

Biofuels and (Ir)Responsible Innovation Conference, 13-14 April 2015, Eindhoven University of Technology

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Biofuels and (ir)responsible innovation conference

13-14 April 2015, Eindhoven University of Technology

Conference Report



TU/e **NWO**

Colofon

Biofuels and (ir)responsible innovation conference

13 – 14 April 2015

→ http://w3.ieis.tue.nl/nl/groups/tis/tis_education/ctdg/tdg_research/biofuel_research/biofuels_and_irresponsible_innovation_conference/

Eindhoven University of Technology

Department of Industrial Engineering & Innovation Sciences

→ <https://www.tue.nl/en/university/departments/industrial-engineering-innovation-sciences/>

Netherlands Organization for Scientific Research

This conference was part of the research program (MVI) 'Responsible Innovation' of the Netherlands Organization for Scientific Research (NWO).

→ <http://www.nwo.nl/onderzoek-en-resultaten/programmas/maatschappelijk+verantwoord+innoveren>

Organization & Contact

dr. Henny Romijn h.a.romijn@tue.nl

dr. Auke Pols a.j.k.pols@tue.nl

Evelien de Hoop MPhil e.d.hoop@tue.nl

Beknopte Nederlandse samenvatting

(Brief Summary in Dutch)

Al zolang biobrandstoffen een prominente rol spelen in EU beleid zijn ze een omstreden energiebron. Gewassen zoals *Jatropha* zijn eerst verwelkomd als 'wondergewas' om vervolgens binnen een decennium ineens te storten. Deze verandering gaat gepaard met complexe problemen zoals de voedsel versus brandstof-discussie en indirecte veranderingen van landgebruik en blijven onenigheid tussen sociale actoren veroorzaken. De gevolgen van de roerige geschiedenis van biobrandstoffen zijn voornamelijk voelbaar in het zuidelijke deel van de wereld. Landroof en opportunistisch gedrag van investeerders hebben daar grote sociale en ecologische problemen veroorzaakt. Voorstanders van biobrandstoffen claimen dat dit reden te meer is om door te gaan met investeringen en innovatie: nieuwe energiebronnen, zoals de resten van planten en algen, zouden zo uiteindelijk alle problemen oplossen. Maar in het licht van de grote onzekerheden en problemen uit het verleden zouden we deze claims niet zonder meer moeten accepteren, noch zouden we moeten aannemen dat alle problemen specifiek horen bij bepaalde technologieën.

Biobrandstoffen als case study roepen fundamentele vragen op over drie thema's: beleid en bestuur, verantwoorde innovatie en duurzame ontwikkeling. Voor het beantwoorden van deze vragen is een multidisciplinaire blik noodzakelijk. Dit zijn de belangrijkste bevindingen:

- *Beleid en bestuur*

Op dit moment zijn er geen succesvolle projecten die een biobrandstofbeleid met expliciete bijmengdoelstellingen zoals dat van de EU legitimeren. Er is uitgebreide documentatie over de negatieve gevolgen van dit beleid in landen zoals Guatemala en Tanzania. Certificering als oplossing kent ook veel problemen. Daarom maakten de deelnemers van deze conferentie bezwaar tegen beleid dat de import van grote hoeveelheden biobrandstoffen uit het zuidelijke deel van de wereld vereist, zelfs als er nieuwe-generatie biobrandstoffen ontwikkeld worden.

- *Verantwoorde innovatie*

Verantwoordelijkheid (in de context van verantwoorde innovatie) is verdeeld, niet alleen onder innoverende partijen en belanghebbenden, maar ook onder beleidsmakers en semionafhankelijke financiers van onderzoek. Alle partijen zouden hun aandeel van verantwoordelijkheid serieus moeten nemen. Het is belangrijk dat ze zich bewust zijn van de legitimerende kracht van termen als 'verantwoord' en 'duurzaam' omdat deze termen vaak onterecht biobrandstofprojecten en beleid hebben gelegitimeerd.

