Stakeholder dialogue
on the implications for transition pathways

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Abstract	This report describes the multi-stakeholder dialogue sessions and specifically involves the perspective of non-governmental organizations on the transition to sustainable fuels and chemicals.

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Consortium Information

Coordinator:

1. UNIVERSITEIT UTRECHT (UU)

Beneficiaries:

2. COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (CEA)
3. EUROPEAN RESEARCH INSTITUTE OF CATALYSIS A.I.S.B.L. (ERIC)
4. UNIVERSITEIT GENT (GU)
5. UNIVERSITEIT LEIDEN (LU)
6. UNIWERSYTET WARSZAWSKI (UW)
7. FUNDACIO PRIVADA INSTITUT CATALA D'INVESTIGACIO QUIMICA (ICIQ)
8. SIEMENS ENERGY GLOBAL GMBH & CO. KG (SE)
9. DECHEMA GESELLSCHAFT FUR CHEMISCHETECHNIK UND BIOTECHNOLOGIE (DECH)
10. FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV (Fraunhofer)
11. CARBYON BV (CAR)
12. TURUN YLIOPISTO (UTU)
13. USTAV FYZIKALNI CHEMIE J. HEYROVSKEHO AV CR, v. v. i. (HIPC)
14. UPPSALA UNIVERSITET (UppU)
15. COVESTRO DEUTSCHLAND AG (COV)
16. CO2 VALUE EUROPE AISBL (CVE)
17. FUNDACION IMDEA ENERGIA (IME)
18. ALMA DIGIT SRL (AD)
19. INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM (IMEC)
20. AVANTIUM CHEMICALS BV (AVT)
21. NEXTCHEM S.p.A (NEXT)
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31. TOTALENERGIES ONE TECH BELGIUM (TEOTB) -- **Associated Partner**

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Executive summary

This report aims to capture the discussions between the quadruple helix stakeholders (i.e. government, industry, research and civil society (organizations)) on the important cross-cutting socio-technical challenges related to the SUNER-C technology choices (identified in Deliverable 6.1) regarding sustainable fuels and chemicals, which include synthetic and solar fuels and chemicals, amongst others. The term "cross-cutting socio-technical challenges" refers to a whole set of social, economic, organizational, environmental and other disciplinary factors that influence the development and deployment of technologies. The report describes the following SUNER-C multistakeholder events organized under WP6.2:

- The SUNER-C stakeholder dialogue workshop in Brussels, 2023;
- The SUNER-C Dialogue Workshop on Cross-Cutting Issues' in Utrecht, 2024;
- A dialogue with an energy cooperative at the SUNER-C event in Ghent, 2024, co-organized with other WPs;
- Intended, but so far not done due to delays in WP3: Application of the Conversation Tool (from D6.1) to the different working groups of WP3: the Roadmap.

During these events, we aimed to place centre stage the prospective actors, like (trade) unions, youth climate groups, NGOs, and energy cooperatives that are currently underrepresented in industry and research-led discussions about the architecture of our future energy system. As summarized in the table below, we (i.e. all the quadruple helix actors) discussed the following themes:

- The impacts of the transition towards sustainable fuels and chemicals, in terms of social, environmental, economic, infrastructural and landscape impacts;
- The allocation of limited resources (to different production processes) as well as the limited sustainable fuel and chemical (intermediary) products (to use in different sectors and applications);
- The roadmaps and visions created on what technologies and applications should generate what levels of outputs, when, in what types of energy systems;
- The governance arrangements that underlie these visions and roadmaps and their pursuit.

As the table shows, numerous topics underlie these themes, which illustrates the complexity of the decisions to be made in the transition to sustainable fuels and chemicals, and the profound and different impacts these decisions will have on our society. When developing a Large-Scale Research Initiative, such topics and questions need to be dealt with to ensure SUNER-C's impact towards a societally desirable outcome of the ongoing transition process.

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Table: Overview of topics raised in the multi-stakeholder dialogues of WP6.2

Theme:	**Underlying topics:**
Transition impacts: - Social - Environmental - Economic - Infrastructural - Landscape	- Renewable and sustainable CO2 source and the preconditions for sustainable CCU(S) - Assessing rebound effects of sustainable fuels and the role of behavioural change in reducing sustainable fuel demand (e.g. more flying on solar fuels vs. flying less first and what demand remains is met by solar fuels[1]) - Assessing global social, economic, environmental, infrastructural and landscape impacts (of imports/*neo-colonialism)* on people and regions affected by the transition and ensuring *just transitions* – meeting all SDGs - Balancing different societal needs: energy security / strategic autonomy, sustainability, affordability - New business models may be necessary like prosumer models of energy cooperatives in which local citizens benefit - Energy communities enable feelings of co-ownership and community in the energy transition - Technology performance indicators may differ per continent (efficiency, EROI in EU; ease of manufacturing; affordance of materials in developing countries)
Allocation of limited resources and (fuel and chemical) outputs	- *Trade-offs* in allocation of scare resource (H2, CO2, lipids, rare materials etc. and even fresh water): under what conditions is allocation acceptable? - Resource and energy *efficiencies* vs. 'difficult to abate' applications (e.g. waste lipids for bio-diesel or kerosine) - Prioritization of sustainable fuel use sectors and applications - Prioritization of applications beyond fuels and chemicals (food over fuel) and the associated public support/legitimacy
Roadmaps & Visions	- Technology selection and competition for the next dominant design - How is the selection of technology designs progressing at EU level? Is convergence taking place? - How to select amongst the plurality of sustainable fuels in different TRL? How many dominant designs to select for what consumer markets? (e.g. electrification for passenger transport, H2 for long distance trucks, solar kerosine for aviation?)

[1] See CLEVER (2023) roadmap: "Climate neutrality, Energy security and Sustainability: A pathway to bridge the gap through Sufficiency, Efficiency and Renewables

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	- The preference for centralized vs. decentralized (and more democratic, locally-owned and just) energy systems[2] - How to deal with claims of continued growing demands vs. demand reduction measures in line with planetary boundaries? - Size (order of magnitude) of sustainable fuel & chemical markets - The rate of transition: when to achieve what targets? - How to deal with different energy storage solutions and their systemic integration? - What is the role of intermediate transition technologies (like hybrids and blue hydrogen)? - Be mindful of the danger of hypes (and the associated decline/through of disappointment) - Are visions and roadmaps consistent across technology fields (/working groups)?
Transition Governance	- How to involve different stakeholders when making decisions on 'roadmap & vision' topics? - Aligning technology development with what is societally accepted and brining this largely industrial transition into a quadruple helix debate that involves the broader public (instead of only asking people to generate societal acceptance for the visions of technical scientists) - What is the role of energy communities & cooperatives; how can they involve citizens in a just and sustainable energy transition, and how can they recombine renewable energy technologies to match local energy supply and demand? - How to deal with different technology pathway perception, within and outside of SUNER-C? (e.g. within technology fields) - How to align visions and policies at different levels of governance (local, national, EU, global)? - The role (dirigiste vs hands-off), level and preconditions for public policy, investment and regulation - How to organize defossilized circular value chains and valorise fossil waste without sustaining long-term lock-ins of fossil fuel technologies? - How to deal with information asymmetries: industry monopolizes data and expertise and can claim authority more easily than NGOs, while today's industry's interests typically don't align with those of a sustainable society) - How to enable (e.g. infrastructural and value chain) network externalities?

[2] Current preference seems to be for centralized; but it also depends on the technology field

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	- How to move beyond TRL, to e.g. manufacturing (or society-readiness) levels? - Opening industrial facilities to the public may increase local public acceptance (e.g. DAWN tower) - Who will have the power in the envisioned solar-fuel-based energy systems? - Overcoming chicken-and-egg problems: technology investors wait for guaranteed off-take and energy & resource supply (e.g. large scale electrolysers) - How to anticipate the global and EU direction and rate of the sustainable fuel transition? - What is the role of SUNER-C in this transition and in the selection of technology alternatives? (move beyond informing towards proactive lobbying?)

