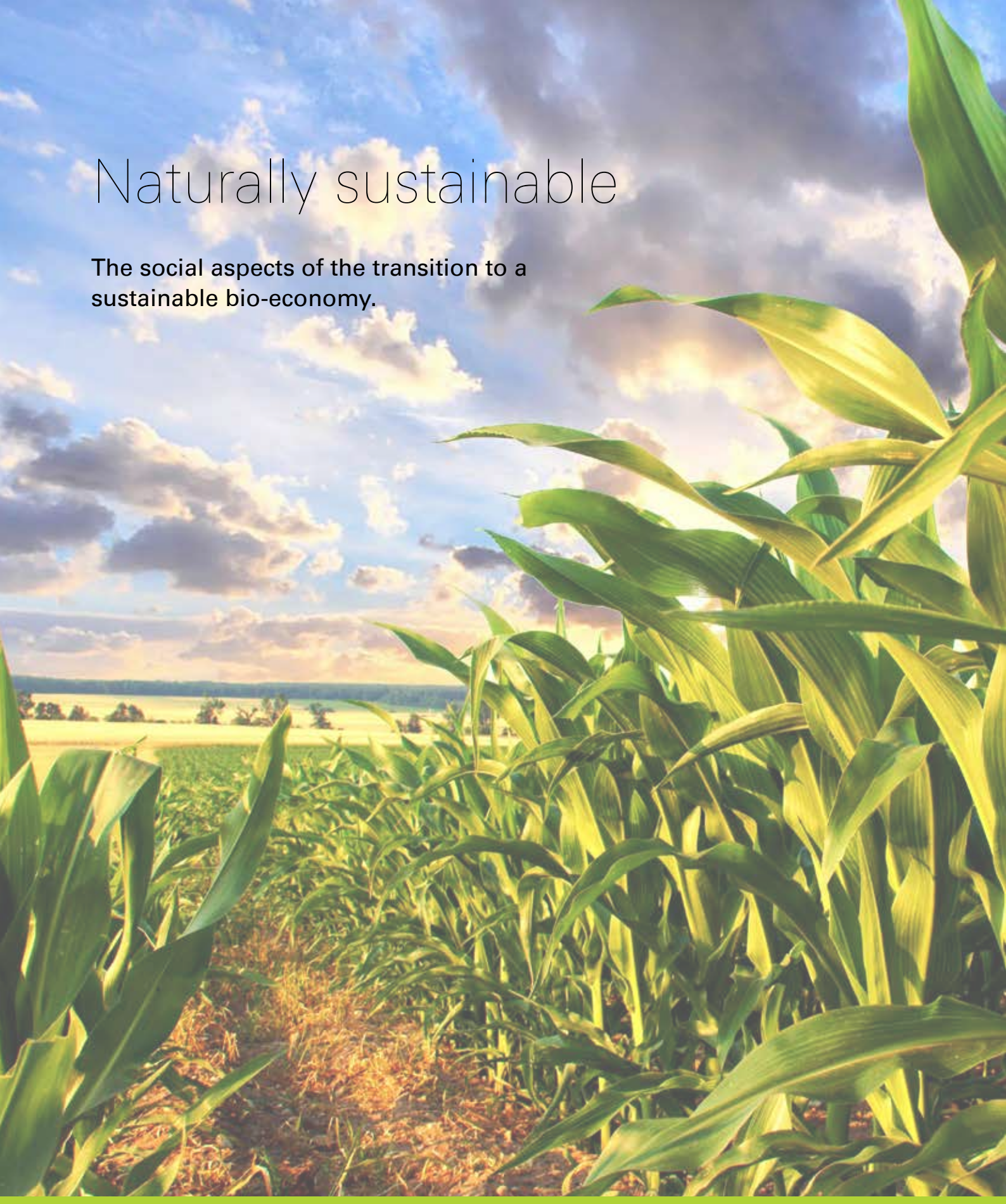

Naturally sustainable

The social aspects of the transition to a sustainable bio-economy.

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Preface

The bio-economy is promising technological concept, centering on the use of biomass. Sustainability is an important societal driver for this concept, next to energy independence and economical opportunities for agricultural entrepreneurs.

A successful bio-economy does not only require technological innovation, but also a considered embedding of that technology in society. For that reason the bio-economy requires a Responsible Research and Innovation (RRI) approach par excellence. In this approach societal actors engage in an interactive process in order to identify societally sensitive issues.

The transition from fossil to biobased resources requires new chains of co-operation. This leads us to re-examine specific societal values. In this research we focused on issues related to trust, sustainability, distributive justice and naturalness. These issues have a crucial role in the considerations and choices for new innovation trajectories. Only once these are clearly in sight and receive due attention, can the bio-economy flourish.

This reports contains the outcomes of a project financed by The Netherlands Organisation for Scientific Research (NWO), in its framework program for Responsible Research and Innovation. A panel consisting of a broad range of societal actors has played a vital part in this research. The list with their names and organisations can be found at the end of this report. We thank the panel for their open and enthusiastic input. We expect this report to contribute to the further development of a sustainable, societally supported, bio-economy.

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Executive summary

The transition to a partly biomass-based sustainable society will not be an easy one to make. This is because the main benefits of biobased products are to do with sustainability, but the definition of sustainability within the bio-economy is insufficiently in keeping with existing public perceptions of sustainability. The term sustainability therefore needs to be defined so that the relevant actors are able to recogni2se themselves in it. A broadly-supported sustainability perspective can prevent social conflict, encourage cooperation, open new innovation opportunities and provide a foundation for a biobased product market.

This need for a broad definition of sustainability is related to new developments such as regionalisation, the application of advanced genetic technology, the Netherlands as a biomass distribution country and the need for close cooperation between actors in the biobased chain, such as farmers, energy producers and chemical companies.

This study therefore focuses on sustainability-related social issues that do not as yet receive the attention required from actors in the chain. Examples of such issues are the fair distribution of resources (distributive justice), having an influence on and participating in technological developments, and the further industrialisation of agriculture. This last issue touches on ideas about natural qualities and the value of nature, which can be an important factor in the social acceptance of the bio-economy.

Perceptions of sustainability and nature are connected to world views. These world views form the moral framework within which people make sense of the world around them. In the academic literature, they are often divided into four quadrants. Based on this literature, therefore, we assume the four following types of world view. By no means do we try to assert that these four world views describe all possible attitudes to new technology. However, the quadrants do sketch a reasonably reliable picture of the sources of differences in views on new technology.