- *Duurzame ontwikkeling*

Het bepalen van de duurzaamheid van biobrandstoffen is veel complexer dan werd aangenomen op het hoogtepunt van de biobrandstofhype, en zou een breed spectrum aan onderwerpen moeten behelzen, zoals (on)gelijkheden tussen het noorden en het zuiden van de wereld, eerlijke aankoop van grond, tekorten aan grondstoffen die nodig zijn om biobrandstoffen te produceren, gevolgen voor de arbeidsmarkt en het gebruik van de biobrandstoffen (zoals lokaal of op de wereldmarkt). Met de groeiende ervaring met biobrandstoffen onder onderzoekers de afgelopen jaren verbreedde de notie van 'duurzaamheid' zich. Maar in de meeste politieke discourses vernauwde deze notie zich juist tot het terugdringen van CO₂ emissies.

Executive summary

For as long as biofuels have prominently appeared in EU policy, they have been a contested energy source. Crops such as jatropha have been hailed as ‘wonder crop’, only to experience an ‘extraordinary collapse’ within a decade. From the food vs. fuel discussion to indirect land use change, wicked problems have plagued biofuel developments and continue to provoke disagreement between societal actors. The impacts of biofuels’ tumultuous history have been felt particularly in the global South, where land grabbing and opportunistic behavior of investors have caused great social and ecological problems. Proponents of biofuels claim that this is all the more reason to continue with investments and innovation: new sources of biofuels, such as plant residues and algae, will eventually solve all our problems. Given the great uncertainties and past harms, however, these claims should not be accepted lightly, nor should we assume that all encountered problems are technology-specific.

Biofuels as a case study raise fundamental questions with regard to three themes: policy and governance, responsible innovation and sustainable development. Therefore, this conference was devoted to addressing these fundamental questions from a multidisciplinary perspective. These are the main findings:

- *Policy and governance*

There are no successful projects that would legitimize a biofuel policy with explicit blending targets as the EU has at the moment. There is extensive documentation of the negative effects of this policy in countries such as Guatemala and Tanzania, and a host of difficulties associated with certification (which aims to ensure sustainable biofuel production through the use of certificates) have been identified. Therefore, participants of this conference objected to policies that require large amounts of biofuel imports from the global South, even if next-generation biofuels are to be developed. Namely, we found that institutional factors play an important role regardless of the type/generation of biofuel. At the same time, there are severe material limits to the amount of biomass the earth can produce and therefore to the amount of biofuels we can produce.

- *Responsible innovation*

Responsibility in the context of responsible innovation is highly distributed, not just among innovators and stakeholders but also among policy-makers and semi-independent research funders. All parties should be aware of their share of responsibility. It is important to be aware of the legitimizing power of terms like ‘responsible’ and ‘sustainable’, for these terms have often unjustly served to legitimize biofuel projects and policies.

- *Sustainable development*

Determining biofuels’ sustainability is much more complex than was assumed at the height of the biofuel boom, and should incorporate a wide range of issues such as (in)equalities between the global North and global South, fair land acquisition, limitations to inputs required to produce biofuels, labor market impacts and the use of the biofuels (e.g. locally or for the global market). While the notion of ‘sustainability’ widened among researchers as experience with biofuels grew, the same notion got reduced in most political discourses to avoiding carbon emissions.

Conference Report

Day 1: Presentations by scientists

The first plenary session was introduced by the conference team and Floortje Alkemade, professor of Economics and Innovation & Technological change of the Eindhoven School of Innovation Sciences. Floortje Alkemade highlighted that we need fundamental environmental, social and economic changes to deal with the challenges we are facing. Because these changes are interrelated in many ways, we need to combine different kinds of both quantitative and qualitative ways of doing research, rather than being dismissive of different approaches, and the program of this conference offers such a range of approaches. Henny Romijn, associate professor Technology and Development and project leader of the NWO-MVI project, continued in a similar vein, discussing that the multi-disciplinary work done as part of the NWO-MVI project 'Biofuels: sustainable innovation or gold rush?' had brought to the fore that biofuel successes have been hard to find. As a consequence, the initial question of the project 'how can sustainable biofuels be realized' receded to the background to make place for the question 'can sustainable biofuels be realized?'