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Table of Contents

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List of abbreviations

List of abbreviations	
CSA	Coordination and Support Actions
CSO	Civil Society Organization
C&D	Communication and Dissemination
D	Deliverable
H2020	Horizon 2020
IAB	International Advisory Board
IEA	International Energy Agency
KPIs	Key Performance Indicators
LSRI	Large-Scale Research and Innovation Initiative
MI	Mission Innovation
NGOs	Non-profit Organisations
RTOs	Research and Technology Organisations
R&D	Research and Development
R&I	Research and Innovation
SMEs	Small and Medium-Sized Enterprises
SRIA	Strategic Research and Innovation Agenda
USP	Unique Selling Point
WP	Work Package

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1 Introduction

1.1 SUNER-C

The overarching objective of the SUNER-C project is to create an inclusive innovation community and eco-system that builds on the current SUNERGY network and includes new stakeholders across Europe. Bringing together fundamental and applied knowledge from various sectors of society as well as often unique resources, the enhanced community will prepare a Large-Scale Research and Innovation initiative (LSRI) beyond the CSA, as a partnership or another instrument to be discussed and agreed upon with the Commission and the Member States and Associated Countries. The goal is to overcome scientific, technological, organizational, environmental and socio-economic challenges, accelerate innovation in sustainable fuels and chemicals, and enable the transition of existing and future technologies from laboratory and demonstrator levels to large-scale industrial and broad societal applications.

Through a holistic approach, SUNER-C will contribute to a circular economy by replacing fossil-derived fuels and chemicals with renewables and carbon recycling as a key element toward the EU net-zero emissions target by 2050. SUNER-C will build upon the work of SUNERGY, a pan-European initiative on fossil-free fuels and chemicals from renewable power and solar energy, with currently over 300 supporting organizations across and beyond Europe to date.

Figure 1 is an overview of the work package structure of SUNER-C with its eight WPs. The deliverable D6.1 “Identification of important socio-technical cross-cutting challenges and relevant stakeholders” is a deliverable of WP6 “Socio-technical and cross-cutting aspects”.

Please see here https://sunergy-initiative.eu/suner-c-project/ for more information.

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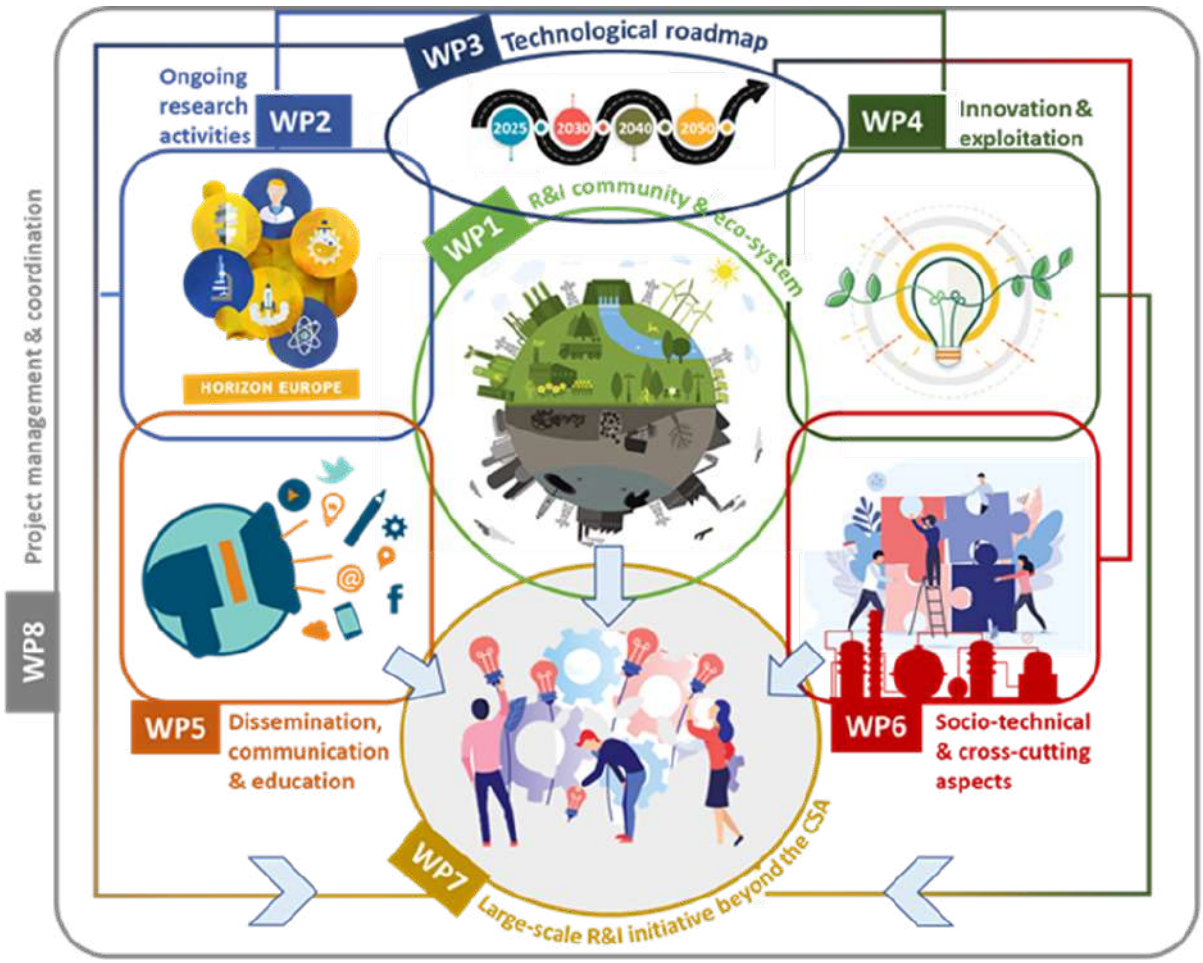

Figure 1: SUNER-C CSA project and its eight work packages.

1.2 The objective and approach of this deliverable

Task 6.2 of the SUNER-C project aims to discuss, in a multi-stakeholder setting, the important cross-cutting socio-technical challenges related to the SUNER-C technology choices (identified in Deliverable 6.1) regarding sustainable fuels and chemicals. The term "cross-cutting socio-technical challenges" refers to a whole set of social, environmental, economic, infrastructural, landscape and governance challenges that influence the development and deployment of multiple technologies. Examples include social challenges (e.g. distribution of costs and benefits across social groups), environmental challenges (e.g. effects on resource use and emissions), legal challenges (e.g. translation of policy into law and regulations), governance challenges (e.g. who decides and who is left out?) or ethical challenges (e.g. the acceptability of risks).

To arrive at the most desirable energy system design and to enable successful societal implementation, it is key that these challenges are discussed in a multistakeholder setting that involves the quadruple helix model of innovation. That means that all actors impacting the innovation and societal transition towards sustainable fuels and chemicals are involved in the discussion. Research organizations shape the direction of innovation trajectories by doing basic and applied research into the possibilities and development of (technological and other) innovations. Industry invests in the development and deployment of these innovations.

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Government influences the rate and direction of transition (and as such which innovations are favoured over others, based on their societal impacts) via public policy, investments and regulation. And finally, overlooked in more classical models of innovation (e.g. linear model; triple helix model), civil society. Civil society includes the actors that safeguard societal interests and includes 'the broader public', and specifically societal interest groups like labour and youth representatives, and climate- and other types of non-governmental organizations (NGOs).

