengthening public engagement. We argue for a mentality change with regard to the potential role of citizens in a bio-based economy.

6.1 Introduction

Attempts are made to move from a fossil fuel based economy to a bio-based economy (Asveld et al., 2011; OECD, 2009; Soetaert & Vandamme, 2006). Bio-renewable feed-stocks are envisaged to contribute to the supply of the basic materials for chemicals and materials such as plastics, and energy for transport and other uses. Guided by policy measures, this transition is to establish new strategies for industrial production (for processes and products e.g. of fuels and materials). These strategies are expected to benefit society in terms of sustainability and energy security. Besides, the transition should be guided with due attention for equal benefit sharing and local development (Osseweijer, Ammann, & Kinderlerer, 2010; Osseweijer, Landeweerd, et al., 2010). Poverty alleviation, food security and higher living standards for an increasing population are criteria that are seen as conditional for a just introduction of these new strategies (Osseweijer, Landeweerd, et al., 2010).

The transition to biomass and biological processes as a basis for industrial production will have implications for global trade, agriculture and transportation of raw materials. Growing sufficient biomass for the domestic production of materials, chemicals and energy is not possible in all places of the world. This is specifically valid for Europe where one would have to use about 70-100% of the arable land in order to provide for 10-20% substitution of its current fuel usage by biofuels (Landeweerd et al., 2011). Hence, the power relations between different stakeholders (e.g. governments, multinationals, NGOs, the general public and specific communities) will change and will affect issues of morality, ethics and welfare (Enriquez, 1998).

The production chain in a bio-based economy runs from biomass to end product and back to resources. This demands the establishment of a circular infrastructure for this economy, adopting a more cradle to cradle approach (McDonough, Braungart, Anastas, & Zimmerman, 2003). This approach makes a distinction between a biological and technological cycle in which a bio-based economy is often perceived as the biological part. Currently, members of the public are usually taken into account only at the end of a production chain. The circularity of a bio-based economy changes this, since the public's waste streams become resource streams through their contribution to recycling. By making specific choices in their daily life, civic society[18] can contribute to the objectives of governments and industries for the transition to a bio-based economy.

Stakeholders supporting the bio-based economy include farmers, industry, the European Commission and other governmental institutions, European ports and their industrial hinterland,

[18] We use civic society instead of civil society as we are talking about the public, all the individuals who make up society rather than just the NGOs and non-profit organisations (civil society) who represent specific values or interests.

universities and public-private enterprises. They work on producing, distributing and converting biomass to make this economy a viable alternative for the current fossil-fuel based economy. Although bio-based products and processes enter the market slowly, engagement of civic society in the transition remains limited (Asveld et al., 2011; Berg et al., 2013; Pesch et al., 2010; Velde et al., 2011; Veldkamp, 2013). This lack of engagement can be problematic for the economic viability and political legitimacy (Thorpe & Gregory, 2010) of the bio-based turn.

Public engagement forms a part of a broader tradition of deliberative, participatory and inclusive approaches. Following Lorenzoni et al. (2007) we consider engagement to be a personal state of mind that forms the prerequisite for such deliberative forms of inclusion and public participation instead of the process of inclusion. In deliberative processes, validity of argumentation and reason-based co-decision making are central. They cannot take shape without this prerequisite. Existing approaches have become criticised for their tendency to frustrate engagement rather than allow for engagement to emerge (Cooke & Kothari, 2001): the problem is that these approaches, having mostly emerged in the context of NGOs' attempts to stir civic activism, have become an institutional instrument to tame political debate rather than facilitating it. As a result, the approaches to nurture active citizenship are frustrated due to mistakes in their design and implementation.

When we look at how people are and can be engaged with complex, technological and intangible issues such as a bio-based economy the role played by emotions in literature and practice is often overlooked (Harvey, 2009; Hoggett & Thompson, 2002). People's emotions are often considered as irrational and disruptive for decision making or as cause of bias that influences information processing (Kahan, 2008; Loewenstein et al., 2001; Slovic et al., 2007). As Roeser (2012b, p. 1033) states: '[i]n the past, emotions were generally excluded from communication and political decision making about risky technologies […] or used instrumentally to create support for a position'. However, although emotions can cloud our judgement they can also give us valuable cues to evaluate issues and the people associated with it (Pidgeon & Fischhoff, 2011).

There is much academic discussion about what is considered an emotion (Scherer, 2005) as they are difficult to define. Already in 1981 Kleinginna & Kleinginna recorded more than 90 definitions of emotions in emotion literature. In this chapter we consider emotions to be the affective response to a given situation that at the same time motivates action and opinion formation. They are subjective conscious experiences that are cognitive processes, accompanied by physiological and biological reactions (Frijda, 2005; Scherer, 2005). Emotions are guiding structures that link what is important for us as individuals to other people, things and

events. They help us to give meaning to the world in which we live (Kahan, 2010) and are considered as socio-cultural products embodying values and social norms of a society (Elster, 1999; Frijda, 2005; Nussbaum, 2001).While it is generally acknowledged that emotion, cognition and action interact in the process of opinion formation and decision-making, the positive potential of emotions for strengthening the engagement of civic society in science related policy and practice has been underemphasised.

In this chapter we perceive of the 'bio-based turn' as a typical example of a 'wicked problem' (Rittel & Webber, 1973): a type of problem, characterised by its complexity, ambiguity of its problem statement, and apparent insolvability. For governance of this turn, active citizenship is necessary, and thus, public engagement is a prerequisite. Williams (2004) claims that the role of participation is never fully 'tamed' and she therefore provides a more nuanced view. She does, however, see a need for a re-politisation of participation, a form of an open-ended deliberative process. In support of this view, we hope to advise established bio-based economy advocates (governments, natural scientists and industry), by raising awareness over the need for a mentality shift which would entail changed perceptions of the need, shape and legitimate use of public engagement.

6.2 What is the transition to a bio-based economy?

Different types of biomass have always been used for various products and processes. Previously, straw and hay were used as feed but also as insulation material; wood was and still is used as a building material, for cooking, heating and running steam engines. During the industrial revolution this system of use and production was increasingly replaced by the use of fossil resources for fuels, materials (amongst others plastics) and electricity. Although the industrial revolution carried along many societal problems, in the end, it did allow for a level of prosperity that was previously inconceivable (Asveld et al., 2011). Rapeseed was used to run the first diesel engines, but with the widespread introduction of cars, fossil fuel replaced this source of fuel. Bio-based products remained in use. For instance Flax produces linen for fabrics and vegetable oils produce paints. Biofuels also remained in use. For example due to international economic embargos in the wake of the first oil crisis, the use of biofuels for cars in Brazil was intensively stimulated in the 1970s.

Fossil fuels are finite. Thus increased focus on sustainable production and the mitigation of climate change, scientists search for alternatives. Although the development of large scale shale gas and oil production may diminish the urgency for finding alternatives for fossil fuels and energy independency, these fossil resources do not resolve problems of environmental damage and climate change. The new bio-based economy uses renewable resources of our planet to

cope with the population growth and mitigate the effects of global warming and to combat climate change.

Current efforts to foster transitions to a bio-based economy are predominantly managed top-down, guided by technocratic governance structures that mainly involve expert stakeholders (Sanders & Langeveld, 2010; Schmid et al., 2012). Many scientists, industrialists and policy-makers believe in the potential of industrial biotechnology for the sustainable development of a bio-based economy (Paula & Birrer, 2006; Soetaert & Vandamme, 2010). Financial incentives are provided to enhance the competitiveness of bio-renewable production[19]. But the bio-based turn demands more than a mere change of the mode of production.

Policy incentives are implemented to safeguard energy security as part of a sustainable society. They address issues of climate change, strengthen independence from other countries and give rise to new economic development and safeguard efficient use of energy[20] (Asveld et al., 2011; Landeweerd et al., 2011; Langeveld et al., 2010; Soetaert & Vandamme, 2006, 2010). At the same time, non-profit and non-governmental organisations involved, such as the World Wide Fund for Nature (WWF), the Action Group on Erosion, Technology and Concentration (ETC group) and Oxfam (Bang et al., 2009; ETC Group, 2010; Kelly, 2012) focus on specific societal concerns that arise with the development of a bio-based economy. They argue that moral issues about deforestation, private interest lobbies, monocultures and biodiversity, land grab and fair trade should be part of the transition agenda (Bang et al., 2009; ETC Group, 2010; Kelly, 2012).

6.3 A bio-based economy needs a bio-minded society

People's personal choices influence the direction of development of the application of industrial biotechnology (Gijsbers et al., 2005; Paula & Birrer, 2006). What they purchase, how they vote, how they travel, or how they recycle their waste, as well as their level of acceptance of technology and governance will influence the development and structure of a bio-based economy. Civic society can make all these choices on the basis of a combination of self-interest and collective interest (for the public good).

The necessity for engagement of civic society is broadly recognised (Cologne Paper, 2007; Commission, 2011a, 2012; OECD, 2009; Paula & Birrer, 2006; Schuurbiers et al., 2007; Sociaal-Economische Raad, 2010; Zachariasse et al., 2011). Public engagement is a

[19] For instance the TKI BBE in the Netherlands, which is a grant scheme that supports the development and creation of knowledge and innovations related to the bio-based economy.

[20] Energy efficiency is one of the goals of a bio-based economy. An increase of efficiency may however lead to a higher use of natural resources and hence pressure on available resources through the so called rebound effect.

prerequisite for successful societal embedding of innovation and a means of improving decision-making process (Irwin, 2006; Stirling, 2008; Tallacchini, 2009). However, bio-based economy advocates translate public engagement too easily as public support for the necessary policies and actions, and many of the ways in which this is done miss the original goal (Jensen & Wagoner, 2009).

To harness the full benefits of a bio-based society collective action and behaviour changes are required. Many advocates of the bio-based turn perceive of this as a mainly techno-industrial in nature. They mostly aim to generate policy commitment and disregard the need of public engagement. But it has become commonplace to support an open, informed dialogue during the development of technology (such as Commission, 2011a, 2012). We have thus witnessed much effort and emphasis on engaging the public (Felt & Wynne, 2007). Whilst this call is laudable, many public participatory approaches in policy tend to be used to legitimise existing agendas and depoliticise the debate (Williams, 2004), rather than soliciting co-decision and co-responsibility from the public. Cooke and Kothari (2001) argue that existing models for public engagement hold a contradiction in that they are 'tyrannical' rather than empowering, suppressing those who they actually seek to empower. Rather than feeling empowered, participants in public engagement events feel disempowered due to the restrictions of the format used and their lack of influence over what happens with their input (Cooke & Kothari, 2001; Felt & Fochler, 2008, 2010; Mejlgaard & Stares, 2013). Organisers often seem to be annoyed by such criticism, rather than taking this as a deficit of their activities. Many approaches of public engagement seem to suffer from the similar democratic gap that they seek to bridge. The institutionalised functionalization of public participatory tools carry along an instrumentalisation of such tools. Organisers of the engagement process thus legitimise policy rather than shaping it. They focus on generating trust and support rather than critical dialogue (Irwin et al., 2013). This is also valid for the bio-based turn: a public with a positive opinion of a bio-based economy and biotechnologies is considered an asset for the future by expert stakeholders (Cologne Paper, 2007, p. 13; Commission, 2012). At the same time, potential public adversity or resistance against the use of techniques such as genetic modification (GM) or synthetic biology is perceived as a hurdle for the successful development of a bio-based economy (Cologne Paper, 2007, p. 13; Commission, 2011a, p. 42; OECD, 2009, pp. 19, 155; Zachariasse et al., 2011, p. 39), and is expected to need a premeditation by informing and engaging civic society.