Plenary session 1 | The Political Power of Biofuels (Lena Partzsch, University of Freiburg, Germany)

Lena Partzsch addressed concerns with regard to (ir)responsible innovation and sustainability through the lens of power. She distinguished between three forms of power, namely power over (characterized by coercion and manipulation), power to (characterized by creativity and resistance) and power with (characterized by cooperation and learning). She then used these distinctions as an analytical lens to understand the distribution of power in various kinds of biodiesel production systems at the moment, and as activating entities: for example, by promoting and facilitating 'power with', one could make biofuels more equitable. These ideas led into a discussion focusing on the role of power in the responsible innovation framework: just as mutual learning rather than one way learning is important in a responsible innovation process, power also has to be rather more 'power with' and perhaps a bit of power 'to' and relatively little 'power over' to achieve a better balance between all three forms of power.

Parallel session 1a | Responsible innovation 1

Papers presented by Ravi Srinivas (RIS New Delhi, India) and Lotte Asveld & Ibo van de Poel (TU Delft, Netherlands) continued this focus on what responsible innovation could be and how this could be achieved. Ravi Srinivas argued for the development of a framework that has locally relevant values at its foundations, rather than only values that are currently important in Europe. For India's case, he suggested access, equity and inclusion, based on an analysis of policy documents. Lotte Asveld & Ibo van de Poel suggested ways to avoid policy lock-in, by designing policy focusing primarily on goals rather than technologies, being transparent about the values underlying the policy, and particularly designing policy in a way that anticipates policy change. This raised a lot of questions: how can you avoid that this does not lead to people waiting forever to undertake action? How can this be used as a way to avoid lock-in if the lock-in of first generation biofuel policy was

perhaps created on purpose? At the same time, the idea of thinking about policy as a set of paths with foreseeable crossroads, where strategies can be changed was received as particularly inspiring.

Parallel session 1b | Effects of EU biofuel policies

In the parallel session two papers focused on the sustainable development of biofuels by studying the effects of EU biofuel policies on various countries. Richard Helliwell (University of Nottingham) and Julia Tomei (University College of London) contributed by outlining how EU biofuels policy has shaped biofuel industries and has had consequences for sustainable development in two countries peripheral in biofuel production: the UK and Guatemala. They concluded that the EU's policy rubber stamped existing practices; its benefits accrued to the powerful, already established actors and did not reach weaker and marginalized agricultural actors. Also, the EU biofuels policy led to too little environmental and social change. David Harnesk and Sara Brogaard (Lund University, Sweden) contributed to the discussion by presenting the impact of the EU's 2009 Renewable Energy Directive on Tanzania. They concluded that the EU's norms aggravated sustainability challenges of policy, tenure and land-use in Tanzania. Both presentations led to the question of: how to include smallholder farmers in biofuel production? And considered as even more important: do we actually want to include smallholder farmers? And do they want to be included? There was agreement that smallholders do not necessarily always want to be included.

Parallel session 2a | Historical analyses in Brazil and reports from the FAO, IEA and UNEP

David O'Byrne & Sara Brogaard (Lund University, Sweden) and Flávia Gouveia (DPCT - University of Campinas, Brazil, and GSPR - School for Advanced Studies in Social Sciences, Paris, France) & Markku Lehtonen (school for advanced Studies in the Social Sciences, Paris, France) made contributions that focused on the developments of discourses on and approaches to particular biofuels over time. In particular, Sara Brogaard discussed how major reports from the FAO, IEA and UNEP changed their approach to biofuels after the 2007/08 food crisis in various ways. There was a general move away from quantification of benefits and problems associated with biofuels, while UNEP started highlighting a lot of problems associated with biofuels and the IEA remained rather optimistic about the potential of biofuels. Flávia Gouveia gave a comprehensive overview of Brazil's approach to biofuels since the pre-ethanol time. This brought to the fore that the economic dimension of biofuels had always been important in Brazil, and that this related to strong path dependencies that were difficult to be broken. Discussions following these two presentations brought to the fore that learning from history was considered very important. This may seem to be a rather obvious point, but many people had experienced in their research that biofuels had been presented and often studied as something 'new' without due attention to similar approaches that had already been tried and studied before.