Without the inclusion of the typically underrepresented civil society organizations (CSOs), innovation and transition risks being pushed too strongly by research and industry, resulting in technology solutions that reflect the interests of academics (typically curiosity driven, related to scientific novelty and funding) and industry (profit-based) but that do not align with the broader needs of society regarding a just, sustainable energy transition. Therefore, in Task 6.2, we aim to place CSOs centre stage in the discussions on cross-cutting socio-technical issues, hoping to learn from and incorporate their perspectives on the transition to sustainable fuels and chemicals, in SUNER-C's ongoing work (cq. the description of the co-productionist model (Jasanoff, 2015) in Box 1). Furthermore, we explore the differences in perception of the cross-cutting issues across the different technological fields include in SUNER-C's scope (i.e. across the different technology working groups defined under WP3: Roadmap).

Box 1: the co-productionist model of technology development

The concept of co-production is central to this report (Jasanoff, 2015). According to the co-productionist model, the trade-offs between these societal implications that are manifested in technology decisions, should not be made by technology-developing research and industry alone, but should be made in open dialogue and with input from policy-makers, societal stakeholders like unions and NGOs, and a broad pallet of knowledge. Recognising this dynamic of co-production becomes all the more important in turbulent times. The sustainability ambitions that the European society has set for itself by 2050 are enormous and will lead to deep societal changes. These ambitions constantly interact with ongoing, and as of yet unclear, geopolitical changes in relations with the rest of the world. Under these circumstances, the model that claims that innovations start in the 'neutral' environment of the lab (which never was neutral, anyway) and then spread out through markets, is outmoded.

Instead, thinking from a co-productionist model teaches that technology development – and thinking about future visions and roadmaps for technologies – has to try to take the shifting societal context in account, try to be aware of societal needs and look at conflicts and controversies surrounding technologies, recognise the roles of different societal actors and their concerns surrounding technology development (such as who wins and who loses, who is responsible, who has a voice). In this model, societal actors are not passive; even if they do not 'make' technologies, they are actively involved in shaping the context and thinking about desirable futures; they voice concerns; they have their own interests; they may have different ideas and experiences about what works; they have their own knowledge and expertise about what is relevant.

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2 Approach

The multistakeholder dialogues organized under Task 6.2 include the following:

- The 'SUNER-C stakeholder dialogue workshop' organized in Brussels, in October 2023. During the biannual SUNER-C consortium meeting in Brussels, we invited to the stage three NGOs [3] (Bellona Europe, Bond Beter Leefmilieu, and Transport & Environment) to be interviewed by the triple helix (incl. a research, industry and EU policy representative). These triple helix representatives then made a statement based on their interviews. Finally there was room for discussion, questions from the audience and a reflection by the Deputy Head of Unit Fair Green and Digital Transition, DG EMPL.
- The 'SUNER-C Dialogue Workshop on Cross-Cutting Issues' organized in Utrecht, in March 2024. During this multistakeholder session we invited to the stage the representatives from the different SUNER-C technology Working Groups (as defined by WP3: Roadmap). We interviewed them on the cross-cutting societal issues to explore the differences in perception on these issues, and whether alignment between the technological fields needs to be made.
- The Suner-C workshop of July 2024 was dedicated to stakeholder pitches where different companies and organisations could give a 10 minute pitch on a project related to e-fuels. The day was closed with an interview with Sophie Loots, founder and project manager at a Belgian energy community ZuidtrAnt.
- Application of Conversation Tool in the context of the Roadmap's technology working groups. The goal is for the social scientists and NGO employees from WP6 to engage in conversation with the technical experts from the working groups, about the societal implications that could be expected from developing focal technologies according to certain designs. These discussions, structured by the Conversation Tool in Deliverable 6.1, would allow us to identify large undesirable societal impacts, profound barriers to implementation, and tensions between technologies' overarching socio-technical systems. However, as discussion in the final section, this series of events has so far not taken place yet.

In the next sections we provide the reports from these SUNER-C dialogue events.

[3] Unfortunately, industrial global labor union IndustryAll could not be present.

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3 Report Stakeholder Dialogue Workshop

Brussels, 11 October 2023

Introduction

Context of the Stakeholder Dialogue Workshop

This document summarises the exchanges at the SUNER-C Stakeholder Dialogue Workshop, chaired by the project partners leading the SUNER-C Work Package 6 - Socio-technical and cross-cutting aspects. The event has been organised as part of Task 6.2 - Stakeholder dialogue on implications for transition pathways (lead: UU, participants: GU, LU, Fraunhofer, CVE, EERA, BBL; with input from all partners).

Objective of the activity

In view of setting up a dialogue process with stakeholders about the implications of cross-cutting issues for different transition pathways in the development of carbon-neutral fuels and chemicals, a conversation took place between prominent SUNER-C representatives of research, industry and policy on the one side, and NGOs on the other side. It allowed becoming more aware of the needs and concerns of these stakeholders in an early stage of technology development, so their interests may be reflected in transition pathways to be taken. The results will feed back into WP1 and WP3.

Agenda

- Representatives of research, industry and policy interview societal stakeholders
- Questions from the audience
- Representatives of research, industry and policy give a statement on how to include the issues raised by societal stakeholders in ongoing SUNER-C activities
- Societal stakeholders respond to the statements
- Questions from the audience
- Session wrap-up

Speakers

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- Facilitator: Joeri Wesseling (Assistant Professor at Utrecht University)
- Industry representative: Tudy Bernier (Senior Policy Manager at CVE)
- Research representative: Ann Magnuson (Associate Professor at Uppsala University)
- Policy representative: Carina Faber (Programme Manager EIC)
- NGO representative: Laura Buffet (Energy Director at Transport & Environment)
- NGO representative: Benjamin Clarysse (Policy & Project Coordinator at Bond Beter Leefmilieu)
- NGO representative: Ana Serdoner (Senior Policy Manager at Bellona Europe)
- Concluding remarks WP6-lead: Kasper Ampe (Postdoctoral Researcher at Ghent University)
- Reflection: Fabio Domanico (Deputy Head of Unit Fair Green and Digital Transition, Research Unit at European Commission, DG EMPL)

Introduction by the facilitator

Welcome to this SUNER-C stakeholder dialogue workshop, where we hear more about the societal concerns of transitioning to sustainable fuels and chemicals. There are different ways to making our energy and industrial systems more sustainable. One such sustainability pathway, sometimes contested due to its energy-inefficiency and near net zero-emissions but seen as a necessary solution to decarbonize difficult to abate sectors, is sustainable fuels and chemicals. But sustainable fuels and chemicals is quite a broad field, as there are different trajectories to producing sustainable fuels and chemicals. Each trajectory and specific set of technologies has its own environmental, economic, and societal impacts. Today we want to hear more about these societal issues.

That is why we bring to the stage non-governmental organizations (NGOs). Although other actors (like politicians and social scientists) also focus on societal issues, NGOs explicitly aim to represent societal interests and concerns. Unfortunately, industrial global union IndustryAll, the only union active on this topic, could not be here today and we couldn't find youth climate representatives with expertise on this topic that are based nearby Brussels. We hope that the societal issues NGOs raise, may help shape the visions and roadmaps we, our consortium of largely industrial players and researcher organizations, create for our future energy and chemical production systems.

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Industry and research organizations are known for their knowledge, particularly technical knowledge, but have different stakes in large scale transitions. It is therefore paramount that in shaping the plans for a future society, that the interests of societal stakeholders are reflected in these plans. This can only be done by including societal stakeholders in the process of vision creation.

This is why today we will listen to three prominent NGOs, two that operate at the EU level, and one located in Brussels that operates at the national level. We have

- Ana Serdoner, Senior policy manager at Bellona Europe, where she focuses on the EU energy, climate and industry policy, with a particular focus on steel, chemicals and cement. Before that she did a traineeship at the European Parliament, so she is quite the expert on the EU situation.
- Laura Buffet, Energy Director at Transport & Environment, where she is directs the energy campaigns of T&E and focuses on making European fuels policy more sustainable, moving away from oil towards better advanced alternatives, and phasing out the support to land-based biofuels. Like Ana, Laura also worked at the European Parliament before T&E.
- Benjamin Clarysse, policy and project coordinator at BBL (Bond Beter Leefmilieu Vlaanderen), a Belgian NGO, where he coordinates the advice to policy makers and the multi-stakeholder projects on transition themes, including energy, circular economy and mobility, and living environment, on which sustainable fuels and chemicals all have a major impact.