Making choices in relation to the bio-based economy is a tight rope act as these choices will also affect other parts of the world and perhaps more importantly future generations. Furthermore, most choices that are made, are made on higher aggregation levels of society. But these levels do need public support and when uncertainties, unknowns and misunderstandings

are involved people tend to behave in a more self-interested manner than they would otherwise. To avoid self-interestedness and address other core motivations for collective behaviour (Vugt, 2009) people need to have a feeling that this transition also concerns them, they can trust other stakeholders and they have the capacities to be engaged. When uncertainties about the choices that civic society can make, are reduced and more information about the consequences of these choices is available, they can also better decide about their own personal choices (Pidgeon & Fischhoff, 2011).

If a bio-based economy is to be embedded in society it should be organised as a shared enterprise with shared tasks and responsibilities which asks for a change in mentality of all parties involved. Capabilities such as reflexivity, resilience, responsiveness and revitalisation are regarded essential to deal wisely with wicked problems (Termeer, Dewulf, Breeman, & Stiller, 2013). Such capabilities and change in mentality cannot be achieved by applying formal, procedural, reason based procedures[21] but ask for an alternative approach. Focussing merely on expert aspects related to for instance research and innovation in establishing a bio-based economy may steer the deliberation towards subject matters that are less relevant for civic society. In relation to societal issues carried along by innovation – the (side) effect of the implementations of innovation – it is members of the public themselves, rather than public opinion experts, that are argued to qualify best and thus they should be involved (Wynne, 2007). Civic society's emotions also play a role in how its members perceive information from already engaged stakeholders such as policy makers NGOs and industry (Fischer & Glenk, 2011) and the role they play. Both Kahan (Kahan, 2008; Kahan, Peters, et al., 2012) and van Vugt (2009) pointed out that members of the public are more inclined to align their perception and actions based on the perceptions and actions of their peers, the community to which they want to belong rather than what they are being told by experts.

6.4 Problems with bio-minding society

A 'wicked' problem is an ill-defined and ambiguous problem, whose direction and impacts for collective actions are uncertain, with multiple interdependencies and complex social dynamics (Rittel & Webber, 1973). The transition to a bio-based economy meets all these criteria. The development of a bio-based economy is characterised as complex (Michalopoulos et al., 2011) and surrounded by many (scientific) uncertainties and lack of clarity (Osseweijer, Landeweerd, et al., 2010). For example, information about the available land for the cultivation of food crops and bio-based products and the actual impact on sustainability, which is different in different

[21] Reason in this context should be understood as articulated arguments based on factual evidence

regions is uncertain. Moreover, the various stakeholders hold differing, and sometimes conflicting values (Cuppen et al., 2010) which increase the difficulties in dealing with this problem. Inherent to its wickedness, finding solutions for a collective bio-based economy can not be guided by predefined rules, as the current problems that need to be solved resulted from understanding and solving earlier problems (Rittel & Webber, 1973).

Due to the wickedness and complexity of the transition, public engagement is difficult (Frame & Brown, 2008; Mikhailovich, 2009). The subject is not tangible to the individual and formal, procedural and reason based approaches for involving civic society seem insufficient, as we argued above. Members of the public have been found to have difficulties in recognising that comparable technologies have different application areas, and they do not seem to understand the economic role of industrial biotechnology sufficiently (Osseweijer et al 2010; Sciencewise 2009).

Results from a study on the public's perceptions towards industrial biotechnology (Opinion leader, 2009) demonstrated that participants are distrustful of governments' and industries' motives for going bio-based. This coincides with the dominant views amongst European citizens that policy makers and multi-nationals are no credible resources of information about this development (Commission, 2010; Gaskell et al., 2010; Opinion leader, 2009). At the same time civic society puts government and industry in the lead of this development (Berg et al., 2013).

Different master narratives on the bio-based society (and the shape its economy is to take) have been identified in research on discourses concerning the bio-based economy, for example an agro-ecology narrative or the knowledge based bio-economy narrative (Levidow et al., 2013). Felt & Wynne (2007) stress the importance of considering and reflecting on such narratives as they provide people with varying perspectives. These narratives express varying views on how collective systems should be organised. According to Birch et al. (2010) and Levidow et al. (2013) the master narrative of a 'knowledge based bio economy' for Europe promotes primarily industrial research and development with the aim of opening new markets for the exploitation of renewable resources. The various stakeholders have differing, and sometimes conflicting, values, which makes public engagement complicated (Cuppen et al., 2010; Landeweerd, Osseweijer, & Kinderlerer, 2009; Schuurbiers et al., 2007). Although economic drivers are very dominant in any transition, it is argued that scientific development and economic progress can not be the sole drivers for the transition from fossil to bio-renewable resources (Osseweijer, Landeweerd, et al., 2010) and that its attainment may even be hampered when other societal success factors are not taken into account.

Many approaches to science/society interactions presuppose a lack of knowledge of the public. This knowledge deficit is then to be overcome by providing sufficient information. This would then increase public support for science and technology. Such 'deficit model'-based strategies are problematic for public engagement. When they lead to instrumentally-motivated processes of engagement (Fiorino, 1990; Stirling, 2008) they pose a risk of backfiring on the goals to which such engagement is deployed. Legitimacy for the bio-based turn cannot be reached by mere persuasion of the public. This is only possible by actively engaging them in a more dialogical process whilst the transition unfolds (Irwin, 2006; Paula & Birrer, 2006). Despite the instrumental argument for public engagement, – to achieve predefined goals – Fiorino (1990) identified two additional rationales for doing so. The normative argument states that public engagement is the right thing to do whilst the substantive argument asserts that public engagement aims to achieve qualitatively better outcomes (Fiorino, 1990; Stirling, 2008). All these rationales need to be satisfied for a legitimate establishment of a bio-based society.

The process of public engagement comes at a price for civic society. Thorpe and Gregory (2010) describe public engagement as a form of cognitive interpretive, affective and social work for those who take part. Engagement means effort, ranging from the processing of information to the production of an opinion or getting into action. Moreover, engagement is demanding on people's time; to absorb the given information, to attend an engagement activity, and even time for considering what choice to make. And this competes with other issues asking for the same time and effort. As the level of engagement increases, according to May (2007) prevalence decreases. The higher the level of engagement that is required from people, the fewer there are who are willing and able to commit. Integrating emotions in public engagement could help, but should not be used as a public relations instrument to resolve the issue of a lack of trust (Engdahl & Lidskog, 2012), but rather to re-establish a meaningful relation to civic society. By engaging members of the public in a way that is multi-directional and takes their emotions into account, they can develop a sensitivity for collective decision-making.

6.5 A different angle: affective engagement with a bio-based economy

We argued that civic society should be included in the process of preparing society for an alternative for the current fossil fuel based economy. The question remains how to achieve this. Landeweerd et al. (2011) argued that for complex developments, such as the bio-based economy, a wider, less unidirectional engagement of the public is needed. Based on Michael's (2002) examinations of the different approaches on public understanding of science, Horst and Michael (2011) propose a communication model for public engagement that caters to such a need. Their so called 'emergence model' does not conceptualise communication as a 'flow of

information' (Rowe & Frewer, 2005), but analyses it as a constitutive force in which science and society are shaped. In practice this means that communication does not mean only transfer of information from one party to the other. The model is more attuned to the relation between science and society and the way in which this relation is established. In this way the model also includes encounters with civic society that does not engage the way the initiator of the engagement intended them to engage, incorporating the unexpected, eventful incidents and emotions.

Many experts state that emotions are relational (Boiger & Mesquita, 2012; Oatley & Johnson-Laird, 2014). If viewed as such, they relate external events and people to inner concerns in the form of an evaluation. As such emotions expose what is of importance for society's engagement. A capacity to feel is the basis for being part of and participating in a democratic society (Marcus, 2002). Several authors have argued that emotions should be considered as a form of cognition and insight (Frijda, 2005; Roeser, 2009, 2010b) and as such a natural and necessary part of decision-making that allows people to develop a practice-oriented rationality (Damasio, 1994; Marcus, 2000, 2002). Emotions towards an issue entice reflection and motivate people (Roeser, 2012b), and taking them into account in public engagement will likely stimulate engagement.

To be able to take emotions into account for initial engagement one needs to be aware of the kinds of emotions that exist amongst civic society. Based on stakeholders' visual representations of a bio-based economy Sleenhoff, Cuppen, et al. (2015) distinguished four different emotional views. The compassionate environmentalist, principled optimist, hopeful motorist and cynical environmentalist views indicate what kinds of aspects of the bio-based turn are important for civic society. These views show people's emotions are rather complex being comprised of an array of emotions towards different aspect of the transition. And more importantly the views show that society's emotions extend beyond the mere distinctions of favour or aversion. Besides civic society's emotions, stakeholders would do well to consider the emotions of their own position. The emotional views lay bare what is the starting point for building a relation for shaping a bio-based society.

How one may include emotions in public engagement depends on the setting and topic in question. For example: some time ago we prepared a design for public engagement (See chapter 5). We planned and organised a banquet for 40 citizens from the region of Delft, with the aim to engage several representative regional organisations and individual citizens with a bio-based economy by giving attention to emotions (BioBased Economy, 2013). We had already identified different emotional views and different capabilities for action amongst members of the public (their perceived efficacy beliefs) in a study of the Dutch public (Sleenhoff, Cuppen, et al., 2015; Sleenhoff & Osseweijer, 2015) (See chapter 2 and 3) . This formed the conceptual basis

for the event. We invited representatives of various societal groups: people from the Delft entrepreneurs' association, members of different service organisations (aka, Rotary Club), local members of the Dutch Women's Institute, members of various sustainable or transition organisations, and several interested citizens. The banquet was organised in a multifunctional space in the city centre, which functioned as meeting point, a debate centre and pop-up store and gallery for diverse art.

The guests were seated at a long table, of which elements were made from hogweed *(Heracleum mantegazzianum).* The paper of the menus was made from vegetable waste. Thus, we made the bio-based economy tangible for our guests, demonstrating the versatility of possible applications beyond food. Small cards with provocative questions and statements were distributed, for instance, 'when industry produces more sustainably I don't have to change my personal behaviour'. This was meant to trigger conversation. This also encouraged people to reflect over their role in bio-based developments.