Parallel session 2b | Algae biofuels in Turkey and Bioelectricity in Vietnam

Duygu Kasdogan (York University, Canada) contributed with her paper on algae biofuels in Turkey. Algae are increasingly drawing attention as an alternative biofuel source, also in Turkey where there is extensive biofuel research in laboratories. However, she drew attention to the fact that the success of algae biofuel is more than a technical issue, therefore she argues that it is important to learn about how algae research in laboratories proceeds, because labs are not neutral 'producers of knowledge', but rather are techno-social settings shaped by political economy, ecological realities and interpretations. Le Quyen Luu (Vietnam Academy of Science and Technology, Vietnam) presented her Life Cycle sustainability assessment of rice husk based electricity compared to coal fired electricity in Vietnam. She stated that bioelectricity is more sustainable than coal fired electricity since it has a higher negative impact on human health, but this is compensated by a lower negative impact on ecosystem quality and natural resources and a higher positive impact on social wellbeing and prosperity. The discussion followed by the presentations went into the method of assessing the sustainability over the life cycle of projects. Le stated that such assessments are not inclusive, and that some of the large amount of information which is needed for such an analysis may be unavailable. This discussion revealed both the difficulty of quantifying life cycle sustainability, as well as the difficulty of understanding the economic impacts of biofuels compared to other energy sources.

Parallel session 3a | Biofuel pathways in West-Africa and Colombia

Charly Gatete Djerma (2iE Ouagadougou, Burkina Faso) and Marie-Hélène Dabat (CIRAD Montpellier, Paris-sud University, France) contributed to the questions of sustainable development of biofuels by outlining the bad influence of policy on biofuel development in the West-African Countries Benin, Burkina Faso, Senegal and Mali. They stated that despite the existence of a national biofuel strategy in all countries, Mali is the only country which has a strong public coordination and structuration of the biofuel sector. This unique position of Mali is a result of the cooperation of public stakeholders and the involvement of both the agriculture and energy ministries in biofuel policy making. In the other three countries an institutional vacuum has arisen. Victoria Marin-Burgos (University of Twente) contributed by challenging the linear relation between the policy-driven biofuel demand in the North and the expansion of biofuel production in the South. Victoria stated that the ways in which biofuel crop booms unfold depend in each case on the country specific geographies and political economies, illustrated by the case of palm oil in Colombia. In the discussion this idea was supported by pointing at the limited influence of EU policies on the production of palm-oil based biodiesel in Colombia. Also, in the discussion Julia Tomei (UCL) pointed at the striking similarities between the cases of Colombia and Guatemala, such as the pressing issue of land-tenure and the need for stronger regulation in both countries. Finally, in talking about country specific trajectories, it was noted that there is a large difference between the weak production of biofuels in West-African countries and the biofuel production for large (international) markets in Latin-American countries.