The balls in the quadrants represent ‘nature’. One group perceives nature as resilient – not easily ‘pushed over the edge’. In this case, nature can be exploited (‘nature as resource’) without too many problems. Another group believes nature finds itself in a precarious balance, and that a push in any direction could be

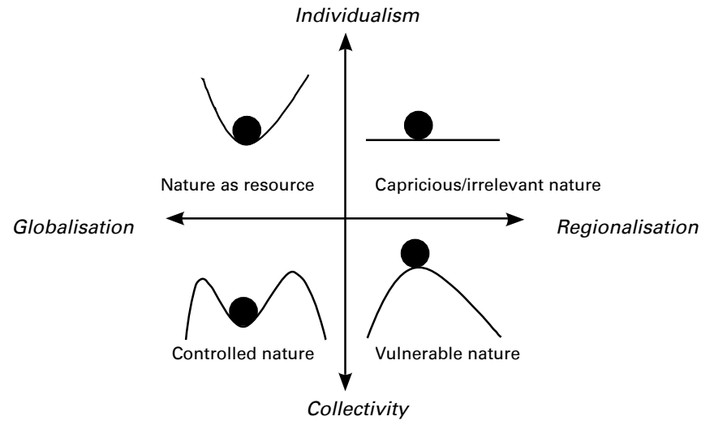


Figure 1. Four world views of the bio-economy. Based on and partly adopted from De Vries and Petersen (2009), Thompson (1997) and IPCC (2000).

fatal ('vulnerable nature'). The 'fair bio-economy' perspective lies exactly between these two extremes: this group sees opportunities for exploiting nature but also recognises that there are limits that must not be exceeded. Finally, the 'capricious nature' world view group does not believe that any form of control is required. This group includes, for example, poorly-educated people with little influence in society. These differing world views conflict with one another in the case studies on high-rise pig farms, biomass plants and advanced technology. At the same time, opportunities can be found for looking for links between the world views, as described in the following recommendations.

Highlight the common denominator There are several aspects to the bio-economy that are of interest to all groups. These are: it is efficient to reuse resources, small-scale pays off and nature has plenty to offer. Emphasise these aspects and use them to guide the design of biobased applications. Invest in small-scale, local projects that reuse waste streams. There are also opportunities here for multinationals: if small-scale is not an option, closing the loop may be. Show how this can be done. Example: Van Gansewinkel.

Invest in egalitarian processes Many people appreciate having a say in the development of new technologies. Invest, therefore, in the egalitarian embedding of biobased technology by listening to the views of people living around biobased production plants, amongst others.

Respect the division between industry and agriculture Make sure that industry and agriculture are kept separate where possible. Be wary of placing industrial plants on farms, and take careful note of relevant legislation concerning risk and ensure that public consultation takes place.

Initiate the advanced technology debate Start a discussion about technologies such as synthetic biology and genetic modification, with the main question: what are the benefits of these technologies, and who benefits most? This debate can lay a foundation for guidelines on the use of these technologies that are drawn up based on the input of a wide range of actors.

Expectations with regard to sustainable biomass can also vary widely within the chain, for example concerning the predictability of the properties of biomass, continuity of quality, and financial risks. Actors operating within the chain need to be aware of this variety in expectations, as it can hinder the development of trust. This, in turn, can affect relationships between partners in the chain.

Consider cooperative organisational structures A model often seen in agriculture – the sector with the most experience in biomass – is a cooperative one. Such a model may help ensure the quality and availability of different biomass types, such as biomass from the wood sector. It also provides opportunities for spreading financial risks.

Invest in mutual trust Use instruments such as codes of conduct, corporate identities and third party warranties to clarify differing interpretations of values such as sustainability and resource requirements, so that expectations are spelled out clearly. Not only does this benefit partnerships between biomass producers and processors, but also partnerships between companies and NGOs. This last group plays a vital part in the relationship between consumers and companies, which is why it is essential that actors in the biobased chain work together with NGOs.

1. The transition to a bio-economy

The bio-economy offers an attractive perspective regarding the way in which we use resources. Climate change, diminishing oil reserves and geopolitical tensions are all fuelling the search for alternatives to fossil resources. Biomass such as plants, manure and algae offer numerous opportunities when it comes to energy, chemicals and pharmaceuticals, examples being electricity from wood, or plastic from plants.

However, a transition to a society in which biomass replaces fossil resources will not be easy. There are already examples of biobased products being used as alternatives to existing fossil products, such as bioplastic to replace normal plastic, biofuel to replace fossil fuel, and bioethylene to replace petrochemical ethylene. However, these biobased alternatives are often more expensive than their fossil equivalents.

The main advantages of biobased products compared with their fossil equivalents have to do with sustainability.[1] Some biobased applications have properties that make them more attractive than their fossil counterparts – for example the bioplastic PEF is harder than conventional plastic (PET) – although their commercial availability is as yet limited. Biomass is therefore mainly used because of the guarantee of sustainability associated with it.

However, the way in which sustainability is defined within the bio-economy is insufficiently in keeping with existing public perceptions of sustainability. The term sustainability therefore needs to be defined so that the relevant actors are able to recognise themselves in it. That still happens far too rarely. The bio-economy is perfectly suited for building bridges between actors with diverging views on sustainability, and such bridges can provide a foundation for a biobased product market, prevent social conflicts, encourage cooperation and open new innovation opportunities.

A wide range of actors have already been united under the flag of the bio-economy, when 43 parties – including environmental organisations, banks, energy producers and chemical companies – signed the Bio-economy Manifesto in 2011, in which they defined joint objectives such as CO_2 mitigation and biodiversity conservation.[2] The advice for a sustainable bio-economy provided by the Corbey Commission is another example of cooperation between various actors that aims to encourage a sustainable bio-economy.

Although in both the examples given above a broad definition of sustainability is applied, aspects are still missing that are essential if a sustainable bio-economy is to succeed. Actors in the biobased chain should pay attention to these aspects, to obtain support for the bio-economy from other actors and to create or maintain mutual trust. Examples of such aspects are issues concerning distributive justice and the interaction with our natural environment. Biomass is obtained directly from the natural environment and developments in the bio-economy therefore touch on ideas about

[1] The original focus of this study was bioenergy. However, since energy, chemicals and agriculture are inextricably linked in the bio-economy, these last two sectors are also addressed in this study. The original focus was also on social issues such as trust, sustainability and distributive justice. However, it became apparent that natural qualities are also important, as shown in this report.

[2] Manifest Biobased Economy, http://www.biobasedeconomy.nl/2011/10/03/manifest-voor-biobased-economy-2/

natural qualities and the value of nature. Such ideas often play an important role in different perceptions of sustainability.

Expectations relating to sustainable biomass can also vary greatly within the chain. Actors operating within the chain need to be aware of this variety in expectations, as it can hinder the development of trust. Actors operating within the chain need to be aware of this variety in expectations, as it can hinder the development of trust. This, in turn, can affect relationships between partners in the chain. This, in turn, can affect relationships between partners in the chain.

At the end of this report, we outline possible courses of action available to actors in the biobased chain for addressing the sustainability aspects named above and for looking for links between the different sustainability perspectives. First, however, we describe the relevant sustainability perspectives. These different perspectives are the result of varying world views, formed by the primary elements of nature, social organisation and risk management. We then illustrate what these world views mean for the bio-economy, based on various ongoing discussions on biomass. This highlights the disparities and the similarities, or opportunities.

2. World views

World views form the moral framework within which people make sense of the world around them.[3, 4] There are a number of concepts that play an important role in these world views and in the corresponding attitudes to new technology. These often centre on ideas about nature and natural qualities and these ideas are related to a person's attitude to genetic modification, for example.[5, 6] Ideas about nature and natural qualities also often affect ideas on sustainability and its importance.[7]

For example, there is a group of people that considers local, small-scale, organic agriculture to be the most sustainable because food does not need to be transported far, large companies are not involved, and no chemicals are used.[8, 9, 10] This group also opposes genetic modification.