Through the design of the furniture, the menu and through three dinner speakers, the bio-based economy became (literally) tangible for our guests. The banquet addressed all senses, contributing to the formation of representations of the bio-based economy. We thus helped people to connect with a bio-based economy, stimulating engagement, and provided an arena for truly joint decision-making.

According to Harvey (2009) it is often ignored that engagement is theatrical and emotional for members of the public (Harvey, 2009). Experiencing emotions helps people by familiarising themselves with the unknown (Hoijer, 2010). They help make unfamiliar issues such as a bio-based economy become more tangible and less abstract through the production of social representations (Moscovici, 2002). These representations are commensurable to Morgan's (2002) mental models approach which he developed in the context of risk communication focussing on harms and benefits. According to Gottweis (2005), increased scientific, political and social uncertainties and complexities accompany the development of novel technologies in the field of life sciences (i.e. industrial biotechnology or medical genomics). He also argues that with this increased complexity the language of emotional values, ethos-based discourse, has become increasingly important as they bring focus to what is at stake.

Through an appeal to people's affect, one can circumvent the problem associated with engaging with what Michael (2002) called a disembodied public. Doing public engagement with a bio-based economy mechanistically only captures people's ideas and apprehensions instead of changing their actual state of engagement (Lezaun & Soneryd, 2007; Lorenzoni et al., 2007). Such public engagement - only based on people's ideas and thoughts of the issue at hand - will

be problematic. A disembodied public – a presumed representation of a public trough a collection of their opinions and reflections – is not an agent. It cannot make any choice or change in its behaviour for the social dilemmas it is confronted with. Although emotions are subjective conscious experiences which also have a mental process, they are also characterised by physiological and biological reactions which requires a body to experience these. Through affect the public becomes embodied, facilitating active participation since here the public is identified as people instead of merely a collection of impressions of their ideas or opinions.

6.6 Concluding remarks

The idea of bio-basing of our current fossil-fuel based economy should not be steered merely through scientific expertise and corporate agendas. These agendas promise beneficial outcomes for society, but citizens need to be engaged in the drafting of such agendas. Next to conventional scientific expertise their lay knowledge should be taken into account in the assessment of societal benefits and harms (Wynne, 2007). This assessment becomes manifest in political decisions and day-to-day life decisions of citizens. In this paper we have argued for engaging civic society with the development of a bio-based economy and proposed that this can be best achieved by taking their emotions seriously since these indicate best what matters to them. We conclude that adequate engagement of civic society is a prerequisite for bio-basing our economy. Such engagement would be nurtured by creating space for and appealing to emotions and affect.

Due to the complexity of the transition to a bio-based economy, engaging citizens is complex and difficult to achieve. The view that emotions play an important role in people's decision-making process underlay our analysis since emotions entice reflection on the issue at hand and guide people into action. We argued that by affectively engaging citizens – which is also an emotional process for them - they can build their own relation to a bio-based economy. Civic society's engagement will be largely determined by their own conceptualisation of the issue based on their emotions, worldviews and the extent of their self-efficacy, how capable they feel they can make a meaningful contribution (Hedlund-de Witt, 2012; Sleenhoff, Cuppen, et al., 2015; Sleenhoff & Osseweijer, 2015). As pointed out above public engagement should not thus merely follow mechanistic approaches. Through more meaningful engagement we can become a society with a bio-based mentality making sense of its complexity.

Chapter 7

Discussion & Conclusion

Chapter 7: Discussion & Conclusion

In this study I have explored the value of emotions for public engagement, how they can be measured and triggered in a meaningful way with the transition to a bio-based economy. To answer the research question I used and combined different qualitative and quantitative approaches. Measuring and analysing emotions as well as engaging the public with the emerging bio-based economy is challenging. Bringing together fields of knowledge from (industrial) biotechnology, climate change, science communication, (social) psychology, research policy and (moral) philosophy was necessary to do justice to the complexity of the central subject of this thesis. In this final chapter I will highlight and reflect on the main conclusions.

In the next sections I will first discuss and reflect on what has been concluded in the different studies. An approach was developed for measuring people's emotions and perceived self-efficacy to a bio-based economy (Chapter 2 & 3). Subsequently, I will take the opportunity to link and compare the results from both Q studies. The effect of a more affective and visual form of communication for engagement was explored and applied in chapter 4 & 5. I will discuss the impact of making abstract issues more tangible for engagement. The importance of emotions for engagement with a bio-based economy was elucidated in chapter 6. In section 7.7 I will answer my research question. Section 7.8 discusses the relevance of this study for the stakeholders engaged in the bio-based transition. This chapter ends with the limitations of this study and suggestions and recommendations for further research.

7.1 Measuring emotions

To be able to say anything about the value of emotions for public engagement at all, I first had to find a way to establish what kinds of emotions people have towards the transition to a bio-based economy. Since Dutch society is still largely unaware of the occurrence of a bio-based transition, simply asking them about how they felt about this transition would require a lot of explanation from my side. This is already challenging but I also had to avoid framing my participants beforehand since I wanted to avoid influencing their emotions. The bio-based turn involves different research fields and issues some of which are more familiar to people than others. As these research fields and issues converge so can people's emotions towards the separate fields and issues get intertwined. Because of the complexity of the emerging bio-based economy and people's unfamiliarity with it, I used social representations theory as a framework to study how members of society would familiarise themselves with this bio-based transition. I focused on the use of visual social representations because images and pictures are efficient in

carrying emotional content and triggering emotional responses that generate collective meanings. In addition, they have the potential to make the abstract more concrete.

Having individuals evaluating single pictures and describing what kinds of feelings they experienced as a result would not be sufficient to say anything about what feelings they have towards a bio-based economy. So, I chose to use Q methodology, a method developed to measure subjectivity. In a Q interview participants were asked to compare pictures with each other. This methodology allowed me to study how individuals constructed their own emotional views whilst I would still be able to say something about these views on a higher aggregation level identifying what kinds of emotional views can be found amongst Dutch society. The methodology provided me with an easily understandable format for producing rich and subtle interpretations of a complex phenomenon. Through the combined qualitative and quantitative approach of Q methodology I was able to capture public emotions that were grafted by bio-based visual representations. I demonstrated that four distinct emotional views amongst the Dutch public at large could be found: (see also chapter 2)

1. Compassionate Environmentalists
2. Principled Optimists
3. Hopeful Motorists
4. Cynical Environmentalists

The unravelled emotional views appeared to be complex. They are comprised of multiple emotions. Although some of the views displayed similar emotions of hope, enthusiasm or frustration each emotional view had its own take and focus point on the bio-based transition. These were for example the mode of production or people's environment that constituted the issues through which people connected to the transition. Since emotions help people to focus their attention, these emotional views bring clarity in what aspects of the bio-based turn are of importance for them. Each emotional view opened a deeper insight into a more complex array of emotions connected to personal norms, values and opinions. At the same time these emotional views indicate how the issue of the transition is understood by the public; through the Q sort my participants constructed their own social representation of what a bio-based economy encompasses and actually started to engage. As such the found emotional views are a starting point for public's engagement with a bio-based economy. Based on the pictures, participants were able to construct their own view of how they feel and conceptualise this economy.

7.2 How people feel they can have efficacy

Besides affective and cognitive aspects there is also a behavioural aspect to engagement. In addition to what people know and feel they also need to have an idea of the ways in which they

can act to give expression to their engagement. And only looking at what people do without knowing what is in their heart also makes it hard to determine if those people are engaged. The behavioural sphere, the concrete actions through which people can express their engagement is just as important because their behavioural intentions are often driven by their emotions.

Which behaviour changes and personal actions are necessary, desired and accepted in respect of the emerging bio-based economy and the extent to which members of the public feel they can and are willing to act is up for debate. To gain insight in which ways members of the public feel they can engage I looked at what efficacy beliefs members of the public develop through the interaction with stakeholders' representations of a bio-based economy. Using the same set of pictures (Q set) and group of participants (P set) as those that were used for unravelling people's emotional views I was able to analyse how participants perceive themselves (in)capable of making a meaningful contribution to the bio-based transition. I found five distinct ways through which members of the public perceive they could add to more collective action and support.

1. Conscious shopping by…
2. Saving the world despite the technical terms
3. Recycle to…
4. Filling my car with the right fuel
5. System limits personal contribution

These efficacy beliefs show actions in which members of the public feel empowered and indicate ways in which they can initially be engaged. On the other hand, these views also make clear how members of the public feel unable and incapable to act in a bio-based transition.

This study showed that participants' efficacy beliefs differ in the size in which they perceive the context of their engagement. This difference shows a variety in people's level of engagement: either on the level of personal responsibility or on a systems level. The differences between the beliefs in terms of the level of responsibility will influence the development of a bio-based economy. The beliefs indicate how much time and effort people are willing to invest and to what extent they will interact with others to coordinate their actions. These beliefs show that people foresee different ways and directions of development for the bio-based economy.

Having insight in people's efficacy beliefs is valuable. When people know how they can make a meaningful contribution they are more inclined to learn new skills and adopt their behaviour accordingly (Ballard 2005). Instead of approaching civic society as a blank slate with no knowledge or emotions bio-based stakeholders would do well to take the connected emotional views and efficacy beliefs into account. Stakeholders should be more aware of the implications and effect of their own representations for public engagement. It is most likely

members of the public will encounter these representations when they start familiarising themselves with its development. I encourage engaged stakeholders to engage themselves in conversation with these publics if a more sustainable mode of production is what they envision for this bio-based economy. Stakeholders should not be afraid for members of the public who partake in such public protest or openly state that we should consume less. On the contrary, their emotion driven behaviour shows there is something important at stake for them and should be the starting point for engagement.

7.3 Combining emotional views and perceived efficacy beliefs

The design of the Q studies created the opportunity to analyse whether specific emotions trigger specific types of efficacy beliefs by combining the data. With public engagement being comprised of three spheres of cognition, affect and behaviour (Lorenzoni, 2007) this design may create the opportunity to say something about various types of engagement. Although different mathematical approaches have been used for establishing a relation between the different views, these results were not significant enough to confirm this idea of different types of engagement. Still, when looking at the different emotional views and efficacy beliefs the qualitative aspects of the Q study indicate relations between how people feel on the one hand and how they perceive themselves able to act on the other hand.

Here I will discuss a few of the possible ways for members of the public to be engaged. People with a *compassionate environmentalist* emotional view care about their environment and worry about the deterioration of our habitat. They are enthused by all sorts of personal activities through which they can take care of their own environment. This could be via consumption, recycling or attending demonstrations. The *hopeful motorists* fear that due to a transition to a more bio-based economy they might have to give up owning and driving a personal car. On the other hand they are hopeful about the development of biofuels which would allow them to continue their driving habits. It is not hard to foresee that these participants want to *continue filling their cars with fuel* regardless which type. For *principled optimists* fairness and equality are very important conditions that should not be violated in the transition. Through the choices that we as citizens make each day, we contribute to the direction into which our society develops. This thought relates to the *conscious consumers'* efficacy belief as a manner to engage with the transition. Principled optimist's optimism could also stimulate their *recycle to* efficacy belief; the idea that through recycling they can meaningfully contribute to the transition. The *cynical's* starting position is to distrust the institutions that drive the transition to a bio-based economy. This emotion can motivate them to initiate or join public protests towards these stakeholders.