Parallel session 3b I Responsible innovation 2

Henk van den Belt & Tjidde Tempels (Wageningen University, Netherlands) and Evelien de Hoop, Auke Pols and Henny Romijn (Eindhoven University of Technology, the Netherlands) made contributions that raised serious issues on the concept of responsibility. Tjidde Tempels concluded his presentation with the question whether the current approach to responsibility in the RI debate is actually a desirable and feasible concept: if every innovation has to be responsible, we may never come to any kind of innovation. Evelien de Hoop questioned the legitimacy of responsible innovation processes if the discontinuation of an innovation is not an explicit and possible option in the process. She made this observation based on fieldwork in Hassan, India. She also highlighted the irresponsibility of doing research and carrying out biofuel projects in practice if they do not take the history of the biofuel crop into account – in this case a crop that had been used for soap production for decades, and biofuel production competed directly with the existing demand from the soap industry. These perhaps contradictory conclusions were fruitful material for discussion, in which the idea was raised that responsible innovation as a framework should perhaps be interpreted as an attempt to make innovation less irresponsible rather than responsible, and that introducing possibilities to facilitate discontinuing innovation could be one of the ways to do this. At the same time, how to distribute responsibilities and how to start innovating (e.g. gaining interest and in particular funding) if discontinuing is an explicit possible outcome, remained important questions. Furthermore, what if serious negative effects of an innovation only surface after its large-scale introduction? Is it possible to think of ways to create opt-out options even at this much further stage?

Plenary Session 2: Biofuel investments and the question of local economy in Africa (Atakilte Beyene, Nordic Africa Institute, Sweden)

and

Wasteland energy-scapes: Biofuels, land politics and social inequality in South India (Jennifer Baka, London School of Economics, UK)

In the light of the strong role of Europe in biofuel developments in Africa, Atakilte Beyene argued that biofuels should perhaps not be looked at so much from the European perspective, but primarily from the angle of Africa's needs. Jennifer Baka showed how the 'wastelands' on which India's biofuel policy is predicated do not exist: their current use as source of fuelwood from *Prosopis juliflora* yields more energy than *Jatropha curcas* could do, and this fuelwood is crucial to many parts of the local economy. In addition, lands acquired for *Jatropha curcas* plantations were later turned into real estates, facilitated by the biofuels' policy mechanisms for easy land acquisition. Both of these findings are embedded in India's earlier approaches to 'wastelands', securing energy access and land regulations. Discussion following these presentations focused on the responsibilities of industry and policy-makers in biofuel projects in Africa and India, and the importance of recognizing the political implications of what may seem a 'neutral' technical analysis of land availability, potential energy yields etc.

Day 2: Scientists and other stakeholders; presentations and constructive debate

Based on issues that came up in various forms during the presentations and discussions from day 1, the following four topics were identified for in-depth discussion:

- Many biofuel projects have problematic social and environmental aspects. Given this observation, there may be cases in which innovations should be stopped. But is this an option? What would be the consequences of including such an option in an innovation process?
- Different biofuels have been shown to have different material problems, which may make it difficult to learn generic lessons from first generation biofuels for the responsible development of second generation biofuels. Yet, we have also seen that institutions (organizations, mechanisms and orientations) are perhaps an even more important issue when studying the sustainability outcomes of biofuels. The key question then is how you get people to collaborate.
- How do you reflect on your own role as a responsible actor in biofuel innovation processes?
- Given the importance of reflection on existing circumstances and history, and given the difficulty for actors such as policy makers and consultants to pay attention to such issues due to time-constraints on their work schedule, how can researchers communicate their wider knowledge with consultants and policy makers?

Plenary session 1: Experiences from stakeholders

Both ENDS, Rathenau Instituut, TU/e innovation lab, Diligent Tanzania

Further input to think about these issues was provided by Nathalie van Haren (Both ENDS, the Netherlands), who showed how large scale promotion of not only *Jatropha curcas*, but also crops like palm oil and soy have led to various social and environmental problems in developing countries. There were material problems, such as the destruction of large tracts of biodiverse ecosystems, but also rather more social problems: increasing inequality due to a strong profit-driven model aimed at the global market, the lack of engaging civil society in policy making and (natural) sciences research agendas, the absence of awareness of stakes and conflicts between land users and the absence of particularly natural scientists outside their labs and models to see contextual realities on the ground.