On the other hand, there is a perspective that propagates large-scale, factory farming because this is the only way to feed the world population and achieve CO_2 mitigation.[11, 12, 13] Genetic modification is also part of this perspective. Representatives of this group accuse the previously-mentioned group of encouraging global injustice; of undermining the global food supply just to feel good about their own organic food.[14] Conversely, this group is accused of upholding the interests of large companies to the exclusion of others and of ignoring alternative solutions.[15]

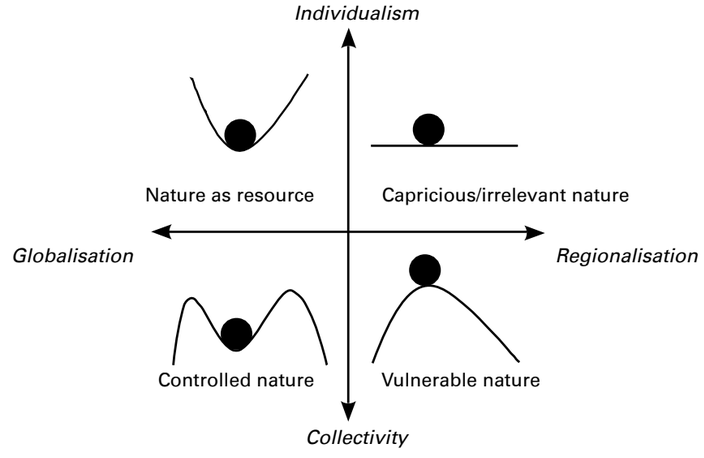


Figure 1. Four world views of the bio-economy. Based on and partly adopted from De Vries and Petersen (2009), Thompson (1997) and IPCC (2000).

The perspectives named above can be placed in the quadrant shown below, along with two other world views. This quadrant has been constructed based on similar, existing diagrams and on empirical data on world views.[16, 17, 18, 19, 20]

By no means do we try to assert that these four world views describe all possible attitudes to new technology. Many attitudes are found somewhere within the four quadrants: some at the extremes, some more towards the centre and some maybe even outside. However, the quadrants do sketch a reasonably reliable picture of the sources of differences in views relating to new technology. Furthermore, the dominant voices in a debate can be placed in such a quadrant.[21]

Four attitudes

The diagram above roughly outlines four attitudes to and the corresponding perspectives relating to the vulnerability of nature. These different ideas about nature result in different perceptions concerning management of the risks associated with new technologies and sustainability. This is also related to ideas on desirable forms of social and economic organisation. For example, individualism opposes collectivity, and globalisation opposes regionalisation.

Nature as resource

One group perceives nature as resilient – not easily 'pushed over the edge'. Nature can therefore be exploited ('nature as resource') without too many problems. This group includes not just multinationals, but often pioneers of new technology too, such as

[3] Hedlund-de Witt, A. (2013) *Worldviews and the transformation to sustainable societies. An exploration of the cultural and psychological dimensions of our global environmental challenges*. Amsterdam: IVM.

[4] Taylor, C. (1989). *Sources of the Self. The Making of the Modern Identity*. Cambridge: Harvard University Press.

[5] Thompson, M., 1997. Cultural theory and integrated assessment. Environmental Modelling and Assessment 2, 139–150.

[6] Dragojlovic & Einsiedel (2013) Framing Synthetic Biology Evolutionary Distance, Conceptions of Nature, and the Unnaturalness Objection. *Science Communication* October 2013 vol. 35 no. 5 547-571

[7] Hedlund-de Witt, A. (ibid.).

[8] Sijtsema, S., Haaster – De Winter, M.A. van & Verain, M.C.D. (2012) *Samenspel duurzaam en gezond? Duurzaam eten in consumentperspectief* Den Haag: LEI

[9] Schuttelaar & Partners (2011) *Duurzaamheidskompas 2011* http://www.duurzaamheidkompas.nl/

[10] Bodelier, H., Trouw, 2013. http://www.trouw.nl/tr/nl/4332/Groen/article/detail/3513959/2013/09/22/Biologisch-eten-is-goed-fout.dhtml

[11] Fresco, L. (2012) *Hamburgers in het Paradijs. Voedsel in tijden van schaarste en overvloed*. Amsterdam: Prometheus - Bert Bakker

[12] Dijkhuizen, A. Trouw, 2012 http://www.trouw.nl/tr/nl/4504/Economie/article/detail/3310252/2012/09/03/Of-intensieve-landbouw-of-honger.dhtml

[13] De Weerdt, S. (2013) *Is local food better?* WorldWatch Institute http://www.worldwatch.org/node/6064

[14] Dijkhuizen, A. (ibid.) Bodelier, H. (ibid.)

[15] Birch, Kean, Levidow, Les, & Papaioannou, Theo. (2010). *Sustainable capital? The neoliberalization of nature and knowledge in the European "Knowledge-based Bio-economy"*. Sustainability, 2 (2898-2918).

[16] Douglas, M., & Wildavsky, A. B. (1982). *Risk and Culture: An essay on the selection of technical and environmental dangers*. Berkeley: University of California Press.

[17] Brom, F., A. Thijssen, G. Dorren & D. Verhue (red.) (2011): *Beleving van technologie en wetenschap - Een segmentatieonderzoek*. Den Haag: Rathenau Instituut.

[18] Hedlund-de Witt, A. (ibid.).

[19] IPCC (2000) *Emission scenarios*, Cambridge: Cambridge University Press.

[20] De Vries & Petersen (2009) *Conceptualizing sustainable development. An assessment methodology connecting values, knowledge, worldviews and scenarios* Ecological Economics, pp. 1006 – 1019.

[21] Cf. Brom et al.

developers, small start-ups and venture capitalists. This group does not approve of regulation, which fits in with its individualistic attitude and aversion to collectivity.

Vulnerable nature
Another group believes nature finds itself in a precarious balance, and that a push in any direction could be fatal ('vulnerable nature'). This group includes, for example, environmental organisations, organic farmers and collective energy purchasing groups. In the vulnerable nature world view, only some technologies are beneficial and only then when bound by solid social and legal frameworks. This group has a strong preference for local economies, in which buyers and producers know one another and in which large companies are either absent or have only limited influence. It is this group that embraces a collective decision-making process, as long as everyone has their say.

Controlled nature
The 'controlled nature' perspective lies exactly in between: this group sees opportunities for exploiting nature but also recognises that there are limits that must not be exceeded. These actors usually recognise the benefits of new technology, but are also aware of the possible risks, and therefore desire regulation. This group is not so concerned about everyone having their say; in an efficient organisation the tasks can also be shared. This group includes government bodies, factory farmers and medium- and large-sized companies.

Capricious nature
Finally, the 'capricious nature' world view group does not see the point of any form of control. This group has little influence in society and includes, for example, poorly-educated groups and unschooled farmers in developing countries that may be affected by the bio-economy. This group is usually uninterested in new technology and its regulation, unless it produces obvious benefits in the local area, local region or individual day-to-day lives.

These world views result in a wide range of attitudes to the bio-economy and to the meaning of sustainability within the context of the bio-economy. As previously mentioned, issues such as control over resources, economic justice, the industrialisation of agriculture and the social embedding of new technology take a central role in this.