Following this introduction, they will be interviewed in an interactive manner, by

- Ann Magnuson, from Uppsala University in Sweden, who represents the research side of the SUNER-C consortium on stage today. Ann works as Associate Professor at the Department of Chemistry, focusing on natural and artificial photosynthesis, but also on renewable energy policy making and science outreach.
- Tudy Bernier, senior policy manager at CO2ValueEurope, where he leads the work on advocacy and public affairs on EU policies on energy and climate. He analyses EU policies, drafts strategies and position papers and represents the CCU value chain in regular meetings with policy makers and EU stakeholders.
- Carina Faber, Program Manager for renewable energy conversion and alternative resource exploitation at the European Innovation Council (and SMEs Executive Agency). She was involved in SUNERGY and actually has experience at ENGIE and did a PhD and 2 postdocs so can be considered as representing all three actor types.

After about an hour of interview, we open the session up to questions from the audience, before we take a coffee break. During the coffee break, the interviewers will retreat to each write the basis for an oral statement in which they reflect on what they've heard and how they can

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include the issues raised in their ongoing and future SUNER-C activities. The NGOs will then have a chance to comment on these statements, before we again open up this dialogue session to the audience.

So, the goal this morning is to hear more about the societal issues involved in in transitioning to sustainable fuels and chemicals, and reflect on how these issues are included in ongoing SUNER-C activities and hopefully find ways of connecting even more closely to these societal issues, raised by NGOs. You will get an anonymized report of this sessions, to hopefully help you incorporate some of today's thoughts into your own work (packages).

Interviewing societal stakeholders

Question (Q): The goal of this project is the **creation of an innovation community** for sustainable fuels and chemicals. What are your views on that?

Answer (A): Our goal as an NGO is to create a sustainable policy context for e-fuels, with climate benefits and social benefits. The policy context of biofuels counts as a bad example in that regard. In terms of hydrogen as a sustainable fuel, we point out that green hydrogen is not available in large quantities. Therefore it needs to be used cautiously, where it is the most efficient and where battery/electrification poses no alternative, e.g. in aviation and shipping.

Q: How do you look at the issue, what are the **key elements** to be taken into account?

A: E-fuels and hydrogen are scarce, so it needs to be used where it is the best alternative for fossil fuels, while also taking into account societal aspects, e.g. the job implications, the impact on climate mitigation,... We do believe there are priority industries for getting access to synthetic fuels. We don't believe it should be used for heating buildings and driving trucks. *Defining which sectors need access to e-fuels should be part of a wider debate to avoid the wrong allocation of investments.* However, *that debate is currently not taking place, neither are societal considerations being taken into account*.

Q: Do you have **methodologies** for screening the use of e-fuels on their societal impact?

A: We work with a team of analysts and models and rely on EU research and research reports from the International Council for Clean Transportation. In addition to that our organisation also commissions studies. We are not a research institution, but try to combine different visions, draw conclusions and point out societal aspects and the best way forward for our society.

Q: How do you see your **role** in this debate?

A: Our role is to bring the voice of people who aren't heard, bring the different perspectives in the public debate and inform the industries about how we see the way forward to climate

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neutrality.

Q: What's your opinion on the need for **renewable energy storage**?

A: Storage and flexibility in the energy sector is a crucial factor together with energy efficiency measures where there is still a lot of margin. The public debate now focuses too much on hydrogen, while it risks cannibalising renewable energy production. Storage has an economic opportunity which should be encouraged by the government. Electric car batteries and even buildings can serve as storage solutions, but this needs to be flanked by a performant policy context and technological innovation.

Q: What are your views on **carbon capture and utilisation (CCU)**?

A: It is a viable option in certain sectors, but in terms of carbon sources for e-fuels it is blurrier. Direct Air Capture (DAC) could be a good alternative but it is not available yet. We need to better understand its impact and policy makers have to come up with the right framework conditions, also to avoid lock-in effects. Without such policy intervention, business will continue with business as usual.

Q: E-kerosene would reduce the carbon footprint of planes, while also enabling the public to fly guilt free and undermine **behavioural change**. What's your position on this?

A: We need to be aware of the rebound effect of technological innovations. We will not achieve our climate targets without behavioural change. We therefore target corporate travel and run campaigns to limit the growth of air travel. There is a need for a flight movements cap to curve the current trend. You also have the noise pollution impact of aviation, and also the impact on material use. That also goes for electric cars. We need to discuss the need for societal changes, how do we change our society to reduce the amount of energy and materials we require to function. Do we all need our own car? Do we need such large and heavy cars? The company car subsidy system plays an important role in this. We need to move to improved material and energy efficiency. In order to realise behavioural change the climate and energy transition needs to be a social and just transition, we still have a long way to go. Flanders recently decided to subsidise electric vehicles, while such a system mainly supports those who already can afford it. Subsidising care sharing systems and public transport would be much more beneficial and social. Governments have to focus on social aspects, and help people to overcome financial barriers. If not, you will see more and more resistance against any green investment and climate policy as you already see towards infrastructural projects like Ventilus, and this creates bottlenecks on the long term.

Q: What is your perspective on **defossilisation**?

A: Circular economy is a crucial factor, but changing the value chain is a difficult task and we

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have to engage in that effort, businesses have to valorise their waste streams *[i.e. value recovery or waste reclamation]* while avoiding lock-ins *[e.g. becoming locked into buyer-supplier relations or technology investments on certain valorised fossil fuel waste streams which hampers moving away from fossil fuels entirely]*. Companies can already take into account their scope 3 emissions[4] and the government has to provide flanking [supportive] incentives.

Q: How do you take up your **responsibility as an NGO** in the debate?

A: As NGO we are engaged in the industrial debate, make active use of our seat in policy advisory boards and try to get our insights across the table, convince both industry and government, and feed the discussions with our societal concerns. That also includes stressing the importance to engage in conversations with the people and countries (potentially) impacted by the transition. If we omit that aspect, it will jeopardise the energy transition, while it should be a lever for prosperity.

Q: How do we get to **social acceptance**?

A: Public authorities but also industries have to engage in the public debate. This [stakeholder dialogue] event is a good step, but we need a debate involving the broader public. At the same time we need to show to the public that climate investments are beneficial, cf. energy cooperatives, and can be just. However, the latter requires just policies. We have to give guidance, take positions, push for that at policy level and in the public debate, engage with the industries, the trade unions, the policy makers, and with the general public; we need to make alliances.

Q: What is your perception of **transition technologies** (technologies that help us transition from the technologies of today, to the more radically new and sustainable technologies of the future)? For example, do you consider blue hydrogen a transition technology to green hydrogen?

A: Transition technologies may play a role. But we do not believe that that blue hydrogen functions as a transition technology, as it reinforces the lock-in on existing fossil fuel systems to such an extent that it does not compensate for the boost it gives to the implementation of hydrogen demand-side infrastructures. Furthermore, blue hydrogen was not used in combination with CCS, despite promises and subsidies, and its low-carbon status is questionable due to fugitive methane.

[4] 'Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organization indirectly affects in its value chain. An organization's value chain consists of both its upstream and downstream activities.' EPA, 2024, link

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Statements from the interviewers

- How can sustainable fuels be relevant in our society? The world needs to use more renewable energy. When doing that, we need to have sustainable, safe, endurable storage of renewable energy. But when looking at the bigger picture, we also need to think about the efficiency of storing energy. Energy is more efficiently stored in fuels than in batteries. We need to look at the efficiency and sustainability of the whole system. In Suner-C we often have this bigger picture in mind. We consider renewable sustainable fuels as a big solution for a big problem. After today's discussion I understand NGOs consider sustainable fuels, e-fuels, solar fuels rather as a niche product, or only for particular sectors. That brings me to the struggle for alternatives. Does this mean that the Suner-C project doesn't have much relevance for society, or that we need to work harder to demonstrate our relevance to society? I hope we can discuss that.