Because of the scale of the transition they likely feel that the system in which this transition unfolds limits their potential to contribute. These descriptions of people's possible motives and forms of engagement show the various ways through which they can contribute to the creation of a bio-based economy collectively. Of course many more connections between people's emotions and efficacy beliefs can be made but I think these examples make clear that public's engagement is multi-formed. We all perceive our social responsibility for a bio-based economy differently. Our emotions can drive us to different actions that may nevertheless lead us in a similar direction.

7.4 Unexpected encounters

Emotions are of value for public engagement as they guide and manage our thoughts. Taking emotions more consciously into account in communication enhances public engagement with complex issues. Doing so can reduce unconstructive emotions and motivate action. However, how to actively accommodate for these emotions in a meaningful way is not obvious. Enhancing public engagement explored the potential of bio-art, as a more affective form of communication for the engagement of its observers with a bio-based economy.

Through a series of interviews and focus groups I found two main lines of thought on a bio-based economy amongst visitors of the D&A4G exhibition. A *managed–vs-wild*- and *useful-vs-useless*-line of thought provide insight in how visitors get engaged and with what. The managed-vs-wild theme showed how visitors got connected with the malleability of life whereas the useful-vs-useless shows how they associate with the impact of technological developments on life. Both lines of thought uncover how visitors create their own representations, how they connect the issue of a bio-based economy in their personal context.

The results also showed that the visitors prefer to engage with the envisioned implications of the bio-based transition over engaging with the application of the technologies involved. Although the artworks aroused emotions of visitors, these did not alter their positions towards the perceived issue. Their emotions enticed visitors to reflect on the represented issue through the artwork – triggering an intrapersonal dialogue. They are stimulated to think about what is signified and what it means for them.

Observing the artworks created a starting point for further dialogue and collective action. By stimulating visitors imaginative and emphatic capacities the artworks enabled imagining possible impacts of the current or future developments. Visitors said they were motivated to come into action, and to take personal responsibility towards the issue at hand. Although this study identified a way in which emotions can be taken into account for public engagement, it also showed that by doing so the engagement of visitors is eventful, and outcomes indeed less

predictable, controllable and steerable. The manner in which people engage depends on the context of their personal mind-set and the context in which they encounter the artworks.

7.5 Bio-based Banquet; putting research into practice

After having unravelled people's emotional views and perceived efficacy beliefs, and after having studied the value of emotions in the emergence of public engagement I decided to put my research results into practice to initiate public engagement in an alternative way. Therefore I organised a bio-based dinner for citizens of Delft.

With the banquet I managed to move my guests through the different ways in which the bio-based economy became (literally) tangible for them. Through the design of the dinner the different emotional views and perceived efficacy beliefs were incorporated and addressed. By eating and tasting, touching, listening and talking about food, by talking about what you can do with the food besides eating it, and by discussing what the implications and alternatives are, I offered my guests an opportunity to connect with a bio-based economy. This holistic approach, which involved addressing all their senses instead of only the ratio, allowed them to create their own representation of what this economy might look like and what it meant to them.

The banquet demonstrated the importance of opening up opportunities for people to make a difference themselves. Through the different talks and examples of a bio-based dinner my guests' perceived self-efficacy got enhanced. Through the conversations and discussions my dinner guests were presented with and could exchange different ways through which they could connect to this emerging bio-based economy in their own region. Sometimes my guests would talk on their own behalf and sometimes as the representatives of societal organisations they were, exchanging between individual and collective perspectives. They encouraged each other to learn about and question bio-based developments creating their own representations.

All my guests came with different backgrounds to the table and represented different social groups or communities that are active within the vicinity of Delft. Through the dinner they engaged in an informal learning experience. Many of my guests expressed that they would carry on what they had heard and learned during the evening extending the reach of the banquet.

7.6 Bio-basing society by including emotions

The transition to a bio-based economy can not only be driven by scientific expertise, corporate agendas and enthused policy makers. I analysed stakeholders motives and drivers in the current development of a bio-based economy and reviewed how the transition is governed. I evaluated stakeholders reasons for engagement of civic society and argued these were mainly instrumental, dealing with political legitimacy and economic viability. I conclude that not

adequately engaging civic society in the bio-basing of our economy will lead to an unsustainable development of a bio-based economy.

Every member of the public is also a stakeholder in the transition and thus equipped to assess the social benefits and harms involved. However, the complexity of the transition makes that engaging citizens in a meaningful way is complex and difficult to achieve. I argued that current approaches to engage the public with a bio-based economy, be it through direct public participatory exercises, or through charting public opinion, have proven to be insufficient in giving the public a voice. Sometimes such approaches frustrate public engagement and merely serve as a formal justification of predefined agendas. Dominant rationalistic approaches to public engagement appear to alienate the public from the issue at hand, and rather than engaging them, it creates disembodied publics.

To remediate this problem I proposed to embrace emotion and affect in the communication and engagement process. Rather than perceiving these as traditionally was the case, i.e. as barriers to innovation, I consider emotion and affect as a key element in raising public awareness, critical reflection, collective support and public action for the development of a bio-based society. Emotions are the starting point for engagement. By affectively engaging citizens – which is also an emotional process for them – they can build their own relation to a bio-based economy, and start to take their own responsibility. Through more meaningful engagement we can become a society with a bio-based mentality making sense of its complexity.

7.7 Answer to the research question

The emerging bio-based economy demands society to familiarise themselves with the subject and related issues. In order for members of society to meaningfully engage in this transition they need to familiarise themselves with what such an economy entails and expects from them. Emotions have been found to be important for such engagement. But what was unknown is which emotions and how they can be taken into account in an open and honest fashion. This thesis therefore aimed to answer the question: *In what way can emotions entice collective engagement for a bio-based economy?*

The results and outcomes of the presented studies in this thesis allow me to answer this question. Using visual representations of a bio-based economy – making this transition tangible for people – triggered different kinds of emotional views, which also rendered explicit different social representations of a bio-based economy within Dutch society. The emotional views showed which aspects of the transition are of utmost importance to them and which are less important. Besides, the representations also triggered different kinds of efficacy beliefs on how people could be involved in this transition or not, either on a personal or on a more systems

level. Combining the emotional views and efficacy beliefs showed a myriad of ways of how members of the public can be engaged.

The emergence of a bio-based society requires collective action and responsibility. Not only from engaged stakeholders but also from the public at large. Understanding what issue triggers which emotions amongst members of the public, both positively and negatively, opens-up meaningful ways for their engagement. The emotional representations of this new economy lays reveal how members of the public perceive to be able to contribute to this transition or not. Mind you, these contributions are not all the same forms of engagement and action. Rather they are actions and responsibilities towards the collective of a transition to a bio-based society. The effect of more affective, non-verbal communication is that the engagement of members of the public becomes more eventful. Accommodating emotions engaged members of the public from their own context. For meaningful public engagement public emotions should be the starting point. This way of engagement allows engaging people beyond the small group of the concerned or affected. Different members of society can engage from their own context contributing in various ways to collective goal.

7.8 Suggestions for further research

In this thesis I used visual representations – pictures, images, info graphics, and art – as a vehicle for and trigger of emotions and studied how and in what way members of the public became engaged. As such this research is a start for filling the knowledge lacunae on how non-verbal forms of communication affect public opinion formation. It would be interesting to compare these results with a more verbal approach and see if respondents would come up with similar emotion and efficacy views. More research could be done on how individual engagement can contribute to collective goals and how this should be communicated, initiated and harboured.

I looked at how members of the public create social representations of a bio-based economy. Although I have visualised their emotional and efficacy views based on their descriptions in the pictures on page: 40 and 59 it would be interesting to study the kind of image, or representations members of the public would draw themselves. In addition, it would be interesting to look at to what extent the found public views match or converse from stakeholders representations. Now I have unravelled which emotional and efficacy views can be found amongst the Dutch general public it is possible to look into how big each category is; what percentage of society falls into which category? And in line with the research of Cuppen et al. (2010) and (Cormick & Romanach, 2014) it will also be interesting to study how members of the public will engage if one targets communication based on the unravelled views instead of this being based

on stakeholder type or demographic variables. However, one has to keep in mind that a person's emotional and efficacy views - just as social representations - are not fixed. They are constantly reshaped as one communicates about the bio-based economy. So also the numbers of who has what emotional and efficacy view will change over time.

Another interesting venture for research is to study what happens after engagement with the bio-based economy is triggered. Since I only looked at how engagement got triggered it would be interesting to look at how members of the public shape and extend their engagement, or not. This would extend our knowledge on how one can overcome the value-action gap as was described by Blake (1999). People's efficacy belief is an important aspect in determining how and to what extent they engage with a bio-based economy. A final suggestion for further research is to look at to what extent a linkage between these beliefs and the emotional views can be found.

In this study we identified several emotional views amongst members of the public towards the emerging bio-based economy. With the bio-based banquet these views were used in the design of the set-up of the event, combining and addressing all views. However, it would be interesting to study what kinds of interventions can be designed taking only one emotional view as a starting point. And also to study the further engagement that would emerge. Another interesting topic is to look at what kind of emotional views stakeholders have towards a bio-based economy. In this study I only focussed on the emotions of members of the public. However, stakeholders also have emotions which are important starting points for interaction and further development of their bio-based activities. What are their emotional views towards a bio-based economy?

7.9 What this thesis is not

Emotions are an indistinguishable part of communication, albeit often rendered implicit and underexposed. With this thesis I tried to shed some light on how to explore, elicit and articulate emotions for public engagement. Researching the values of emotions for public engagement raised a lot of questions about the goals of my thesis. I did not intend to design ways to manipulate the public into acceptance of the use of industrial biotechnology and the transition to a bio-based economy via their emotions. But still, wasn't I setting up a marketing campaign for the scientists and policy makers who work on different aspects related to the bio-based economy so they can more easily justify what they are working on and why?

This thesis is not about how you can make people accept this transition. Instead of presenting you, my reader with a step-by-step receipt on how to achieve this, this thesis takes a totally different stance toward engagement. Engagement is something that emerges between

two different parties. And this takes work, work in finding and understanding each other. Manipulating people's emotions has even shown to disengage people (O'Neill & Nicholson-Cole, 2009). Marketing is the business of communicating the value of a product, company or service to customers with intention to sell or promote that same product to your customers. However, in this study I focus on triggering engagement through emotions, how that engagement further develops and takes shape, either positive or negative, active or passive is beyond the scope of my research.

Engaging the public early in the transition process –upstream- can create an open atmosphere in which it is possible to negotiate what changes are acceptable and possible, shaping the transition. This needs to be an atmosphere in which one also dares to take painful and difficult decisions. Engagement of members of the public does not per se have to be about the technical aspects as this thesis has shown. On the contrary, members of the public are much more interested to talk about the impacts and implications of this technological transition, the painful decisions that have to be made instead.