Even so, it is possible to make links between these world views. Sustainability criteria are a good example of this, as they form a link between three of the world views described above. Sustainability criteria are a form of regulation that also provide possibilities for the bottom-up contribution of a wide range of actors. This fits in with the idea of vulnerable nature. At the same time, such criteria are usually not very strict. For example, companies may choose whether or not to apply for certification. This fits in with the vision of nature as resource, in which too much control is considered undesirable. However, the criteria can also easily be used as a policy tool, as in the EU biofuel policy. This fits in with the controlled nature perspective. This tool therefore accommodates the views associated with three of the perspectives and allows the interests of the capricious nature world view group, often found at the bottom of the economy, to be recognised.

Such developments can provide opportunities for resolving conflicting ideas about the bio-economy. These conflicting ideas are the result of four main trends that can be discerned in the transition to a sustainable bio-economy: regionalisation, the potential of advanced genetic technology, continuing internationalisation and efficiency through cooperation. Each of these trends touches on sensitivities in society relating to varying perceptions of nature and sustainability. These trends and related sensitivities are discussed below.

3. Regionalisation

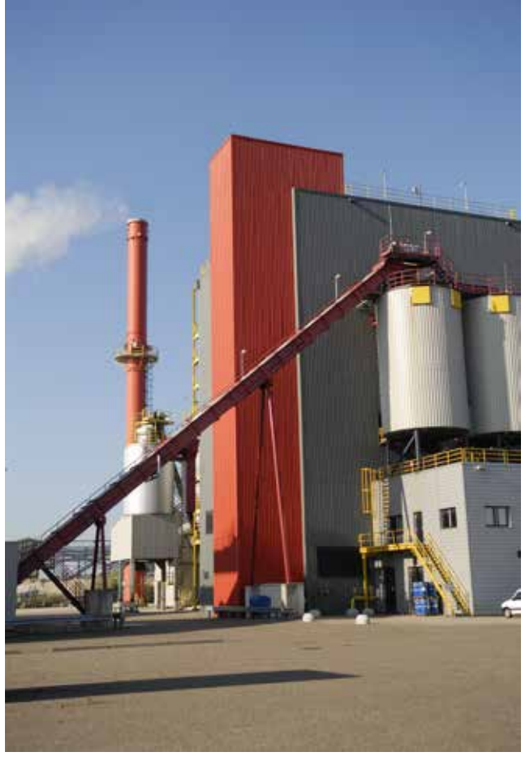
New phase in the industrialisation of agriculture

The bio-economy could have an enormous impact on the existing agricultural system in the Netherlands, which is currently mainly used to produce food. In the bio-economy, farmers will also supply raw materials for the chemical and energy sectors. Indeed, these two sectors will be integrated into the farm to some extent, as this is more efficient when it comes to biomass.

As wet biomass often largely consists of water, it does not make sense financially to transport it over large distances. According to the Scientific and Technical Committee for the Bio-economy (Wetenschappelijke en Technologische Commissie voor de Bio-economy, WTC BBE), the limit of economic feasibility is 50 to 60 kilometres. The same committee has concluded that biomass-based chemical processes involve less risk than petrochemical production processes, as they take place at lower temperatures. This makes the processes easier to integrate into rural areas (rather than on industrial estates). In addition, biobased processes such as fermentation are profitable on a smaller scale than the petrochemical processes currently applied.

According to the WTC BBE, these three properties of the bio-economy make more decentralised production possible: small-scale chemical plants and energy production on the farm. This also makes it easier to monitor soil quality, because residual nutrients from the production process can be returned directly to the land.[22, 23]

Biomass for the recently opened Essent (Bio-economy Park Cuijk) and Eneco (Bio Golden Raand in Delfzijl) biomass plants is obtained from within a relatively small radius, of about 500 km for Bio Golden Raand



and about 150 km for Bio-economy Park Cuijck. Work is taking place in Cuijk to integrate energy, chemicals and agriculture, whereby agriculture provides manure that Essent uses to produce electricity, heat and raw materials for artificial fertilisers and DSM provides enzymes to speed up the production process.

Regionalisation does not however mean that only biobased products from Europe will reach the Dutch market. The processing of biomass near the place of production can also be done elsewhere in the world, such as South America or Asia, and the products shipped to the Port of Rotterdam, for example.

Linking agriculture to the chemical and energy sectors in this way will however involve some resistance, as it touches on issues that affect people in their day-to-day lives, such as their living environment and their food. Tensions relating to these developments can already be detected in the ongoing public discourse, in particular with reference to issues of participation and regulation, as well as ideas about the value of agriculture. In discussing such issues, we refer in this report primarily to the Dutch context.

[22] WTC BBE (2013) *Strategie voor een groene samenleving*, Den Haag: WTC BBE, p. 43
[23] The global transport of biomass will probably continue, as not all biomass is wet.

High-rise pig farms

The next phase in the industrialisation of agriculture is already taking shape in new technologies such as biogas plants on farms. However, developments such as high-rise pig farms (also called factory farms) can also be seen in this light. The more advanced types (such as the Transforum Agropark concept) integrate efficient waste management, energy efficiency, climate control and animal welfare. The production and processing of feed and pigs takes place at the local level, so that little transport is required.

Although high-rise pig farms are not usually considered to be part of the bio-economy, the debate surrounding them provides some insight into societal concerns regarding the bio-economy in the Netherlands. High-rise pig farms embody an ideal as far as the efficient use of biomass and closing the loop is concerned. An examination of the Dutch bio-economy usually fails to consider livestock, but this will – sooner or later – also enter the debate as Dutch agriculture is so closely entwined with livestock production. For example, biogas plants are run on animal manure. In addition to societal concern regarding biogas plants, therefore, we also address concerns regarding high-rise pig farms. There are on average 1,000 pigs on a Dutch pig farm, whereas high-rise pig farms can hold 20,000 to 100,000 pigs. In terms of productivity and efficiency therefore, this represents a large gain. Given the current intensity of Dutch pig farming, high-rise pig farms would seem to be the next logical step.

However, there is a lot of resistance to high-rise pig farms from local residents and environmental organisations. The municipality of Almelo, for example, recently decided against the construction of a high-tech high-rise pig farm – Agropark – due to public opposition. Rotterdam also abandoned plans for an Agropark for the same reason.

Animal welfare organisations are usually less critical, as they see opportunities for improving the welfare of pigs in the high-rise farms.[24] However, environmental organisations are concerned that farms will lose their rural character and change into large-scale industrial plants, with all the associated problems such as intensive transport and large waste streams. They claim that such large-scale industry does not belong in rural areas, but on industrial sites. Furthermore, they believe that family-run companies should remain just that. If it were up to the environmental organisations, all factory farming would be stopped: an objective that is even further away with the development of the high-rise pig farm.[25] The same difficulties may be encountered with other biomass plants if they process waste streams from factory farms.

For many people living near high-rise pig farms, the reduced quality of life is the main concern. High-rise pig farms can release a pungent smell, local residents believe that they cause landscape pollution, and they can cause diseases that are carried by animals. In the next example too – biogas plants – odour is a major concern for local residents. Odour issues must therefore always be placed high on the agenda when developing biomass facilities.