André Krom (Rathenau Instituut, the Netherlands) presented a recent report titled 'sustainable alleviation of resource hunger', listing various strategies to ensure a sustainable supply of resources which are currently important for the Dutch economy: improve recycling (circular economy) and experiment with new forms of trade such as sustainable economic zones. Specifically, this report aims to make the use of resources in the Netherlands sustainable (in terms of life style and economy), while at the same time making this sustainable (in terms of environment, social values and human rights, and general welfare) for the source countries. This approach was questioned:

can't, and shouldn't we, turn this approach around, start from a societal aim of social and environmental sustainability worldwide, and ask what we need to do to ensure this? Or another question would be: how can we make sure that source countries truly benefit from their resources and open up other possibilities beyond selling these resources to richer countries?

André Krom used the report and his experience in discussing it with a wider audience beyond scientists to continue the discussion on the role of researchers and their relation to other actors in society. He highlighted the importance for researchers to relate to policy makers' language if one wants to draw their attention with one's own research.

Han van Kasteren and Janske van Eijck gave a valuable business-based perspective. Han van Kasteren highlighted that current biofuel policy had resulted in the construction of never-used biorefineries. In accordance with the biorefinery concept, there are more profitable forms of biomass resource use such as cosmetics and plastics. He also highlighted that while local production chains can be controlled, but global chains cannot be controlled, whether one uses certification or not. Janske van Eijck gave a comprehensive overview of the many challenges one faces when trying to run a biodiesel business based on feedstock grown by Tanzanian smallholders on the edges of their lands. One of the specific issues was the large discrepancy between (Western) certification demands and local realities. Those difficulties made that reaching a break-even point took a long time, and this fact combined with the overall bad reputation of biofuels made that investors pulled out of the undertaking. Discussions focused on the consequences of shutting down this organization. In particular, for smallholder farmers, the most important stakeholders perhaps, this was bad news. Yet, the business model, based on small amounts of seeds from hedges, made that the farmers were not badly hit as their main sources of income were not affected. This insight contributed particularly to the discussion about the consequences of stopping an innovation process. A strategy of starting on a small scale was advocated.

Plenary session 2: Selling the idea of biofuels: Discourses and explanations of *Jatropha*

Carol Hunsberger, University of Western Ontario, Canada

and

Biofuels, sustainability and Europe's global responsibility

Joachim Spangenberg, UFZ Helmholtz Centre for Environmental Research, Germany

The last two scientific keynote contributions reflected on the discourses that informed the *Jatropha curcas* hype and which alternative approaches one could take to biofuels. Carol Hunsberger documented the discursive flexibility of *Jatropha curcas* (in particular as being able to fulfill many different goals at the same time), and how this diminished as *Jatropha curcas* turned out not to be able to deliver most of those goals. Joachim Spangenberg's approach to biofuels was based on a rethinking of the concept of responsibility and progress from a macro-economic perspective, arguing that responsibility should hold across the world and that progress is not economic growth but rather the quality of life and equality of distribution, while keeping within the limits of what the earth can provide. These limits for biofuels in particular are very strict: Spangenberg calculated that biofuels can only ever substitute a small amount of the fossil fuels we currently use because of the limits on the amount of available biomass across the globe. Furthermore, evaluating the material

characteristics of growing biofuels based on these two premises led him to conclude that in particular large scale biofuel plantations led to significant social and environmental damage, and that biofuel production in the future has to be lean, labor-intensive, efficient and decentralized. The sustainability criteria used for such approaches should be based on a long-term (dozens of years) view.

Break-out group discussions: some reflections

The presentations of the day were interspersed with discussion sessions, during which the attendees (both scientists and societal stakeholders) had been split into four groups to debate the four issues highlighted at the beginning of the day. At the end of the day, these groups reported back on their discussions.

One's own responsibility in processes of biofuel innovation

It was highlighted that the main locus of responsibility lies in how one engages with potentials and failures and particularly in relation to the emotional and monetary investments made. This is difficult: researchers' sponsors may not always want to hear the statements researchers consider to be most important, something which may also hamper the acquisition of funding in the first place.