Lack of public engagement in any topic, leads to lack of policy commitment for such topics, hindering action. The need for a transformation of our economy is high. This is confirmed by experts from very diverse fields. However, currently, there is an increased drive for policy commitment on the basis of economic triggers, rather than the preferences and priorities of the electorate. Also in this arena there is much debate over whether bio-based will be economically interesting or economically less interesting than fossil fuels. For policy, the complexities involved in bio-basing the economy render meaningful public engagement less attractive than the simplicity of our current fossil fuel infrastructures. Public disinterestedness and inactivity are mis-used as an instrument to resolve the issue in favour of continuing on the same fossil fuel based road[22]. Resolving the current disinterestedness of the public may form a means to open up the current situation.

Lastly, she pictured to herself how this same little sister of hers would, in the after-time, be herself a grown woman; and how she would keep, through all her riper years, the simple and loving heart of her childhood; and how she would gather about her other little children, and make their eyes bright and eager with many strange tale, perhaps even with the dream of Wonderland of long ago; and how she would feel with all their simple sorrows, and find a pleasure in all their simple joys, remembering her own child-life, and the happy summer days (Carroll, 1865).

[22] This point refers to chapter 6 of this thesis. For further reading also check out Berg et al. (2013); Birch et al. (2010); Levidow et al. (2013); Zachariasse et al. (2011) for a more bio-based take on this issue and (2011); Lezaun and Soneryd (2007); Michael (2012b) about the constructions of publics dealings with idiots and their implications.

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summary

The transition from a fossil fuel based to a bio-based economy will not be limited to a change in the production or conversion of biomass. Besides the technological aspects, this transition will likely affect developments that deal with governance, mobility, food, health and safety too. Engagement of the public at large with this transition is crucial but hard to achieve. Together we have to discuss and determine what kind of changes, choices and sacrifices we can, are willing and have to make. At the same time this means that we have to take responsibility and accept the consequences of our actions and decisions as a community. A challenge is to create this engagement in a meaningful way, taking into account people's unfamiliarity with the transition and the ruling mechanistic and rationalistic approaches for doing public engagement. Exploring how this engagement can take shape in a more meaningful manner this study focusses on the value of personal emotions for initiating a more collective public engagement for a bio-based economy. Our emotions play important roles in how we make sense of and interact with the world that surrounds us; in judgement formation, decision making, in motivating us and in the way we deal with unfamiliar issues.

Emotions are difficult to identify and to quantify. In my research, I used various forms of visual representations of a bio-based economy. The capacity of images, pictures or art to not only carry but at the same time trigger emotions allowed me to study what kind of emotions members of the Dutch public at large have to a bio-based economy and how they think they can engage with this transition. Using Q methodology, a technique for 'measuring' subjectivity by asking respondents to evaluate and sort pictures in relation to each other, I found four different emotional views: Compassionate Environmentalist, Principled Optimist, Hopeful Motorist & Cynical Environmetalist. The found views not only specifically describe what kind of emotions can be found amongst the Dutch society, they also unravelled that with those emotional views people have different representations of what a bio-based economy is. In addition, using the same methodology for identifying what perceived efficacy beliefs people have to a bio-based economy, I found five different beliefs: Conscious shopping by, Saving the World despite the technical terms, Recycle to, Filling my car with the 'right' fuel & the System limits personal contribution. The identified perceived efficacy beliefs describe how people belief they can or cannot contribute to a bio-based economy and that these perceived actions do not concur with how already engaged stakeholders want to engage the public.

Searching for ways in which emotions can be included in communication without them being used instrumentally following a more emerging approach of public engagement I also studied the impact of bio-art and the bio-based banquet event as more affective forms of communication

to see in what ways and with what these encounters engaged their audiences. Using a thematic analysis on visitors responses of the selected bio-artworks I found two different lines of thought: Managed vs Wild and Useful vs Useless. These lines of thought show in what context the visitors place the artworks and how their engagement is shaped through interaction. The results also demonstrated that art as a more affective form of communication makes the engagement of the observers less predictable, controllable and steerable but indeed more eventful. With the banquet I managed to make the bio-based economy more tangible for my guests. By addressing their different senses I moved my guests which created an opportunity for them to start to engage.

In a final literature review incorporating my results and conclusions so far I argue for a more affective and open approach for public engagement with a bio-based economy; for a bio-based society. The study indicates that initiating meaningful engagement for a bio-based economy through a rational deliberative process is not possible. In order to overcome the value action gap, actually moving and mobilising people instead of their ideas and opinions, we have to connect with our personal emotions and emotions expressed towards the issue at hand. They bring focus to what is of importance and at stake for people.

In conclusion, meaningful public engagement with a bio-based economy asks for a more emerging approach. An approach that accommodates people's emotions. At the same time the found emotions and efficacy beliefs indicate various starting points for this engagement towards the collective of a transition to a bio-based economy. Starting with emotions for engagement invites people to engage from their own context and will make the engagement more eventful.

samenvatting

De transitie van een op fossiele brandstoffen gebaseerde naar een 'bio-based' economie zal zich niet alleen beperken tot een verandering in de productie of conversie van biomassa. Deze transitie zal, naast de technologische aspecten, invloed hebben op ontwikkelingen binnen (openbaar) bestuur, mobiliteit, voedsel, gezondheid en veiligheid. Het betrekken van het publiek bij deze ontwikkelingen is cruciaal, maar moeilijk te bereiken. Gezamenlijk zullen we moeten bespreken en bepalen welke veranderingen, keuzes en opofferingen we kunnen, willen en moeten maken. Tegelijkertijd betekend dit dat we onze verantwoordelijkheid zullen moeten nemen en de gevolgen van onze acties en beslissingen als samenleving moeten accepteren. De uitdaging is om deze betrokkenheid op een wijze te genereren waarbij er rekening wordt gehouden met de onbekendheid van het publiek met deze transitie en de heersende mechanistische en rationalistische wijzen van public engagement. Het onderzoeken van de manier waarop deze betrokkenheid op een betekenisvoller manier vorm kan krijgen staat centraal in deze studie, met een focus op de waarde van persoonlijke emoties om een meer collectieve wijze van public engagement voor een bio-based economie te realiseren. Onze emoties spelen een belangrijke rol bij de wijze waarop we de wereld om ons heen interpreteren: door oordeels- en besluitvorming, en het motiveren van de wijze waarop we met onbekende zaken omgaan.

Het identificeren en kwantificeren van emoties is lastig. In mijn onderzoek zijn verschillende vormen van visuele representaties van een bio-based economie gebruikt. De potentie van afbeeldingen, foto's en kunst om emoties zowel te tonen als los te maken stelde mij in staat te onderzoeken welke emoties Nederlanders hebben ten aanzien van de bio-based economie, gevolgd door de wijze waarop zij denken te kunnen deelnemen aan de transitie. Met gebruik van Q methodologie, een techniek om subjectiviteit te 'meten' door respondenten afbeeldingen te laten beoordelen en te ordenen, heb ik vier verschillende emotionele visies gevonden: Compassionate Environmentalist, Principled Optimist, Hopeful Motorist & Cynical Environmetalist. De gevonden visies beschrijven niet alleen welke emoties er gevonden kunnen worden in de Nederlandse maatschappij. Zij laten ook zien dat mensen verschillende representaties hebben van wat een bio-based economie is. Dezelfde methodologie is gebruikt om te identificeren welk geloof mensen hebben in de manier waarop ze kunnen bijdragen aan een bio-based economie. Ik heb vijf verschillende opvattingen gevonden: Conscious shopping by, Saving the World Despite the Technical Terms, Recycle to, Filling My Car With the 'Right' Fuel and the System Limits Personal Contribution. Deze geloofsopvattingen beschrijven hoe mensen denken al dan niet bij te kunnen dragen aan een bio-based economie. Deze bijdragen komen niet overeen met de manier waarop al betrokken stakeholders het publiek verder willen betrekken.

In de zoektocht naar wijzen waarop emoties meer dan alleen instrumenteel in communicatie gebruikt kunnen worden, in het licht van een emergente benadering van public engagement, heb ik de impact van bio art en een bio-based diner als affectieve vormen van communicatie bestudeert. Dit om te zien op welke wijze en waarbij deze ontmoetingen hun publiek wisten te betrekken. Met een thematische analyse van bezoekersreacties op de verschillende kunstwerken heb ik twee verschillende denkbeelden gevonden: Managed vs Wild and Useful vs Useless. Deze denkbeelden laten zien in welke context de bezoekers deze kunstwerken plaatsen en hoe hun betrokkenheid is gevormd door interactie. De resultaten tonen ook dat kunst als een wijze van communicatie die emoties genereert de betrokkenheid van de toeschouwers minder voorspelbaar, controleerbaar en stuurbaar maakt. Deze betrokkenheid is echter wel veelbewogener. Met het diner is het mij gelukt de bio-based economie tastbaarder te maken voor mijn gasten. Door de verschillende zintuigen aan te spreken heb ik mijn gasten bewogen, wat hun de gelegenheid bood om zelf betrokken te geraken.

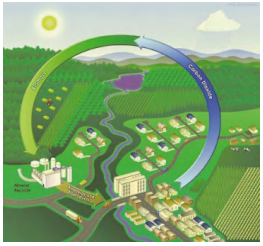
In een laatste literatuuronderzoek, waarin mijn resultaten en conclusies tot dusver zijn verwerkt, maak ik het argument voor een meer emotioneel betrokken en open aanpak voor public engagement naar een bio-based economie en een bio-based maatschappij. Het onderzoek geeft aan dat het aangaan van een betekenisvolle betrokkenheid naar de bio-based economie door een rationeel proces niet mogelijk is. Om mensen daadwerkelijk tot actie aan te zetten, in plaats van alleen hun ideeën en opvattingen te bewegen, zullen we hun emoties op persoonlijk niveau en aangaande de huidige zaken aan moeten spreken. Deze brengen in beeld wat op dit moment van belang is bij mensen.

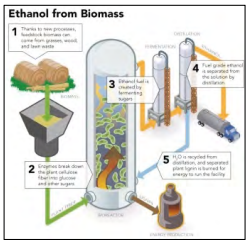
APPENDICES

APPENDIX A

Overview of the used images for Q sorting and their references.

These images were used in the studies of chapter 2 & 3.