- There exists an agreement that e-fuels have a role to play in some sectors. It is also clear that we need to involve more citizens, civil society on the consequences of the climate transition, and reflect on the right way forward. We also understand the caution around the hype of e-fuels. On the other side, we need to provide more visibility and certainty for those sectors who should use e-fuels, and address the need to switch DAC. You see now CCU projects, we need to continue to discuss and exchange with research and NGOs how to address that. There's no silver bullet. We need a combination of solutions and looking at those should not cause stagnation.

- There is a broad range of pathways. The role of e-fuels needs to be defined. Now it is crucial to have transparent methodologies to measure technological, social and environmental impact. Engaging the broader public is also important, the Ventilus example shows that. The social readiness level is also an important factor for success.

Q&A-session

Q: Do you believe that Artificial Intelligence could be of assistance to develop impact methodologies?

A: That would be of great help.

Q: What kind of matrix could assist to determine the order of magnitude e-fuels that would be useful for our society and economy in view of the social cost of carbon?

A: We are in the process of developing such a matrix and methodology and would like to discuss this with NGOs and the e-fuels community.

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A: We are currently performing an exercise and look at what will be needed in terms of renewable energy and CO2-sources and the conclusions will be shared in a few weeks' time.

A: It is worthwhile quantifying the impact of policy decisions and technological options, but not everything is quantifiable. Social implications need to be assessed in dialogue with a wide range of stakeholders.

Q: What are the requirements to prepare a dialogue with stakeholders for defining societal impacts, what would NGOs be looking for?

A: NGOs need facts, it is important to have all implications mapped out, but that alone will not suffice. Science alone will not bring the solution, it needs to be complemented with dialogue.

Q: How are normative decisions being made?

A: By involving all stakeholders, which is not yet the case for this issue. The environmental movement is involved as well as some trade unions, however many remain reluctant, e.g. family representative organisations, health organisations, the North-South movement,...

A: It is also important to involve local communities and show the benefits of the transition.

A: SDGs contain quantifiable targets which can be used in existing impact evaluation frameworks

A: it starts to be more discussed at the policy level, e.g. the CCUS forum chaperoned by the European Commission, and social acceptance/societal aspects have also become more important and need to be brought more into the policy discussions.

Q: What is the relevance of e-fuels for trucks?

A: According to a study of the VUB, Brussels university, looking into the decarbonisation of logistics, electrification would be the preferred way in Flanders where the majority of the movements are short distance, and only 20% would benefit from using hydrogen. Such short-distance logistics is however only a fraction of truck transport within Europe, and hydrogen likely plays a bigger role on longer distances.

Q: Is there a merit in applying a decentralised model for industry, e.g. with solutions that are adaptable to sites that cannot store energy?

A: For small scale consumption, modular solutions should be welcomed and developed locally, e.g. energy communities. When looking at the industry side the discussion becomes more complicated, e.g. the steel industry is hard to cater with small scale solutions. So it depends on the type of consumer and the needs they have.

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A: Energy communities have a real benefit, citizens have a say in the energy production and consumption, invest in renewable energy, receive financial benefits and it helps to create public support, which is all very important for the transition.

Q: What is your view on the import of energy carriers and neo-colonial practices?

A: we believe that import of energy carriers should be minimized as much as possible for various reasons, but for a region like Europe, this reliance on imports may not be possible to overcome. When importing, it is important to engage in dialogue with communities in the Global South and ensure a Just Transition, where they profit too.

Wrap-up by WP6-lead

The goal of WP6 in our consortium is to highlight cross-cutting issues and link these issues to other WP's in SUNER-C. In today's stakeholder dialogue session, we have heard many of these cross-cutting issues and this has prompted us to raise questions like 'Who is responsible for addressing issues in LSRI?'.

Specifically, the issues that were raised by the NGOs on stage include:

- The **scarcity** of renewables and green hydrogen: What sectors and **applications** do (not) get access and for what reasons? This connects to discussion on what is 'hard-to-abate' and consequently, which EU sectors should rely on electrification, and which are eligible for the limited supply of sustainable (e-/solar) fuels? (implications for Vision and Roadmap)
- Should we follow claims regarding growing demand for sustainable fuels (e.g. tripling of aviation demand and (e-)kerosene), or should we push for reduction of demand on a planet that does not grow along with societal demands? In other words, 'What needs **reduction**?' and how to deal with claims for 'Green Growth'?
- **Who** considers and uses what **carbon sources**? What is the energy efficiency here? Which actors are involved in decision-making or prioritization processes? How can be improve the **public debate** on the trade-offs involved in the allocation of scare resources?
- **Imports** of e-carriers and neo-colonial practices should be minimized (amongst others to improve energy security). Any imports should heed local conditions and facilitate a Just Transition in the Global South.
- The **societal and environmental impacts** (e.g. air quality; water, land and materials use; human rights) of the different sustainable fuel pathways should be considered when drafting plans for the future (roadmaps, visions) to prevent exchanging one problem

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(climate change) for another.

- The above considerations feed into a time dimension: **When**, in the next years/decades, and on what scale do we use what technology? This has profound implications for the Vision and Roadmap.

In the wrap-up, we also reflected on how the issues raised during the stakeholder session related to disagreements, tensions and concerns during the first day of the consortium meeting:

- There was a similar discussion on the allocation and import of scarce renewable energy and Green Hydrogen, and what sectors and applications should get it. But also what non-essential applications are (like cruise ships and curbing increasing SAF demand).
- Regarding WP1 and WP3 there was a discussion on the different perspectives and interests regarding the decentralised route (considered 'useless' by industry due to ROI), or other sustainable fuel routes. Still others say they are technology agnostic and that there is no silver bullet (see also WP6 Discussion paper on stakeholder perspectives regarding different technology routes)

It was clear that everyone has its own truth and that there is no right or wrong.

Considering these different truths, views and interests, it is important to consider who would be responsible for accounting for these issues in an LSRI? Some argue:

- Industry/markets/ROI decides on what technology is needed
- Policymakers decide and we're agnostic
- TEA, LCA, social LCA's etc. decide
- Consumers decide by changing behaviour

Yet the question arises how long we can wait for individual actors like industry, governments, or consumers. Instead of blame-shifting, we should consider what the responsibility of technology-oriented scientists is in SUNER-C? We carry responsibility to understand, build-up and use our capacity to address these issues.

So how to do that in an LSRI and SUNER-C?

- By **acknowledging disagreements and issues**, continuously. And knowing there is no way of solving them, since there's no objective answer.
- Instead, we need to create sufficiently open spaces, or **inclusive governance process**, to consider and negotiate trade-offs amongst these issues. This is the only way towards a legitimate transition process that, as the NGO mentioned, will not falter prematurely due to strong opposition by other actors.
- Such an inclusive governance process requires resources to involve quadruple helix equally, and represent (the interests of) and perhaps even involve 'the public'

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To conclude, recognising cross-cutting issues in an LSRI and establishing an inclusive (quadruple helix) governance process to consider these issues in ongoing debate, may result in 1) more contextualised, just and robust forms of innovation and 2) a USP for the Sunergy/SUNER-C community.

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4 Report Dialogue Workshop on Cross-Cutting Issues, Utrecht, 2024

A conversation on cross-cutting issues between technology working groups

Utrecht, 8 March 2024

Introduction

Context of the Stakeholder Dialogue Workshop

This document summarises the exchanges at the SUNER-C Dialogue Workshop, chaired by the project partners leading the SUNER-C Work Package 6 - Socio-technical and cross-cutting aspects, with the help and participation of the Working Group representatives from Work Package 3. The event has been organised as part of Task 6.2 - Stakeholder dialogue on implications for transition pathways (lead: UU, participants: GU, LU, Fraunhofer, CVE, EERA, BBL; with input from Work Package 3).