However, a reduction in odour is no guarantee that biomass processing facilities will be accepted. The high-rise pig farm case shows for example that first impressions of a new technology are important for the image formed of that technology.[26] The more advanced types of pig farm, such as the Agroparks developed by InnovationNetwork, have probably suffered from the negative publicity surrounding the earlier types of high-rise pig farms. Odour levels have been strongly reduced in the Agropark and other potential benefits, such as improved animal welfare and efficient waste management, have been achieved. Nevertheless, this type of high-rise pig farm meets just as much resistance as other types, in which odour really is a problem.

[24] http://www.varkensinnood.nl/nieuws/nieuwsitem/artikel/megastallen-en-varkensflats/

[25] See among others https://milieudefensie.nl/vee-industrie/megastallen

[26] Cf. Rogers, E.M. (2003) *The Diffusion of Innovations*. New York: Free Press

The conclusion therefore is that improvements such as increased efficiency, environmental benefits, improved animal welfare and economic gain are not enough to make a production facility acceptable. Concerns about shifts in functions are also a source of conflict. Farms that are turned into factories conflict with ideas about agricultural values, our relationship with animals and what the landscape should look like, as well as concerns about security and quality of life. For many people, involvement in the local area is an important component of sustainability, and it is difficult to be involved in a high, closed facility such as a high-rise pig farm.

Such concerns can also play a role in other decentralised biomass plants, as described below. It is important to realise that once a certain technology has a negative image in the public eye, more advanced forms of the technology designed to overcome public concerns will not be easily accepted.

Biogas plants

Other than high-rise pig farms, biogas plants are usually considered to be part of the bio-economy. They can be seen more and more on farms in the Netherlands (and in surrounding countries and developing countries). In a biogas plant, manure is fermented to produce a gas. This gas can be used as energy on the farm or in motorised transport, can be processed into green gas and sent to the electricity network, or can be converted into electricity using a generator. As the energy production of manure is not very high, other forms of biomass are often added, such as maize.

Biogas plants can sometimes arouse a fair amount of opposition, for similar reasons to the high-rise pig farms, such as odour, safety, size and the sense of a shift from agriculture to industry. In the Dutch newspaper Dagblad van het Noorden, for example, local resident Harry Groen said that he was opposed to plans for a biogas plant because it was too big and should therefore be designated an industrial plant.[27] If designated as such, this would have consequences for the distance between the village and the plant, as industrial plants must be built at larger distances from residential areas. In the television documentary De biogas beerput (The biogas cesspool), local residents complained about the smell coming from a nearby biogas plant.[28] They were also concerned about their own safety, because they suspected that the biogas plant was producing toxic and flammable materials. They too saw an industrial plant that, due to legal constructions, was given the status of an agricultural plant but that burdened the area with the risks of an industrial plant.

Biomass processing plants are not always opposed by the general public. The Eneco (Bio Golden Raand) and Essent (Bio-economy Park Cuijk) biomass plants were both built in industrial areas, so that there were no concerns about the threat to agricultural values. This does not mean, however, that building biomass plants in industrial areas will prevent all opposition, as concerns about odour and safety may still be relevant. The Agropark that was to be built in the Port of

[27] http://www.binnenlandsbestuur.nl/ruimte-en-milieu/nieuws/bewoners-foxhol-biovergister-is-industrie.9098353.lynkx

[28] http://reporter.incontxt.nl/seizoenen/2012/afleveringen/16-11-2012

Rotterdam, for instance, was abandoned due to public opposition.

The above examples highlight the conflict between the idea that nature is efficient and controllable under certain conditions and the idea that nature (and agriculture) is vulnerable. The hierarchical organisation model applied for example by municipalities and national government in its subsidy policy conflicts with the public participation model required by many local residents and environmental organisations. For the general public, participation is an important condition for choosing to support a new technology or not.[29]

If the concerns of local residents are taken into account and if the industrial character of the biomass plant is preserved, as with the Essent Bio-economy Park Cuijk and the Eneco Bio Golden Raand, there would seem to be little opposition. Both companies took great care to involve the local residents, an example being the Ruiken aan Cuijk (Smell Cuijk) event organised by Essent to introduce people to the new Bio-economy Park (interview with Den Houting, 25 November 2013). Danny Hanssen, an Eneco employee at the Bio Golden Raand plant, explained how involving local residents helped understand local concerns, such as worries about noise due to previous industrial activities on the site (interview with Danny Hanssen, 18 November 2013).

For the companies involved, the application for licences – such as for the industrial processing of manure – is an exciting time. Any parties opposed will often make use of such formal processes to delay or block further developments, either through the law or through the media.

In general, small-scale biogas plants – for example plants that process manure from 65 cows – meet less resistance. These biogas plants are also cheap, so that they cost farmers less to run.[30] Biolectric, a company that sells such plants, offers a co-investment model to limit the individual risk for farmers – an approach that fits in with the preference for collectivity in some of the world views.

The new Environment and Planning Act of the current Dutch government aims to involve the public in spatial developments at an early stage. This could benefit the bio-economy, because it addresses aspects of sustainability that many people find important. Ideally, the choice of location for biomass plants will be included in the design of the wider area, so that a new balance is found between industrial functions and other functions.

If the industrialisation of agriculture is to be accepted by society, other supporting policy measures are also required, for example to deal with the risks. Biomass plants could be categorised differently, for example in a category named 'industrial agriculture' rather than the existing 'agriculture' or 'industry' categories. Specific requirements could be made of this new category regarding distance from residences[31] and odour pollution. This could allow chemical plants and energy production plants to be included in the intended use of the farm. The changing role of farmers could also be redefined, with specific training requirements and opportunities to match their new role.

4. Potential of advanced genetic technology

There are technologies in the bio-economy that make innovative use of biomass, and sometimes imitate natural processes. Although these technologies are often in the early stage of development, they could potentially have a large effect on the way that the public perceives biomass.

[29] TNS Opinion & Social (2010) *Biotechnology Report* Brussels: European Commission

[30] http://www.boerderij.nl/Rundveehouderij/Nieuws/2011/4/Kleinschalige-biogasinstallatie-operationeel-AGD564557W/

[31] See also RIVM (2010) *Veiligheid grootschalige productie biogas. Verkennend onderzoek externe risico's veiligheid.*

Gene technology offers a wealth of opportunities for adapting biomass to the requirements of specific production processes, such as a lower lignin content or a higher glucose production. Although the cultivation of genetically-modified crops is not permitted in most of Europe, the technology is applied in other areas of the world. Brazil and the United States, for example, use genetically-modified crops to produce biofuels.[32]

Synthetic biology takes gene technology a step further, as organisms are not adapted, but built by engineers. This technology is mainly found in the laboratory[33] in Europe, but the first applications have already been commercialised in the United States. For example, biotechnology company Amyris is producing synthetic artemisin, an anti-malarial drug, and Evolva is producing synthetic vanilla. Synthetic algae that can be used to make biofuels are also on the way.[34, 35] This last application is also being considered in the Port of Rotterdam, where an attempt is being made to achieve the production of isobutanol from cyanobacteria.[36] Another promising technology is artificial leaves produced by the BioSolarCells programme, which convert sunlight directly into energy. Here too, synthetic biology plays a role.[37] However, if the potential of these technologies is to be accepted by society, public concerns need to be properly documented and addressed.