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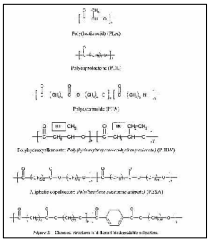

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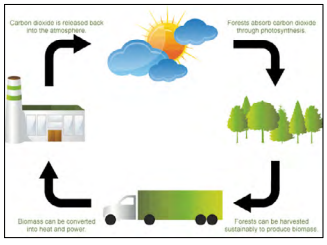

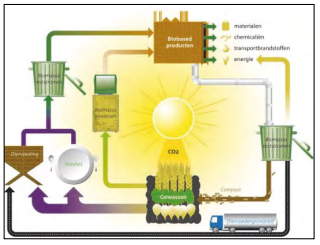

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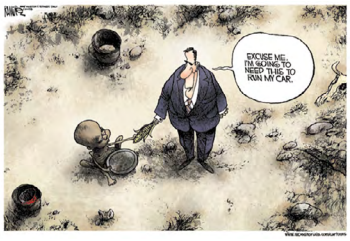

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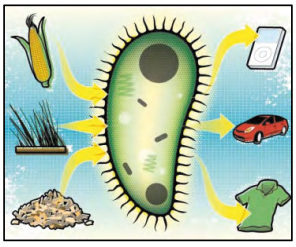

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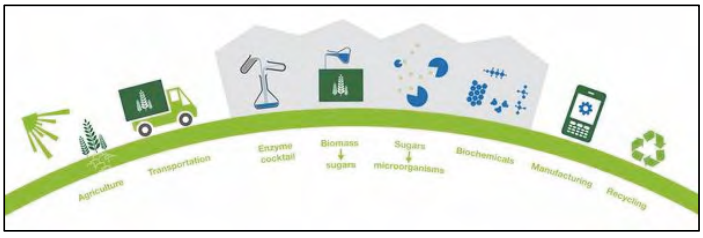

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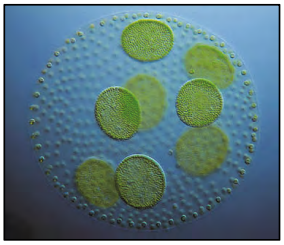

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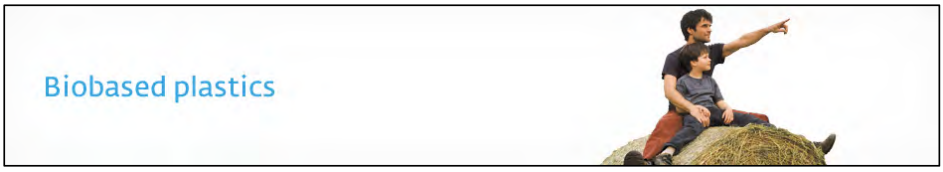

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APPENDIX B

Used pre- and post-interview guide of the Naturalis study as described in chapter 4.

Please note: the interview guide is only available in Dutch

Pre-Interviews Naturalis

Voorstellen/toestemming:

Hallo, Ik ben Susanne Sleenhoff, onderzoeker aan de TU Delft en zou u in het kader van een van de exposities in deze zaal een paar vragen willen stellen. Mag dat?

En zou ik uw antwoorden voor verdere anonieme verwerking ook mogen opnemen?

Intro:

In de tentoonstellingszaal over 'onderzoek in uitvoering' staat een biokunst tentoonstelling met drie installaties/objecten die u kunt gaan bekijken. Deze tentoonstelling is tot stand gekomen door een samenwerking van kunstenaars en levenswetenschappers uit verschillende werkvelden.

1. Wat houd genomics onderzoek in? Wat is dat dan volgens u?
   - Moderne biotechnologie?
   - Genetische modificatie?
   - DNA?
2. Welk gevoel heeft u bij genomics, MB, GM of DNA? Waar komt dat door?
3. Denkt u dat genomics, MB, GM of DNA onderzoek een impact op uw persoonlijke leven zal hebben? Hoe dan of waarom niet?
4. Heeft u iets gelezen of gezien in de krant over de D&A4G tentoonstelling? Wat denkt u te aan te treffen, te gaan zien?

Einde

Dit waren mijn vragen. Heeft u misschien nog vragen voor mij? Dank u voor deelname en een prettige dag nog verder!

Post-Interviews Naturalis

Voorstellen/toestemming:

Hallo, Ik ben Susanne Sleenhoff, onderzoeker aan de TU Delft en bezig met een onderzoek naar de biokunst-tentoonstelling die u net bekeken heeft. Zou ik u daarvoor een aantal vragen mogen stellen?

Vindt u het goed dat ik ons gesprek opneem?

Intro:

U heeft net de biokunst-tentoonstelling bekeken. Waarvoor kunstenaars met wetenschappers hebben samengewerkt.

1. Wat vond u van de tentoonstelling?
2. Welk werk sprak u het meeste aan? Waarom?

    Welk gevoel gaf de bubbel-installatie u?

3. In hoeverre denkt u wat u net gezien heeft feit of fictie is?

Het gemeenschappelijke tussen deze werken is dat ze allemaal met genomicsonderzoek te maken hebben. Alle drie de kunstenaars hebben met genomicsonderzoekers samengewerkt. Genomics is onderzoek naar het de genen van levende organismen.

4. Denkt u dat genomicsonderzoek een impact op uw persoonlijke leven zal hebben? Hoe dan of waarom niet? (veiligheid, duurzaamheid, genetisch onderzoek)
5. Vindt u deze tentoonstelling op zijn plaats in Naturalis?

    Waarom?

Einde

Dit waren mijn vragen. Heeft u misschien nog vragen voor mij? Dank u voor deelname en een prettige dag nog verder!

APPENDIX C

Scenario of the focus groups that were part of the Naturalis study as described in chapter 4. Please note: This text is only available in Dutch

Selecteren van kandidaten

In totaal worden er vier groepsgesprekken gehouden met elk 6 deelnemers. De deelnemers worden geselecteerd en geleverd door CG selecties. De groepen worden ingedeeld op basis van leeftijd en opleidingsniveau om het gesprek en interactie tussen de deelnemers te bevorderen.

De indeling ziet er als volgt uit:

Focusgroup 1
- Gelijke verdeling man-vrouw
- Opleidingsniveau: Middel tot hoog
- Leeftijd 20 – 40

Focusgroup 2
- Gelijke verdeling man-vrouw
- Opleidingsniveau: Middel tot hoog
- Leeftijd 40 – 65

Focusgroup 3
- Gelijke verdeling man-vrouw
- Opleidingsniveau: Laag tot middel
- Leeftijd 20 – 40

Focusgroup 4
- Gelijke verdeling man-vrouw
- Opleidingsniveau: Laag tot middel
- Leeftijd 40 – 65

Deze mensen krijgen een financiële vergoeding om deel te nemen aan het onderzoek via CG selecties.

Locatie van de focusgroup

Vanuit de literatuur wordt aangeraden om de focusgroepen in een neutrale omgeving te houden. Aangezien het bezoeken van de D&A4G tentoonstelling onderdeel is van de focusgroup vinden de gesprekken in een vergaderruimte in museum Naturalis plaats.

Moderatie

Voor deze sessies wordt er gewerkt met twee moderators. Een moderator leidt de groep en de discussie. De andere moderator heeft de rol van assistent en is verantwoordelijk voor het bij staan in het leiden van de groep (als we gaan lopen) Daarnaast maakt de assistent observaties van het gedrag en de lichaamstaal van de deelnemers en maakt deze aantekeningen van de discussie.

De moderatie zal worden uitgevoerd aan de hand van het onderstaand draaiboek voor zover dat mogelijk is.

Het is de bedoeling dat er een 'natuurlijke' discussie ontstaat waarin deelnemers aan de hand van een aantal oefeningen vrij uit kunnen spreken. De totale duur van het gesprek is 1.5 tot 2 uur en zal voor verdere uitwerking worden opgenomen.

Opstelling van de ruimte

De tafels in de ruimte zijn zo ingedeeld dat de deelnemers inclusief moderators in een kring kunnen zitten. Op die manier kan iedereen elkaar aankijken tijdens het gesprek. Verder is het belangrijk dat vanuit de kring iedereen op de flipover kan kijken.
Zorg dat er een klok in de zaal is.

Benodigdheden

Post-its, Dikke stiften, Schrijfpapier/ flip-over, Naamtags, Recorder, Stickers, Evaluatie formulieren

De discussie

Aanvang van het gesprek (5-10 minuten)

Doel: geven van een korte uitleg over het doel van deze bijeenkomst en de spelregels.

Het welkom heten van de deelnemers
Voorstellen van de moderators
Spelregels: Het gesprek wordt op tape opgenomen – denk om toestemming
Er is geen pauze tijdens het gesprek (denk aan toiletbezoek)
Gelieve telefoons uit te zetten
Alles wat gezegd wordt is goed en waardevol
Rollen tijdens de discussie, **wij zijn geïnteresseerd in jullie ervaringen en meningen.**

Even oefenen - voorstelrondje

Doel: elkaar leren kennen, de tongen losmaken.

Vraag: *Ik wil graag dat je je naam noemt en verteld wat je vandaag gedaan zou hebben als je niet hier zat.*

Opbrengst: De regels zijn duidelijk, het ijs is gebroken en de deelnemers zijn met elkaar bekend.

Oefening 1: Associëren (20 minuten)

Doel: inzicht krijgen in hoe deelnemers genomicsonderzoek begrijpen
Wat verstaan zij onder dit soort onderzoek, wat voor gevoel hebben ze erbij.

De deelnemers wordt gevraagd te associëren op 'onderzoek met genen'. Wat voor beeld en gevoel hebben ze daarbij. Aan welke thema's en issues koppelen de deelnemers het onderzoek.

> ***Vraag:*** *Waar denken jullie aan bij 'onderzoek met genen'? Noem drie associaties die voor u het meest kenmerkend zijn.* Schrijf deze op de post-its.

Vang achterliggende gevoelens op en schrijf deze op. Let op: Goed uitvragen, wat bedoeld de deelnemer. Let op, in hoeverre deelnemers hun associaties aan thema's en issues koppelen. Let op, is er overeenstemming over de betekenis.
Sluit af met het gezamenlijk bekijken van de verzameling associaties.

> *Wat valt er op? Ontbreekt er nog iets?*

Opbrengst: In welke mate zijn deelnemers betrokken bij onderzoek met genen. Hoe begrijpen ze wat het is en welk gevoel hebben ze erbij

Oefening 2: visualiseren (10 minuten)

Doel: van individueel naar groepsniveau.
De deelnemers wordt gevraagd om samen een beeld te vormen van hoe de impact van het onderzoek eruit gaat zien.

> ***Vraag:*** *OK we hebben net gezamenlijk een beeld geschetst van wat onderzoek met genen volgens jullie is. Mijn volgende vraag aan jullie is in hoeverre jullie denken dat dat onderzoek een impact/invloed op jullie persoonlijk/dagelijks leven gaat hebben?*
> *En hoe ziet die impact eruit? Kun je die omschrijven?*

Schrijf als moderator de impact in steekwoorden op een flipover. Let op, dat het een groepsdiscussie wordt. Zijn er verschillen in hoe de impact van het onderzoek gezien wordt? Veranderen mensen tijdens deze discussie al van mening over de impact van het onderzoek? Let op: is er overeenstemming over de impact? Of verschillende deelnemers van mening? Zo ja waarop dan?