Objective of the activity

In the last SUNER-C consortium meeting, WP6 organized a multistakeholder dialogue, where several NGOs were interviewed on stage by the tripple helix representatives (industry, knowledge institutes, and policy). During that session, as well as through the study we conducted, we were able to identify some cross-cutting issues, spanning the technological as well as socio-economic and environmental aspects of the transition towards sustainable fuels and chemicals.

To facilitate an open discussion on how these cross-cutting issues are affected by the transition on the medium to long term, the WP6 members have developed a Conversation Tool. The goal is to use this conversation tool in the Working Groups that define the different technology fields of the WP3 roadmap, so that cross-cutting and societal issues are not overlooked.

Today we endeavor a first application of the conversation tool, between the different WP3 Working Groups, to test and demonstrate the tool, and to have a first conversation about the societal implications of the technology outlooks.

Agenda

- Part I: Introduction of the technology scope and state of the art of the Working Groups

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- Part II: Discussion on the societal implications of the Working Groups' technologies
    - Environmental impacts
    - Economic / industry impacts
    - Infrastructural and landscape changes
    - Societal acceptability of outputs
- Part III: What's next?
    - How is technology selection progressing?
    - What is the role of SUNER-C?
- Questions from the audience

Speakers

- Facilitators:
    - [apologized] Joeri Wesseling (Utrecht University)
    - Tycho van Hauwaert (Bond Beter Leefmilieu)
    - Kasper Ampe (Ghent University)
- WG3 Working Group representatives:
    - WG Direct conversion biobased approaches:
        - Joanna Kargul (University of Warsaw)
    - WG Photosynthetic devices:
        - Ann Magnuson (Uppsala University)
    - WG Solar Thermal Conversion:
        - Martin Roeb (German Aerospace Center)
    - WG advanced electrochemical conversion:
        - Joachim John (IMEC)
    - WG Sustainable CO2 sourcing:
        - Han Huynh (ENGIE)

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Part I: Introduction technology scope and State of the Art

Facilitator: The field of innovation studies uses the notion of a dominant design to describe how in early stages of the emergence of a radically new technology, initially different technological design compete for dominance. In these early stages, innovators look for alternative technologies to replace or complement existing, mature technologies that perform much better along some performance characteristics (cost, quality, safety, etc) but worse along others (e.g. sustainability). However, alternative technologies are at such low Technology Readiness Levels (TRL) that there is substantial uncertainty about their future performance. Due to this uncertainty and emerging path-dependencies resulting from earlier technology development investments, different innovating organisations (industrial buyers, technology developers, research institutes) may 'bet on' / invest in the development of different alternative technology designs. As a result, many alternative designs emerge, all competing to become the new dominant design (see Figure 2 below).

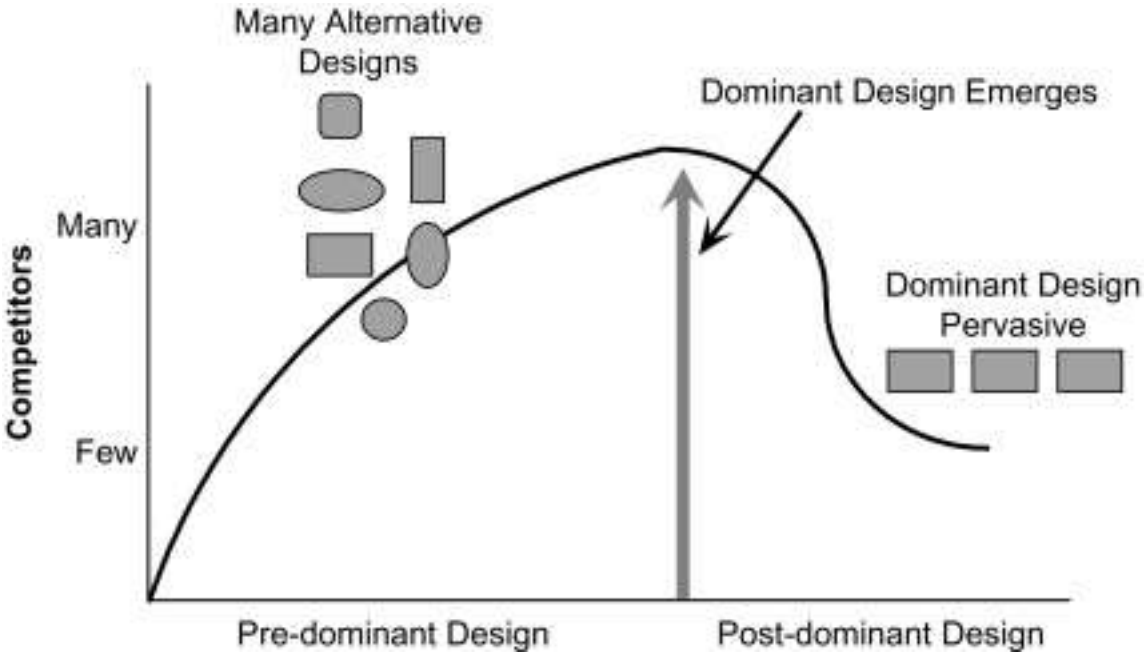

Figure 2: Emergence of a dominant design (*Source*: Amrit Tiwana (2014) 'Chapter 2 - Core Concepts and Principles', Platform Ecosystems, Morgan Kaufmann, pp. 23-48)

As technology development progresses and some designs progress increasingly through TRL 1-9, uncertainty about future performance decreases and it becomes increasingly clear which alternative design become the most viable. As a result, investors and innovators will increasingly drop uncompetitive design and reinvest in the more attractive candidates, creating more momentum and reinforcing the technology development and hence performance of those

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designs. As designs develop and become implemented, they will benefit from increasing results on adoption (think about economies of scale and scope, but also network externalities that increase the value of a technology as the technology becomes more adopted (a phone becomes more valuable the more people have adopted a phone that one can call)), which further benefits their technological performance. As a natural effect, the breadth of competing technology alternatives will decrease over time, and the substantial resources necessary to develop an alternative technology and its infrastructure will become more focused on one or a few new dominant designs.

Q: How many technological designs are competing within your Working Group's technological field?

- *What TLR range do these designs span?*
- *Which designs are (emerging as) dominant?*

Joanna: The *Biological Conversion* Working Group covers the emerging technologies of biocatalysis , microalgae, and photosynthesis, while bioreactors are in the scale-up phase. The key challenges in developing these pathways include 'How to optimize metabolic pathways towards products?' and 'How to maximize yields?'. There are various configurations possible with TRL ranging from 1 to 7 (e.g. ethanol: 7).

Han: The *Sustainable CO2-Capture* Working Group covers several areas:

- CO2 as a feedstock, which looks into concentration/separation issues, either biogenic/fossil (oxycombustion), precombustion capture ; >20% , >50%;
- Direct Air Capture (DAC): adsorption e.g. MOF, electrochemical capture

How to come to concentrated and purified CO2 is an important question. The competitiveness of the technology is linked to the concentration; at the moment post-combustion capture is performing best. Atmospheric capture promises negative emissions, but needs breakthroughs.

Joachim: The *Electrochemical conversion* Working Group covers technologies that are also at very high TLR, like the production of H2 from water. Three main technologies are competing: 1) Alkaline TRL 9; dominant too slow, not effective enough; 2) PEM Pt availability is an issue; 3) SOxide: which is at the prototype level and used for syngas production. Furthermore, next generation Alkaline/Membrane may be a solution. Some of the technologies are so advanced that TRL maybe not the right measure; maybe we should be talking about manufacturing levels.

Ann: The *Photosynthetic Devices* Working Group covers technologies of up to TRL 4. A range of technical solutions is being explored, but no dominant design has emerged yet. Common features of the competing designs are: decentralized , low current high product yield, possibility to be stand-alone.