The synthetic biology debate is currently taking place mainly in the US, but the technology could also play a large role in the European bio-economy, and therefore requires our consideration.[38] Genetically-modified crops could also make an important contribution to the bio-economy. However, this is only possible if public concerns are sufficiently addressed. There are still many issues that receive too little attention in the development of a sustainable bio-economy, such as distributive justice, trust and natural quality.

Some actors have very high expectations of advanced gene technology, such as the director of Amyris, Jay Keasling, who had the following to say at a hearing in the American House of Representatives:

> "These new, advanced biofuels reduce the production of green-house gases, as they are derived from plants that use sunlight and atmospheric carbon dioxide to

[32] De Vriend, H. & Stemerding, D. (2011) *Innovatie: op weg naar een bio-economie?* In Asveld, L., Est, R. van, Stemerding, D. (red.): *Naar de kern van de bio-economie: de duurzame beloftes van biomassa in perspectief.* Den Haag: Rathenau

[33] In the Be-Basic programme, for example, work is being carried out to improve the membrane functions of cells using synthetic biology (www.bebasic.org).

[34] http://www.washingtonpost.com/national/health-science/companies-rush-to-build-biofactories-for-medicines-flavorings-and-fuels/2013/10/24/f439dc3a-3032-11e3-8906-3daa2bcde110_story.html

[35] Wang B, Wang J, Zhang W and Meldrum DR (2012) *Application of synthetic biology in cyanobacteria and algae.* Front. Microbio. 3:344. doi: 10.3389/fmicb.2012.00344

[36] http://www.biosolarcells.nl/onderzoek/algen/

[37] http://www.biosolarcells.nl/onderzoek/kunstmatige_bladeren/

[38] See also: Rerimassie & Stemerding (2013) *Politiek over Leven* Den Haag: Rathenau Instituut.

> grow. These biofuels will reduce our dependence on foreign oil and could rejuvenate the U.S. agriculture economy, potentially making the American Midwest the new Middle East."

In direct contrast with this optimism comes the critical sound of some NGOs, in particular ETC Group and Friends of the Earth. These groups warn of the disruptive effects of synthetic biology on developing countries, because the technology means that more types of biomass can be used, leading to an increased interest from commercial companies in biomass and land, and increased conflict over land use. They are also concerned that synthetic biology will lead to even greater economic disparity due to monopolies of knowledge and raw resources, and point out the complete lack of supervision or democratic control, despite the huge potential risk.

A specific example is the previously-described production of synthetic artemisin by Amyris. According to Amyris, this product makes an important contribution to the fight against malaria, as it reduces drug prices and therefore increases their availability. The ETC Group, however, claims that this form of artemisin undermines the source of income of small farmers producing conventional artemisin.

There is also criticism of 'advanced biofuels' production using synthetically produced algae – this time from Friends of the Earth – as other alternatives, such as wind and solar energy, involve much less economic and ecological risk. Also, although the algae are not cultivated in fields but in containers, Friends of the Earth believes that there is a significant risk that the algae will 'escape' and 'pollute' the natural environment.

We therefore see a clear conflict between 'nature as resource' and 'vulnerable nature' (and vulnerable people in developing countries). Much of the criticism of NGOs directed at producers of synthetic biology relates to the fact that these producers reject any form of regulation.[39] At the same time, the general public is only prepared to support synthetic biology if strict regulations are in place.[40] Both NGOs and the general public, therefore, do not trust companies when it comes to adequately managing the risks associated with advanced gene technology.[41] In Europe, GMO legislation applies to all forms of gene technology. The question however is whether it is sufficiently applied to advanced forms of gene technology. This could be a subject for public debate.

NGOs are also worried about the influence that large companies have on biomass production, as well as on the situation of people in developing countries and the say they have in developments. These are arguments that have gone on for some time in the gene technology debate. Companies like Amyris and Evolva expect their products to have a positive effect, such as greater availability of drugs and fuels and lower CO_2 emissions. They therefore demonstrate a high level of confidence, as well as the power of radical innovation, or as they themselves call it, breakthrough science.[42] These positive expectations have also been heard for some time in the debate. However, the critical NGOs do not believe that synthetic biology and genetic modification are sustainable by definition.

If (advanced) gene technology is to play a significant role in the European bio-economy, these issues need to be adequately addressed. Many of these issues also apply to the large-scale import of biomass from other parts of the world into Europe. Here too, the question arises as to whether this is fair in economic terms,

[39] Friends of the Earth (2010), Synthetic solutions to the Climate Crisis.

[40] TNS Opinion & Social (Ibid.).

[41] Rerimassie & Stemerding (ibid.).

[42] www.amyris.com

and what the implications are for sustainability. Tools have already been developed to integrate societal concerns and practical aspects, the main example being sustainability criteria. These tools could also be applied to incorporate societal concerns regarding gene technology into the development of new applications, for example through sustainability criteria for gene technology.

5. International biomass streams

Despite the cautious attempts made in the direction of regionalisation, a lot of biomass is still purchased in other countries and shipped to the Netherlands. Some of this passes through the Netherlands to other countries in Europe, in some cases after processing, for example for use in coal-fired power stations and biofuels.

A maximum of 25 PJ has been set in the Energy Agreement for the co-firing of biomass in Dutch coal-fired power stations. For biofuels, a 4% blending mandate was applied in 2010. Wood pellets for co-firing, raw materials for biofuels such as vegetable oils and the biofuels themselves arrive in large quantities in the Port of Rotterdam. If we are to achieve the energy objectives for 2020 and 2050, biomass for energy will probably still be much in demand, although biomass may be superseded by other sustainable energy forms after 2020.[43] Biomass imports will however still be required for chemical applications and some forms of transport fuels, given the limited biomass supply within Europe.

Public support for this biomass use relates primarily to sustainability. However, what sustainability means for biomass is a long-running debate in which a wide range of parties have taken part. According to Harold Pauwels from NEN, the concept of sustainability has been discussed enough in this debate, also at the international level (interview with Harold Pauwels, 25 March 2013).

However, public support for the use of imported biomass requires more than a broadly-accepted understanding of the concept of sustainability. Actors in the Netherlands and Europe also need to have confidence in the sustainability claims made of biomass. In addition, the issue of distributive justice must also be addressed.

Trust

As it is produced outside Europe, the sustainability of imported biomass is hard to judge for most actors in the Netherlands and Europe. Actors in the Netherlands, for example, have no way of directly determining the effects of biomass production on developing countries, such as effects on the local economy. They also have no way of calculating the CO_2 mitigation due to the use of biomass, as this requires data and calculations that they do not have access to. If biomass really can be called sustainable, it is usually given a sustainability label. Public actors need to have confidence in such a label if they are to believe the sustainability claims made of the biomass.

The use of biomass for fuels and energy is subject to sustainability criteria, which are usually drawn up in consultation with a wide range of public actors. Sustainability criteria are a legal requirement for biofuels, and are set by the European Commission. The NTA 8080 norm, formulated by the Dutch Normalisation Institute (NEN) forms an important reference point in this. Although sustainability criteria are not yet obligatory for biomass co-firing, agreements have been made in the Dutch Energy Agreement concerning binding sustainability criteria for wood for co-firing.