Opbrengst: Inzicht in mogelijke barrières en kansen voor betrokkenheid van de deelnemers

Oefening 3: bekijken tentoonstelling (20 minuten)

Doel: de interventie – opdoen van indruk van de kunstwerken

De deelnemers krijgen de tijd om de drie verschillende opstellingen van de D&A4G expositie bekijken. En hebben de mogelijkheid om hun indrukken op te schrijven

> ***Vraag:*** *We gaan zo het museum in de D&A4G tentoonstelling in de zaal 'Onderzoek in Uitvoering' te bekijken. Daarna komen we gezamenlijk hier terug om jullie indrukken en ervaringen te bespreken. Jullie krijgen even de tijd om de tentoonstelling op je gemak te bekijken. Het is niet de bedoeling dat jullie ter plekken met elkaar in discussie gaan, dus mocht er iets zijn of in je opkomen dan kun je het opschrijven. Voor jullie ligt een formulier waarop je kort je indrukken, ervaringen en vragen kunt noteren die we later gaan bespreken.*
>
> *Geef ons een seintje als je klaar bent zodat we samen terug lopen naar de zaal.*

Opbrengst: de interventie

Oefening 4: Inventariseren (20-30 minuten)

Doel: Inventariseren van welke indrukken de tentoonstelling op de verschillende deelnemers heeft gemaakt.

Deelnemers wordt gevraagd om hun ervaring van het bezoeken van de expo te delen met de groep. Dit kunnen indrukken per werk of in zijn algemeenheid zijn.

> ***Vraag:*** *Ik ben erg benieuwd om te horen wat jullie van de tentoonstelling vonden.*

Let op: Vang op of de indruk over het onderwerp, het werk of de expo in zijn geheel gaat. Goed uitvragen wat de deelnemer bedoeld. Let op waar de indruk aan gekoppeld is (werk onderwerp, genomics).

De moderator verzameld de indrukken op een flipover.

Gezamenlijk bekijken van de indrukken van de tentoonstelling. *Wat valt er op? Ontbreekt er nog iets?*

Opbrengst: Inzicht in wat de triggers zijn in de tentoonstelling en wat het triggered bij de deelnemers

Oefening 5: Ranken (5 minuten)

Doel: rangschikken van werken.

Deelnemers wordt gevraagd om de werken te rangschikken. Welk werk sprak het meeste aan? Welke minder? Waarom? Had dat te maken met de indrukken?

> ***Vraag:*** *Goed we hebben de indrukken van de expositie verzameld en besproken. Mijn vraag is welk werk jullie het meeste aansprak? Jullie krijgen van mij ieder drie punten (stickers) die jullie mogen verdelen over de drie werken.*
>
> *Waarom sprak dat werk het meeste aan? Waarom een ander werk minder?*

Let op: Hoe zit het met het maken van nieuw leven (system synthetic, transgeen spinnenzijde, kunstmatige huid, het feit dat we wormen als modelorganisme hebben etc)

Opbrengst: Verdiepend inzicht in het effect van de tentoonstelling en inzicht in welk werk het meest 'succesvol' is.

Oefening 6: Associëren (15 minuten)

Doel: inzicht krijgen in hoe deelnemers onderzoek met genen nu begrijpen

De deelnemers wordt gevraagd te associëren op onderzoek met genen. Wat voor beeld en gevoel hebben ze daarbij. Aan welke thema's en issues koppelen de deelnemers het onderzoek.

> ***Vraag:*** *Waar denken jullie nu aan bij onderzoek met genen? Noem drie associaties die voor u het meest kenmerkend zijn. Schrijf deze op de post-its.*

Vang achterliggende gevoelens op en schrijf deze op. Goed uitvragen, wat bedoeld de deelnemer. Let op, in hoeverre deelnemers hun associaties aan thema's en issues koppelen. Let op, is er overeenstemming over de betekenis.

ekijk gezamenlijk de associaties. Wat valt er op? Haal de eerste associatie erbij. Is er iets veranderd? Wat dan?

Opbrengst: in welke mate zijn deelnemers betrokken bij onderzoek met genen. Hoe begrijpen ze wat het is en welk gevoel hebben ze erbij. De uitkomst van deze oefening kan vergeleken worden met die van oefening 1.

Oefening 7: Visualisatie (5 minuten)

Doel: inzicht krijgen in hoeverre het idee dat het onderzoek een impact heeft op hun eigen leven is veranderd.

Haal de flipover met steekwoorden die de impact beschrijven erbij.

> ***Vraag:*** *Dit is volgens jullie de impact van het onderzoek met genen op jullie dagelijks leven. Is dat volgens jullie nog steeds zo of zouden jullie er iets aan willen veranderen? Moet er iets bij, gaat er iets af? Wat dan en waarom?*

Let op: Goed doorvragen wat de deelnemers bedoelen. Is er overeenstemming over de impact? Of verschillende deelnemers van mening? Zo ja waarop dan?

Opbrengst: inzicht in de mogelijke verschuivingen van de kansen en barrières voor betrokkenheid van de deelnemers

Afsluiten (10 minuten)

Dit was de laatste oefening. Ik wil zo de discussie afsluiten.

Wil iemand nog iets toevoegen ?

Wil iemand nog iets zeggen?

Wat gaan jullie hiervan mee naar huis nemen?

Dan wil ik jullie bij deze **hartelijk bedanken!**

APPENDIX D

Public Engagement with System Synthetics

By: Susanne Sleenhoff, Maurizio Montalti & Patricia Osseweijer

Conference proceeding based on one the System Synthetic artwork of the Naturalis study which is described in chapter 4. Published in the Conference proceeding of the 12th International Public Communication of Science and Technology Conference on Quality, Honesty and Beauty in Science and Technology Communication, Florence, Italy, 18-20 April 2012. Edited by Massimiano Bucchi & Brian Trench, Published by Observa Science in Society, Vicenze, Italy, pp 88-91. Available at: http://www.pcst2012.org/images/PCST2012_Book_of_Papers.pdf

Introduction

The concept of a bio-based economy captures the idea of replacing fossil resources and chemical processes by biomass and biotechnological processes. This concerns the production of pharmaceuticals, chemicals, fuels, materials, and energy. Globally, many countries strive for a transition to a bio-based economy as it is expected to benefit society in terms of sustainability, energy security and public health (Langeveld et al., 2010). However, such a transition would require technological innovation, involving important changes requiring engagement of the society as a whole. Its success to achieve these goals is co-dependent on the preparedness of individuals to make choices in daily life, with regard to food, transport and energy usage (Gijsbers et al., 2005).

Achieving engagement on issues that are relevant for the future is not trivial. Bio-art has a potential as an intermediary for the engagement between art, science and society. It can function as a 'double boundary object' (Star & Griesemer, 1989), namely, a configuration between science and art and one between science and society (Hanssen et al., 2006). In this capacity, it has the potential to articulate social, cultural and moral dilemmas carried along by emergent science and technology. Bio-art makes them visible and tangible. By turning the innovation process into something concrete the artist and his work are able to question notions of innovation, and thus trigger dialogue.

System Synthetics is a bio-art project by designer Maurizio Montalti. He was one of the winners of the *Designers & Artists for Genomics Award 2010* (www.da4ga.nl). In this project he explored the impact and social consequences of the latest advancements in life-sciences and microbiology. The installation was on display for half a year at the natural history museum *Naturalis* in Leiden, the Netherlands. The Section Biotechnology and Society at TU Delft studies

different approaches to public engagement. For the presented study engagement is understood as a state of being rather than a process. This 'state of engagement' comprises three spheres: cognition, affect and behaviour (Lorenzoni et al., 2007). For engagement you need to know something about the subject, have a feeling relating to it and a behavioural intention. In this context Montalti's work was studied questioning how the work affected the public and to what extent it triggered engagement with a bio-based economy.

Science-art

For the creation of *System Synthetics*, Montalti collaborated with scientists. This collaboration denotes the first boundary configuration, between science and art. By doing so he became a design-researcher. Montalti proposed an innovative approach to the problem of plastic pollution of the environment. He wished to address the harmful consequences of man-made synthetic materials for human health and vulnerable ecosystems by establishing a form of functional symbiosis between fungi and other organisms. Two different types of organisms were selected; a filamentous fungus that has been found to be capable of depredating plastic materials, and the well-known and much used model organism for research, baker's yeast, which is able to produce alcohol and is exploited for the production of bio-ethanol. The use of biological organisms for production as expressed in Montalti's design resembles production methods for a bio-based economy.

In nature fungi are responsible for performing cycles of decomposition and transformation of organic and inorganic substrates. Unlike in a laboratory environment, where they are often grown and cultivated in a pure culture, fungi in nature co-exist with other micro-organisms. There they either compete with other micro-organisms or establish symbiotic relationships and become co-dependent. Different experiments were conducted in the lab in finding and defining the best conditions under which the two fungal organisms can co-exist. Using a variety of culture media and different inocula densities, the artist was able to define ideal conditions for the start of a peaceful co-existence.

While working in the laboratory it became clear that the aim of creating a man-made endosymbiotic organism in a short time was rather ambitious. The artist became aware of the complexity of scientific research: research requires much work, time and patience. Based on visualisations of the co-culture by using fluorescent proteins, Montalti was able to create a visionary sculpture that depicted the novel endosymbiotic man-made life form. By becoming a design-researcher he was able to critically reflect on his own role as designer to not only create new toxic things. Also he designed an installation that could address the problems of a man-made evolution of life.

Science-public

In the second boundary configuration, through bio-art the social worlds of science and society can connect and demonstrate what is going on in the world of science or what can be expected. *System Synthetics* aimed to provide new perspectives towards the role of microorganisms in society. It tried to inspire the public to discuss the potential benefits and further consequences that could derive from innovation in the form of man-made evolution of life. The work on display consisted of the visionary model, a process-film, and a tailor-made transparent bio-reactor apparatus in which the results of the conducted experiments were integrated (Montalti, 2011). The exhibition created the opportunity to study how *System Synthetics* engages its visitors with a bio-based economy.

In order to assess the extent to which *System Synthetics* engages visitors three different methods have been used to allow for data triangulation. The visitors were observed to see how they reacted and interacted with the project. Next, a series of short pre-, and post interviews with almost a hundred visitors were conducted to evaluate a possible change in the extent to which they were engaged. A series of four focus groups were organised to discuss more closely and in depth how visitors got engaged.

The collected data suggests that *System Synthetics* provided visitors with a better comprehension of what a bio-based economy would encompass. The visitors expressed understanding of an industrial biotechnology process such as those that are used for the transition to a bio-based economy. While observing all aspects of *System Synthetic* visitors explained amongst themselves how the process from plastic to bioethanol may work. In the interviews and focus groups it was stated that this effect was much appreciated. Visitors appreciated to learn how fungi and yeasts would be used in the production process.

Most visitors were amazed by the vision presented by *Systems Synthetics* and were enthused by the idea that a fungi and a yeast could work together in the production of ethanol from plastic. The idea that this man-made organism could tackle the man-made problem of plastic pollution raised visitors' hopes for the future. The installation aroused feelings of amazement and hope amongst visitors. It gave them an emotional outlook to what a bio-based economy would mean for them.