Martin: The *Solar-Thermal Conversion* Working Group covers concentrated sunlight to enable CO2 conversion. There are several designs, and currently it is not yet clear which will win. The designs range from TRL 2-8 and use different ranges of concentration and temperatures (20 - 1000t/a; T: RT-1000°C). Materials can be 3D printed.

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Part II: Societal impacts of technologies

Facilitator: The societal acceptance of new technologies is determined by the impacts the technology has on society. These impacts cover different dimensions: environmental impacts, economic impacts (i.e. impacts on the industry structure and value chain), infrastructural and landscape impacts, but also the outputs of the technology (it's products or services) may create societal support/legitimacy (e.g. food is considered a basic need and therefore a more legitimate output than fuels are, meaning other negative (e.g. environmental) impacts are more readily incurred). There are many relevant questions to understand the legitimacy claims and societal acceptance of SUNER-C technologies, but considering the limited time, we only discuss one or two example questions in this session.

To the representatives, we ask you to please indicate whether the answers to these questions hold for the whole Working Group's technology scope, or whether it differs per technological design.

Environmental impacts of technologies

Q: Is there enough renewable energy, carbon and other critical resources available for the production of sustainable fuels and chemicals via your WG's technology, or do you consider feedstock bottlenecks (renewable energy, carbon or other critical resources) for the use of sustainable fuels and chemicals? If yes, which bottlenecks over time?

- *Under what conditions can (scarce) feedstock be used, for what fuels? And what are the elements of the trade-off?*
- *Do the other Working Groups have a different perception?*

Martin: Explains the example of a solar tower in Jülich that is 60 meters high. They had invited neighbours to show and convince them that it is not dangerous tower. For this concentrated solar technology pathway it seems that there is not enough materials and space in the EU for it to be deployed at sufficient scale. We will have to import under current conditions, which raises questions of: which kind of transport? Which partners? How safe are partnerships?

Ann: For *Photosynthetic Devices* we see there is sufficient solar energy in the EU, but what about materials to build the devices? These are expensive and critical materials. CO2 capture is also a bottleneck.

Joachim (*Electrochemical conversion)*: To meet the demand in green H2, we have to build up a lot of renewable energies. Some say it is possible; others say that we will have to rely on other countries (requiring transport and reducing strategic autonomy). Do we want to take over the existing centralized model, or do we go for a more decentralised model that is also more democratic? This is the real issue.

Joanna (*Biological Conversion)*: We envision a combination of (de)centralized Renewable

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Energy production and complementary transport. You can imagine a local system, but there may be opposition. Water is also a big thing.

Han: price versus cost?

Huub de Groot (audience): other business models are needed, see e.g. agriculture in view of intermittency of green power production.

Joanna (*Biological Conversion)*: can you efficiently recycle materials and make it cost-effective (Energy Return on Investment - EROI). You have to look at the whole value chain and this can lead to a different business case. Biocatalysts can work for diluted / contaminated CO2 streams at ambient conditions. The word 'bio' seems to be important for the public.

Industry impacts of technologies

Q: Will sustainable fuels and chemicals (for your WG) be produced in a more centralised or decentralised system?

- *Who has the power in these systems?*
- *Will there be prosumers, what share?*

Martin (*Solar-Thermal Conversion)*: Solar-Thermal Conversion technologies will produce sustainable fuels and chemicals in both centralized and decentralized systems. Community and local solutions are possible, but I can not imagine this in industry circumstances. (urban)mining of raw materials will be centralized.

Ann (*Photosynthetic Devices)*: In Europe, we are now mainly concerned with efficiency, looking for scalable solutions with grid connections. But stand alone can be important for other parts of the world where they have no or a limited grid. In the global south efficiency is less important, but "ease of manufacturing" and "affordance of materials" may be more important.

Han (*Sustainable CO2-Capture)*: For CC(U)S, both centralized and decentralized systems are possible; such co-existence is already happening in the electricity sector.

Joanna (*Biological Conversion)*: for bio-approaches, decentralized systems are the preferred option. Minimizing production cost is essential here. Using wastewater in a circular manner is compatible with decentral use.

Infrastructural impacts of technologies

Q: (Considering the whole value chain,) What infrastructural changes are required for this technology to operate at full scale?

- *How does the (de)centralized system impact the landscape? (e.g. NIMBY of electricity*

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generation, fuel production & transport)

Joanna (*Biological Conversion)*: we are moving away from using fresh water, to using waste or sea water, which requires less pipelines and uses less valuable water resources. The fact that you can grow this 'technology' anywhere, also means there is no longer competition with other land use purposes.

Nathan (Question from audience): what if GMOs are used? Doesn't that mean that closed bioreactors are needed, to prevent species contamination?

Han (*Sustainable CO2-Capture)*: CC(U)S deals with a chicken and egg problem, making diffusion challenging. A lot of investment will be needed to diffuse CC(U)S. Currently, a lot of systems are relatively far from the living environment of people. If it is decentralized, new infrastructure will be necessary, with possible effects such as noise.

Joachim (*Electrochemical Conversion):* At the moment the direction seems to be centralized, with import from other continents. In practice that means: H2 production → ammonia → transport to Antwerp → crack it back to H2. This is not efficient. The infrastructure is not ready, and you need lots of renewable energy.

Ann (*Photosynthetic Devices)* and Martin (*Solar-Thermal Conversion)*: current technology fuel production capacity is much smaller than what we have now in the energy system. The huge needs for energy carriers means that we need to start from the existing system and continue to add to it, to gradually transition to a full-scale alternative energy system that can meet society's energy needs.

Societal acceptability of outputs

Facilitator: there is often a merit order to what end uses of a scarce commodity (like captured CO2, H2) are most societally acceptable. Eventhough SUNER-C focuses mostly on sustainable fuels, it competes directly for its scarce resources with other end uses and (much like the backlash in societal acceptance incurred by biofuels due to its (in)direct competition with food) this affects the societal acceptance of SUNER-C technologies.

Q: Which end uses of your (WG) technology are most acceptible, ranging from nutrients, to polymers, chemicals, and fuels (Mertens et al., 2023)?

- *Do nutrients / proteins have alternatives?*
- *What fuel types and applications are acceptible according to your WG?*
- *What share of the sustainable fuel market do you anticipate for your (WG) technology on the long term (2050+)?*
- *Reflection: can these WG visions co-exist? If not, at what stage (year) should selection take place?*

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Martin (*Solar-Thermal Conversion)*: we consider any end uses of our technology acceptable, with fuels being used in mobility and aviation, and ammonia in fertilizers.

Ann (*Photosynthetic Devices)*: we consider the production of H2 and CH4 to be the most easily accepted.

Joachim (*Electrochemical conversion)*: The most acceptable end use is H2 as a product for decarbonization. But this will not go to household's green energy needs, but to decarbonize industry.

Han (*Sustainable CO2-Capture)*: I am not able to answer this. Perhaps we should develop some kind of merit order. Is it to generate products (CCU) or to store it (CCS)? Or use it for proteins? The current regulatory framework pushes to use captured CO2 in fuels because of energy independency.

Joanna (*Biological Conversion)*: I consider ethanol and methanol to be the most acceptable outputs, because it allows production of complex chemicals at ambient conditions, which is its strongest point.

Part III: What's next?

Facilitator: Now that we've discussed the range of technologies within each Working Group's field, and discussed some of their societal impacts, we arrive at the questions:

- How do we anticipate in what direction and at what rate this transition to sustainable fuels and chemicals will unfold?
- What is the role of SUNER-C in the transition and the selection between technologies?
- How is the selection of the technological designs progressing at EU level across Working Group technology fields? Is convergence taking place?
    - Who should and can decide on the selection? Who is out?
    - What should be the role of SUNER-C in this selection process?

Joachim (*Electrochemical conversion)*: a lot of decisions have already been made; there is for example huge NH3 storage capacity in Antwerp. We will need decentralized production to stabilize the grid – which is already experiencing problems.