Discontinuing irresponsible innovations

It was highlighted that including an option to stop the innovation process explicitly may make obtaining funds difficult. This was therefore presented as an issue for further deliberation. An important contribution for scientists to make the idea of discontinuing more acceptable would be to publish negative outcomes, if one finds them. Always focusing on trying to identify "best practice" cases was seen as creating an atmosphere that makes acknowledging failure or irresponsibility difficult.

Social and material barriers to biofuel innovation

It was highlighted that solutions to 'unsustainable biofuels' like certification were not adequate since the cause of such problems lie largely in the way the market is set up. Moreover, the group discussing this issue found that there was no unanimous stance regarding the overall role of social structures and material biofuel characteristics in failure of responsible biofuel innovation.

Communication with policy-makers and consultants

It was observed that the first step is to start taking the perspective and interests of the policy-makers and consultants. What are they trying to achieve and how? In their work, they may in fact use science for their purposes. Some participants argued that researchers have to base their communication on that, otherwise they may try to challenge a policy maker's or consultant's frame of reference but there will not be any engagement. This point got debated quite heavily: many other participants felt that there are situations in which researchers should not work within a policy-maker's frame of reference but rather challenge that frame. In addition, informal ways of interaction may often be much more effective in getting one's message across than organizing a formal exchange. This directly reflected on this very conference as part of an NWO-MVI research project. More attention to both the diverging interests of researchers and their valorization partners in the project as well as more creative ways of interaction would be worthwhile developing.

Conclusions

In response to the questions raised at the beginning of the conference with respect to biofuels' material characteristics, responsibility and sustainability, a host of issues were raised. First of all, it became clear that biofuels' material characteristics relate in a complex way to the institutional side of biofuel production. On the one hand, all case studies presented, regardless of the type/generation of biofuels, showed that institutional factors such as policy, certification, the types of companies involved, etc., played an important role in the distribution of the positive and negative effects of biofuel production among people. On the other hand, material characteristics could not be neglected altogether either: there are severe limits to the amount of biomass the earth can produce and therefore to the amount of biofuels we can make. Furthermore, there are many material characteristics to biofuel production that do not commonly figure in mainstream scientific research, such as comparing the energetic value of biofuel crops to those of traditional firewood, the tradeoff of diverting oils commonly used for soap to produce biofuels and the difficulty of obtaining inputs such as water and nutrients (sustainably) in order to produce biofuels in an economically profitable way. The embedding of particular crops and their material characteristics also plays an important role in answering the question raised at the beginning of the conference, namely: '*can* biofuels be produced sustainably?' Indeed, there are no examples, as of yet, in which sustainable production of new kinds of biofuels was possible for an extended period of time. While small-scale projects with very specific usages may be feasible and sustainable, the experience so far provides no legitimacy for ambitious policy-targets.

With respect to responsibility, the number of questions increased during the conference rather than decreased. The repeated observation that responsible research is not always research that will be funded expanded the notion of responsibility beyond that of researchers and innovators to include all stakeholders in any given (proposed) project. At the same time it raises the question: to what extent should research and innovation be responsible? Would any of it still take place if various kinds of suggested criteria would really need to be met? How to find a balance between (trying to) meet responsibility criteria, discontinue innovation processes that are far off from those criteria or discontinue all innovation processes that do not completely meet all those criteria in their entirety?

Lastly, with respect to sustainability, the conference brought forward that the case of biofuels has shown the primary importance of including a wide variety of conceptions of both human and environmental well-being in good analysis. At the height of the biofuels 'hype cycle', human well-being often got equated with having a minimum income and environmental well-being got reduced to 'using biofuels to avoid CO₂ emissions'. Yet, a range of other issues matter as well, such as sustained access to various kinds of land, environmental problems like shortages of water and (artificial) fertilizer, the limits to biomass production, stability of income, etc.