It appears to be the case that there is considerable consensus with regard to the demands on sustainable

[43] Goudswaard, F. (2013) *10 kernpunten 'verduurzaming via bio-economie' voor de Groene Alliantie* Brief van de Groene Alliantie aan de SER.

biomass, however, some contentious issues remain. Many feel that the binding criteria for biofuels are not strict enough, because they fail to take adequately into account indirect land use change (ILUC), for example. It is for this reason that the European Commission is considering adjusting the criteria, which is being met with much resistance from the biofuel industry.[44] As a result, the European Commission has delayed coming to a decision about the criteria. The European ministers of environment therefore proposed to at least limit the blending of biofuels, without taking ILUC into account. This led to protest from some member states, among which the Netherlands, because this approach would undermine any gains for the climate. The proposal will be discussed in the European parliament in the autumn of 2014.[45] According to some media reports,[46] energy producers and environmental organisations also disagree on how strict the co-firing criteria in the Energy Agreement should be.

Aside from some disagreement on the criteria, there is a wide array of various labels that use different certification methods. This abundance causes confusion. Many companies, such as Essent, have produced their own label (the Green Gold label) which they use to control and certify the sustainability of their biomass. For biofuels too, there is a wide range of labels for the certification of sustainable biomass, so that differing standards are applied. Labels for sustainable wood, such as the FSC label, have also been around for a long time. Environmental organisations are less happy with some labels than with others.[47, 48]

Companies can create trustworthy claims on sustainability on their own accord, independent of the European political dynamic. First of all, transparency on criteria and the method of certification are required. Additionally, for users of sustainable biomass, it is essential that NGOs are onboard as far as the certification of sustainable biomass is concerned. After all, NGOs play a crucial role in the relationship with consumers and the general public[49] in the bio-economy. NGOs are traditionally actors that are trusted by the general public, and NGO support for sustainability criteria is therefore important for gaining the trust of the general public in these criteria.

NGOs already play an important role in the relationship between consumers and companies in the bio-economy. They ensure that issues concerning sustainability and biomass enter the public domain, or they support biomass projects. They are also involved in many consultation bodies, such as the Corbey Commission. To support the further development of the bio-economy, this role could be made more use of than at present. For example, NGOs could be given more opportunities for working together with companies, while maintaining their critical position. This is sometimes hindered for example by the use of Non-Disclosure Agreements (NDA), often applied in such partnerships, which make the relationship difficult as they effectively prevent NGOs from talking.

Many companies are also worried that NGOs are looking for easy prey by taking issues out of context and placing them under close scrutiny. A code of conduct drawn up by a party trusted by both sides, rather than an NDA, would improve the relationship between companies and NGOs. A code of conduct compels parties to express their values and their expectations. This can lead to greater consensus between the parties, so that they can draw up an agreement that takes into account shared concerns and opportunities, rather than a standard agreement such as an NDA.

Distributive justice

Another issue that is often high on the agenda of NGOs when it comes to the sustainable use of biomass is the fair distribution of resources.[50] We can ship all the biomass to Europe for processing, and therefore create all the added value in Europe, or we can support developing countries by giving them the technology to carry out at least some of the processing there. These products can then be used in developing countries, or shipped to Europe. This means that at least part of the added value is created in developing countries, boosting the economy of these countries. This also fits in with the trend towards regionalisation, in which biomass is processed as close to the source as possible, which has the added benefit that less biomass needs to be transported.

There is not much value to add to wood pellets for co-firing, but biofuels can sometimes be manufactured in the country of production, as is already taking place in Brazil. A similar model can be applied for the chemical processing of biomass. The Netherlands could export its innovative technology and knowledge on sustainable agriculture to countries with high levels of biomass production.

The recommendations given below are made with this in mind. First, however, we explore some of the issues between actors in the biobased chain and the influence of varying perspectives relating to nature and resources.

6. Efficiency through cooperation

The efficient use of biomass can only be achieved if sectors that do not currently work together do so more in the bio-economy, so that they can make use of one another's waste streams. However, this will not be easy, as Peter-Paul Schouwenberg (Bio-economy Manager at Essent) explained: "Each company wants a part in the revenue model and does not want to take too many risks... It doesn't help that biomass is still not classified as a commodity, such as oil, gas and coal are, for example. The risks are also difficult to manage in time, as a cost increase, for example, can result in direct losses if the price increase cannot be passed on." (interview, 28 March 2013). Many companies want to conclude long-term contracts for steam or electricity for example, at a set price, but biomass prices can fluctuate due to the need to use other raw materials, for example (interview with Den Houting, Essent, 28 November 2013).

The chemical, energy and agricultural sectors can also find it difficult to work together, as they do not always understand one another. "Chemicals and agriculture are different blood groups," explained Kees de Gooijer (chairman of TKI Bio-economy), to give an example.

[44] http://www.euractiv.com/sustainability/crucial-eu-biofuels-vote-close-c-news-530312

[45] http://www.euractiv.com/sections/sustainable-dev/biofuels-debate-continues-despite-eu-agreement-302834

[46] http://fd.nl/economie-politiek/392381-1404/botsing-over-bijstook-hout-zet-energieakkoord-op-scherp

[47] Biofuelwatch (2012) *Sustainable Biomass: a modern myth* http://www.biofuelwatch.org.uk/2012/biomass_myth_report/

[48] http://www.forbes.com/sites/jonentine/2013/04/09/forestry-labeling-war-turns-ugly-as-greenpeace-bungles-logging-industry-attack/2/

[49] See for instance: http://www.edelman.com/insights/intellectual-property/2014-edelman-trust-barometer/about-trust/global-results/

[50] See for instance https://milieudefensie.nl/biomassa

[51] The WTC BBE also states in its most recent report that the cooperative model is suited to the bio-economy (Ibid., p. 47).

"Farmers are used to being flexible when it comes to raw materials. However, chemical engineers like to use one particular raw material as they can predict its properties." (interview, 6 January 2014).

Here too, we see a conflict between two perspectives relating to the use of nature; that of the group that regards nature as a malleable resource ('nature as resource'), and that of the group that recognises the limits to the malleability of nature ('controlled nature'). Some groups, such as the companies referred to by Schouwenberg and the chemical engineers referred to by De Gooijer, regard nature as a resource that should ideally act as a fossil resource – in other words predictably. Farmers, on the other hand, are used to working with biomass and accept its complexity, as well as the fact that it is not completely malleable.

Cooperation as blueprint

If biomass producers were to work together in cooperatives to supply companies that process biomass or use the products, it could be possible to meet the demand for a stable, regional raw material stream. Cooperatives would also respond to the public demand for participation and involvement.[51]

The cooperative structure is common in agriculture – the traditional biomass-producing sector. Mestac, for example, is a cooperative for manure producers, and monitors the quality of the manure supplied and coordinates transport so that actors further along the chain receive a steady supply (interview with Ben Rooyackers, Manager at Mestac, 10 December 2013). The unpredictability of biomass as a raw material is therefore absorbed by the cooperative; if one producer is unable to supply the required quality, another producer may be able to compensate. This gives buyers more certainty, and could be a solution for the wood and forestry sector, where the quality of the biomass supplied is often substandard (interview with Eppo Bolhuis, Het Bosschap,[52] 16 May 2013; interview with Hanssen, 18 November 2013).