On the behavioural aspect, *System Synthetics* triggered statements of personal responsibility amongst visitors. Interview and focus group data suggest they became more aware about their own actions in regard to handling plastic products and plastic waste. *System Synthetics* mobilised them to undertake personal action to reduce plastic waste or to further enhance its recycling. The visitors were emotionally aroused and expressed positive feelings of surprise and amazement. They were motivated and felt capable to change their actions, to take

personal responsibility. Although the visitors gained knowledge about only a small aspect of a bio-based economy, the overall data seems to suggest that *System Synthetics* engaged visitors positively with the transition to a bio-based economy.

Conclusion

We have addressed both sides for *System Synthetics* as a double boundary object: on the one side between science and art and on the other side between art and society. We elaborated how it can trigger engagement with a bio-based economy. As a boundary object between science and art we demonstrated that *System Synthetics* is able to articulate the issues connected to the man-made evolution of life by combining and using fungi and yeasts for solving the man-made problem of plastic pollution. For *System Synthetics* as boundary object between science and society our results suggest such art is able to trigger engagement with a bio-based economy: museum visitors gained a broader understanding of the processes involved in the transition to a bio-based society, the installation aroused emotions and triggered visitors to take personal responsibility. A bio-based economy will necessitate a profound change of the production, use and re-use of everyday products such as plastic. It is a highly innovative and technical transition that so far occurs far from people's daily life and only reaches its economic viability and sustainability promises if every actor in society is engaged. We have demonstrated that it is possible to bring this reality a bit closer to people's daily life by using bio-art.

APPENDIX E

The potential of *2.6g 329m/s*[23] for public engagement with safety through biotechnology

By: Susanne Sleenhoff

Book chapter about the bulletproof artwork of the Naturalis study which is described in chapter 4. Published in Bulletproof Skin; Exploring Boundaries by Piercing Barriers. Edited by Jalila Essaidi Published in Eindhoven, The Netherlands: Jalila Essaïdi (pp73-79).

After a while Alice said to the Queen: "Normally you would get somewhere if you would have walked for some time like we have been doing". "Ah"! Replied the Red Queen, "well here it takes all the walking you can do in order to stay in the same place. If you want to get somewhere else, you would have to walk twice as fast as we have done so far" (Carroll, 1871).

The Red Queen would state that for an evolutionary system, continuing adaptation is needed in order for a species to remain its relative fitness amongst the systems which it co-evolves with (Valen, 1973). With the creation of *2.6g 329m/s* bio-artist Jalila Essaïdi raises the question: 'If we would have a bulletproof skin, would we be better protected against bullets?'. This seems to fit with the Red Queen's statement. The interaction between science and technology on the one hand and society on the other hand can be seen as an adaptation of such evolutionary system: they are ever changing and as with any evolutionary system it evolves by developing new ways to deal with risk. Genomics research is an important area of innovation that demonstrates the properties carried along with the co-evolution of science, technology and society. It provides society with a better understanding of how any organism, via its genes, interacts with its ever changing environment. Through this better understanding new technologies can be developed. Thus society can adapt more efficiently to its evolving environment. This poses the following questions: how does society wants to adjust to this environment; which developments are acceptable; which risks we are willing to take. Or as the Red Queen would ask: 'do we keep on running, should we run even faster, should we come to a stop or should we take a different turn altogether?' In the attempt to decide how we should run it is important to engage society in the advances of science and technology (Irwin, 2006; Stirling, 2008).

[23] 2.6g 329m/s is the name of the Bulletproof Skin Artwork by Jalila Essaidi. 2.6g 329m/s is also the performance standard for bulletproof vests, the maximum weight and velocity of a .22 calibre Long Rifle bullet from which a Type 1 bulletproof vest should protect you.

We studied the way in which art can engage the public. In this context we take engagement to be as a state of being rather than a process. This 'state of engagement' comprises three spheres: cognition, affect and behaviour (Lorenzoni et al., 2007). For engagement you need to know something about the subject, have a feeling towards it and a behavioural intention. In this context Essaïdi's work was studied by questioning how the work affected visitors and to what extent it triggered engagement.

Bio-art can function as an intermediary between art, science and society, facilitating engagement (Sleenhoff, 2005). In this capacity, it has the potential to articulate social, cultural and moral dilemmas carried along by emergent science and technology. Bio-art makes these dilemmas visible and tangible. Due to its ambiguous nature bio-art not only articulates issues, it also raises questions and it communicates affective (and cognitive) information. It articulates what the future could look like. By turning the innovation process into something concrete, art is able to question notions of innovation, and thus trigger dialogue (Hanssen et al., 2006).

2.6g 329m/s aims to explore social, political, ethical and cultural issues related to safety in a world that offers an ever renewing access to biotechnologies. In her project in general and the ballistic test performance in specific, Essaïdi wants to show safety, in the broadest sense, is a relative concept. She does this through a critical artistic examination of the concept of 'bulletproof'. With *2.6g 329m/s* she wants to stir conversation about how different notions of safety would benefit society. Is the technological development of a bulletproof skin desirable or not? Through *2.6g 329m/s* one can study to what extent art can engage visitors with genomics research in relation to safety.

2.6g 329m/s was on display for six months at the natural history museum *Naturalis* in Leiden, the Netherlands. It consisted of a stretched bulletproof skin, a video of ballistic tests on different types of skin and an incubator which contained growing tissue cultures of bulletproof skin, accompanied by guiding text for visitors. The exhibition created the opportunity to study how *2.6g 329m/s* engages its visitors in research into the issue of safety.

In order to assess the extent to which *2.6g 329m/s* engages visitors three different methods have been used. This allowed for data triangulation. The visitors were observed to assess how they reacted and interacted with the project. Next, a series of short pre-, and post interviews with almost a hundred visitors were conducted to evaluate a possible change in the extent to which they were engaged. A series of four focus groups was organised to discuss more closely and into depth how visitors got engaged.

The collected data shows that before visiting the museum, most visitors had mixed feelings towards genomics research in the context of human enhancement. Although they were hopeful over the positive potential of genomics research, they were mainly concerned and frightened by it. They were concerned about how far scientists would go in enhancing people and who controlled the development. Furthermore, they feared the idea that genetic manipulation would be used and what this innovation would bring society.

The collected data further shows that safety in relation to weapons was not an aspect that came to mind when visitors gave an account of what they understood genomics research to be about. Human enhancement was an issue that was more often referred to in both pre- visit interviews and focus groups. Only one visitor expressed her concerns about the possible development of biological weapons with the advances in genomics research. Concerning safety, some visitors raised the topic of gaining a better genetic resistance against diseases, others mentioned the possibility of choosing one's child's IQ to ensure it would have a prosperous life. Apparently, the relation to safety was not an association they made themselves.

The fact that actual human skin was used in the creation of the displayed artwork fascinated visitors. We observed that, visitors were either amazed or appalled by what they saw: the stretched skin made people look twice. As they commented in the interviews and focus groups:

"The skin was impressive, especially when I came to realise it was real human skin. It made me think of WOII, lampshades made of skin and so on, it moved me." (interview post-36)[24]
"… also the fact she used human skin, that came really close." (interview post-30)

The stretched skin gave people an uneasy feeling. Although they found it extraordinary, they also found it gross and horrible to see. For some visitors the fact that actual human skin was used disengaged them. Having seen the skin they turned away and continued their visit through the museum.

"The skin I found a bit freaky to be honest. The human skin, gross." (interview post-34)
"Very dismal to see a real piece of skin" (observation-1)
"I thought the exhibition was interesting, except for the skin. I thought it was a bit frightening, I don't know, something macabre to me" (interview post-28)

[24]In the translation of the quotes I stayed as close as possible to the original statement of the interviewee.

The underlying aspects of the artwork in combination with the skin were stirring for most visitors, in positive and negative ways. The post-visit interviews and focus groups showed that they had different conceptions about the underlying aspects. Visitors connected to ideas of making bulletproof skin, using genetically modified spider silk, the strength of such fragile material, man against nature, using the technology for military purposes and human enhancement. These different aspects that 2.6g 329m/s stirred in people both fascinated them and raised uneasy feelings.

"I never thought that spider silk could stop a bullet. Something organic, that has been made by an animal. ... But this was astonishing, amazing actually" (interview post-39)
"The idea that they are going to implant something into your skin, it looked like science fiction to me but I also find that really scary." (focusgroup 2)
"Using genetic modification for such purposes is ulti-extreme" (observation 3)
"The fact that we can make something that destroys and what nature makes protects, that appealed to me." (interview post-6)

2.6g 329m/s extended visitors' comprehension of what genomics research is about, including aspects of safety. They raised the possibility of building an army of super soldiers. Although that sounded much like science fiction, they were concerned about whether this development would lead to another World War, especially if this technology would fall into the wrong hands. Visitors also foresaw other possible uses for research on bulletproof skin. They thought it could also be a new form of Botox or could be used in cases of severe skin burn.

2.6g 329m/s stimulated visitors' imagination and made them think:

"It was a funny idea that made me think...." (interview post-14)
"I have my doubts about the skin, especially the ethical component. It made me think do we all have a bulletproof skin within 50 years? I don't know if that is something we would aspire, that fascinated me." (interview post-33)
"It really addressed my imagination. I immediately thought of science fiction and the application in films. Immediately a story emerged in my head … .(interview post-10)

2.6g 329m/s raised questions amongst visitors about the development of such technology. They asked themselves whether they would want this for themselves or for society? For some it represented a man-made solution for people getting harmed by bullets; they were very

enthusiastic. Others thought that the development of a bulletproof skin was no solution at all. They were appalled that instead of solving a man-made problem, society was looking for a different more technological direction for a solution. They thought it would be more fruitful to teach people how to handle guns or to stop the production of bullets all together. The development of a bulletproof skin was regarded as a technological fix. Visitors also asked practical questions. They discussed what would happen to the underlying tissue if one got hit and speculated that eventually something would be developed that would surpass the bulletproof skin.

2.6g 329m/s triggered engagement amongst visitors with developments in genomics research in relation to safety. Our results suggest that visitors extended their comprehension of genomics including safety. It aroused emotions and stirred visitors to think about what the development of a bulletproof skin signified. *2.6g 329m/s* moved visitors and opened up their perspectives, but they didn't perceive of it as reassuring. They started questioning the desirability of the development of a bulletproof skin; should we keep running like we did, run faster or change our direction completely?

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This thesis explores the role of emotions for triggering public engagement in the emerging bio-based economy. Emotions have been found to be important in people's communication, judgement formation decision making and interactions with our surroundings. In current engagement practises there is hardly any attention for emotions; how they can be vented, elicited or taken into account in a meaningful way. Approaches such as Q methodology, art and dinners have been studied as alternative means to elicit and articulate emotions hence triggering public engagement. Especially for such a distant issue as the emerging bio-based economy emotions might be a way to get people to consider what it all means, initiating their engagement.

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