About the Eindhoven Centre for Innovation Studies (ECIS) at TU/e

ECIS (Eindhoven Centre for Innovation Studies) is a research centre based at the School of Innovation Sciences at Eindhoven University of Technology, the Netherlands. Innovation is one of the fundamental factors affecting the economic performance of firms, regions and countries, and social welfare and the quality of life at large. The research mission of ECIS is to enhance our understanding of the sources, nature and effects of innovation processes. Our research aims to provide useful insights for an effective governance/management of innovation processes at regional, national and international levels. This research is structured by the following five major research programs:

- Modern Societies in Transition
- Philosophy of Technology: Ethics and Epistemology of Innovation
- Psychology of Human-Technology Interaction
- System Innovations & Sustainability Transitions
- Technology Flows, Knowledge Economy & Economic Performance



About the 'Responsible Innovation' research programme (MVI) of the Netherlands Organisation for Scientific Research (NWO)

The Responsible Innovation programme funds and encourages research in which the ethical and social aspects of new technology are considered right from the design phase. This prevents expensive adjustments having to be made in retrospect or society rejecting the new technology. What are the legislative and ethical consequences of using video equipment in the operating theatre? What went wrong with the electronic patient record and what is needed to gain support? Does the number of hooligans in nightlife areas decrease with increased and more advanced camera supervision or are there other effects? The Responsible Innovation programme funds and encourages research into such questions.

The Responsible Innovation programme's approach has five pillars:

- Interdisciplinary: researchers from all relevant scientific disciplines collaborate closely to come up with socially responsible innovation pathways.
- Valorisation: stakeholders are closely involved with the research via a valorisation panel so that the results can be implemented directly.
- Proactive: ethical and social aspects are involved right from the start and incorporated into the design process.
- Social relevance: a civil society panel representing the business community and NGOs evaluates the research proposals for their social relevance.
- International orientation: explicit attention is paid to the global nature of the research questions, including their relevance to developing countries.



List of participants

Name	Affiliation
Auke Pols	TU/e
Evelien de Hoop	TU/e
Henny Romijn	TU/e
Jennifer Baka	LSE
Atakilte Beyene	Nordic Africa Institute
Carol Hunsberger	U of Western Ontario
Lena Partzsch	ALU Freiburg
Joachim Spangenberg	UFZ Helmholtz Centre
Nathalie van Haren	Both ENDS
Le Quyen Luu	Vietnam Academy of S&T
David Harnesk	Lund UC for Sust. studies
Andreas Spahn	TU/e
Sikko Visscher	KNAW
Tjidde Tempels	WUR
Henk van den Belt	WUR
Duygu Kasdogan	York U, Toronto, Canada
Andre Krom	Rathenau
Lotte Asveld	TU Delft
Ibo van de Poel	TU Delft
Marie-Hélène Dabat	CIRAD Montpellier
C. Gatete Djerma	U.Paris XI and 2iE, Ouagadougou
Flávia Gouveia	DPCT, Unicamp, Brazil & EHESS, Paris
Victoria Marin-Burgos	GTS, U Twente
Joy S. Clancy	GTS, U Twente
Ravi Srinivas	RIS (policy think tank), New Delhi
Richard Helliwell	ISS, Nottingham
Julia Tomei	UCL-Energy, London
Arnoud van Waes	Rathenau
Sara Brogaard	Lund UC for Sust. studies
Bas van den Herik	TU Delft
Mar Palmeros Parada	TU Delft
Janske van Eijck	Independent bioenergy consultant, secretary of the Bioenergy Forum FACT
Johanna Höffken	TU/e
Mara van Welie	TU/e
Heleen de Coninck	RU Nijmegen
Bart Frederiks	Independent bioenergy consultant
Loes van Rooijen	Leiden University
Joana Almeida	KU Leuven
Bie Gielen	KU Leuven
Koenraad van Meerbeek	KU Leuven
Han van Kasteren	TU/e Innovation Lab

Sanne Heijnen	ETC
Jorge Andres Moncada	TU Delft
Dušan Drabik	Wageningen University
Ivan Nygaard	DTU Denmark