In the energy sector, cooperatives are increasingly being set up by the general public. This model satisfies the general public's desire to have a say in the development of new technology, particularly when it takes place in the local area. A farmer's cooperative developing a joint biogas plant could decide to involve the general public united in a cooperative in the farmer's cooperative. Large energy companies that want to emphasise their sustainability could also look to work together with public cooperatives, as these address the aspect of the social acceptance of new technology.

However, the needs of the chemical engineer that wants a predictable raw material that can be stored and has a consistent quality have not yet been met. It is possible that the answer to this lies within hierarchical structures such as the government. The government can create opportunities for chemical engineers to learn to deal with varying raw materials, possibly together with farmers and the support of a third party that understands both the farmer and the chemical engineer, such as a knowledge broker. Once this learning process is complete, a more solid foundation will probably have been created for commercial partnerships between farmers and chemical engineers. One idea could be the production by farmers of semi-manufactured products that meet the quality requirements of chemical engineers.[53] This does of course require the necessary infrastructure in the form of storage capacity and quality control. Parties such as waste processing companies or farmers' cooperatives will probably be prepared to invest in this once the requirements of buyers such as chemical companies have been made clear.

[52] Het Bosschap has ceased activities and its tasks have been taken over by VBNE.

[53] Suggestion made by Carolien Huisman, province of Zuid-Holland.

[54] Veldkamp (2013) Publieksonderzoek biobased economy. Kennis, houding en gedrag. Amsterdam: Veldkamp.

Confidence in the chain

Mutual trust is an essential element of partnerships in the biobased chain. An actor is reliable if he is predictable, which means that he displays consistent behaviour or his motives are clear, or he is tied to certain agreements.

If there are uncertainties, as is now the case in the bio-economy, mutual trust is needed for the actors to continue. After all, they are taking a risk and are therefore vulnerable. If they decide that a potential partner or supplier is unreliable, they will not take the relationship any further. However, the reliability of biomass producers and processors is also a requirement for the acceptance of biobased technologies by consumers and people living near biomass processing plants.

The bio-economy is still in development, which means that the trust between different stakeholders is still being built. Actors in the biobased chain do not usually have a shared history to fall back on (a shared history forms a foundation that allows partners to predict one another's behaviour and therefore forms a base for trust). Parties also often fail to understand one another, as different groups interpret the same terms differently (remark made during valorisation workshop, 8 April 2014).

Personal contact between stakeholders can help build up a relationship of trust; however, this is not always possible and costs time. Other steps are therefore also required, such as the development of a corporate identity, third party warranties or formalisation through codes of conduct.

Corporate identity

The development of a corporate identity can help build trust as the underlying motives and objectives of the organisation are made clearer to other actors. A corporate identity is a clear description of the values considered important by the organisation. Many companies already do this, but there are many newcomers to the bio-economy who do not, such as foundations that bring farmers together to build a biogas plant. Existing corporate identities could also focus more on the socioeconomic aspects of sustainability and other terms that currently sow confusion in the bio-economy.

Codes of conduct

Codes of conduct can clarify the expectations that potential partners have of one another, as well as of producers in the bio-economy and other stakeholders. Examples are a code of conduct for the managers of a biomass processing plant in consultation with local residents, or the formalisation of the expectations of biomass buyers and suppliers in consultation with both parties.

Third party warranty

A third party warranty means that a trusted person or organisation functions as a mediator between the two actors between which a relationship needs to be built. This third person – for example a knowledge broker – can help clarify differences in interpretation of values such as sustainability or resource needs and can help in the search for similarities between the actors, which can be used to further develop the relationship.

Consumers

Consumer demand for sustainable products is another incentive for companies to use biobased resources. "If you really want a green economy, the role of the consumer is essential," said De Gooijer. "Someone needs to create the demand for sustainable biobased products, but the product needs to be sound."

Although more and more people find sustainability important, many are barely aware of the existence of the bio-economy, the specific products and the related sustainability claims.[54] There is therefore still a great deal to achieve when it comes to consumers making a conscious choice to use biobased products. It is true that energy suppliers offer biomass as part of a sustainable energy mix, but this has little to do with consumer choice. After all, the usual choices for consumers are solar or wind energy.

Consumers that are aware of sustainability and therefore choose sustainable biobased products are more likely to be proponents of the 'vulnerable nature' world view. These people are usually averse to large-scale industrial production processes and are more interested in small-scale, rural, cooperative[55] methods. The idea that nature has much to offer also appeals to this group. If this consumer group is to be reached, these aspects of the bio-economy need to be emphasised and made use of. It is also the case that at least some of the companies involved in the bio-economy will agree with these conditions for a bio-economy because they result in efficient operations. There are therefore opportunities for connecting different aspects of the sustainable bio-economy.

7. Prospects for action

Based on the above, we have arrived at the following courses of action for actors in the biobased chain and policy-makers:

Highlight the common denominator
The group from whom the most opposition is to be expected with respect to the bio-economy is also the group from whom the most support is to be expected – the group that considers nature to be vulnerable. To involve this group in the bio-economy, it is necessary to highlight the common denominator in which other actors, such as companies and technology pioneers, can also recognise themselves. Examples: reusing raw materials is efficient, small-scale pays off and nature has much to offer.

Develop the bio-economy in accordance with these shared values
Invest in small-scale, local projects that reuse waste streams and communicate this clearly to the consumer. Try to reflect the natural properties of biobased products as much as possible in the design: raw structures in user products, small-scale plants that fit in the landscape, easy to recycle products. Good example: roundel eggs. There are also opportunities here for multinationals: if small-scale is not an option, closing the loop may be. Show how this can be done. Example: Van Gansewinkel.

Invest in egalitarian processes
Many people appreciate having a say in the development of new technologies. Invest, therefore, in the egalitarian embedding of biobased technology by listening, for example, to the views of people living in the area around biobased production plants, for example by drawing up a code of conduct or by allowing participation in a cooperative that provides people with benefits and allows them to take part. This applies to the agricultural sector as well as the energy and chemicals sectors.

Respect the division between industry and agriculture
Make sure that industry and agriculture are kept separate where possible, and be wary of placing industrial plants on farms. Respect legislation governing risk, so that local residents do not feel that they are being presented with industrial-level risks under the label of the bio-economy. Consider developing specific legislation so that any new forms of industrialised agriculture can be embedded in society, and to cover any possible risks.

Initiate a debate on advanced technology
Start a discussion about technologies such as synthetic biology and genetic modification in which the main question is: what are the benefits of these technologies and who benefits most? This debate can lay a foundation for guidelines on the use of these technologies that are drawn up based on the input of a wide range of actors.

Consider cooperative organisational structures
A model often seen in agriculture – the sector with the most experience in biomass – is a cooperative one. This could also be applied to guarantee the quality and availability of different types of biomass, such as biomass from the wood sector. It could also be used as a model to spread financial risk.

Invest in mutual trust
Use instruments such as codes of conduct, corporate identity and third party warranties to clarify differing interpretations of values such as sustainability and resource requirements, so that mutual expectations are spelled out clearly.

[55] Friesland Campina is also a cooperative but too large in this context.

Valorisatiepanel

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Fokke Goudswaard, Eneco/koepel Bio-energie
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