Han (*Sustainable CO2-Capture)*: See what happened in the recent past with combined heat and power generation: the green movement opposed this, arguing it would create systemic lock-in. The same argument applies to sustainable CO2 capture.

Joanna (*Biological Conversion)*: Society will decide whether a plant can be built; this depends

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on which politicians people vote for. Another thing that is needed is much better interaction between academia and industry, like Lanzatech.

Ann (*Photosynthetic Devices)*: Energy storage in the form of chemicals should come on the political agenda. Long-term storage cannot be done in batteries.

Martin (*Solar-Thermal Conversion)*: We offer different technology options, we can inform stakeholders.

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5 Interview on energy cooperatives

Interview with Sophie Loots: Founder, project coordinator & co-director of energy cooperative 'ZuidtrAnt'

Ghent, 2 July 2024

Introduction

As part of the SUNER-C workshop hosted in Ghent on 2-3 July, WP6 organized an interview with the founder, project coordinator & co-director of energy cooperative 'ZuidtrAnt', Sophie Loots. The name ZuidtrAnt derives from a **tr**ansition at the southern (**Zuid**) border of the city **Ant**werp. We interviewed her about this project, because it tests the economic feasibility of a business model around converting excess/peak electricity from mid-scale rooftop solar PV into hydrogen, in the context of an energy cooperative.

What is an energy cooperative?

Ann: What is an energy cooperative?

Sophie: It generally refers to a self-organized initiative of local communities and citizens to make Return on Investment (RoI) and, in our case, promote the production and consumption of renewable energy. Our community members are prosumers, as we both producer and consume our energy. This allows us to be independent of large energy companies.

We try to make profit, we sell our shares to whoever wants to buy, one share is 100 euros which we invest in renewable projects, solar roof, heating grid, with citizen capital. Citizens get a dividend with the profit we make. We try to make the difference in the energy landscape. The solar roof you see on the slide is owned by the citizens. It doesn't matter how many shares you have, you have the same power in the general assembly. Kringloopcentrum [thrift shop/recycling center], it's their roof. 70% of the energy produced is being shared to the other sites of that non-profit organisation, shops in other municipalities of the Kringloopcentrum.

Ann: what is the difference between energy cooperatives and energy communities?

Sophie: There is no fixed answer as these concepts are used interchangeably and legislation differs per country. Stakeholders within an energy communities know each other and have a community feel to it. Consequently, an energy cooperative, can contain one or more energy communities. We put ourselves in the market as energy community and strive for a connection with citizens. It needs to be a non-profit or cooperative business – it needs to be a legal entity. A House Owners Association can also be energy community. EU legislation dictates that citizens can initiate an energy community.

Ann: You also have hydrogen project?

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Sophie: we also have hydrogen production through water splitting. We heat houses with the waste heat from the electrolysers and we use hydrogen for further energy needs, see Figure 3. We're looking into how to maximise, e.g. full roof with solar power instead of partly full roofs, and that's one of the reasons we are also looking into hydrogen. We have realised this in H2COOPSTorage project (EU funded), also universities as partners, Vlaanderen, ULB… Hydrogen is stored in bottles, can be used for heating or sell it, that's being researched by the university.

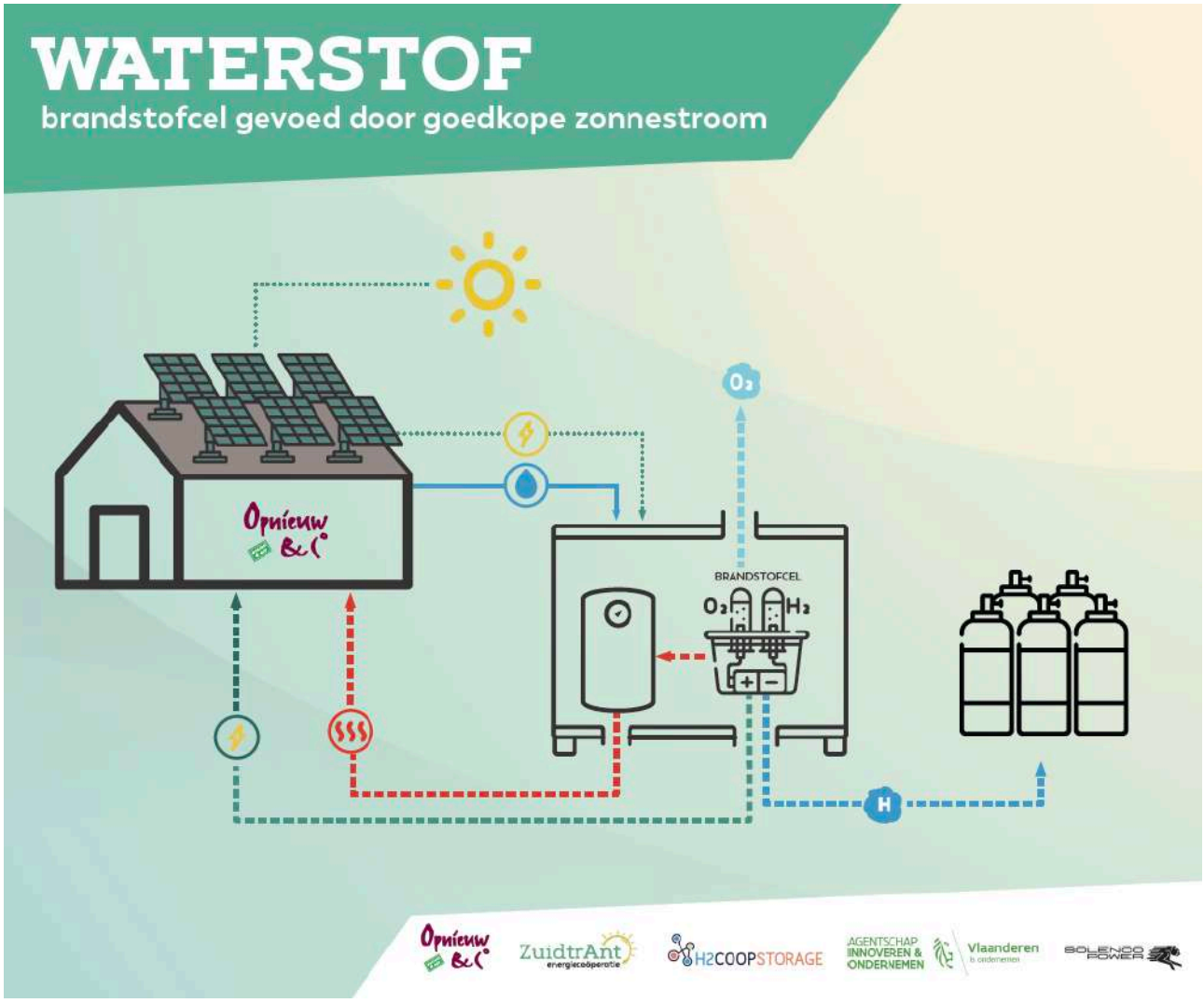

Figure 3: Schematic overview of hydrogen use by the ZuidtrAnt energy cooperative

The business model

Ann: What's your business model?

Sophie: for hydrogen we don't have a viable business model yet. We don't ask money for the universities to research it, we don't ask money for the data it produces. Because we think about the future, the benefit for the society. Installation is done by Solenco Power, who makes a fuel cell. It only started two months ago, so I cannot yet share the data. It started in a little container (See Figure 4), there the fuel cell is installed. You can move the container elsewhere. Solar Car port + EV's: we are trying to do something with the flexibility. We have a big battery made of

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refurbished EV batteries which we use to store the solar energy and use it on the flexibility market – store it when it would cost money to put it on the grid and we cannot consume it. For this we received funding from the Federal Belgian government (transition fund).
We store the H2 in bottles. The university of Brussels is involved: doing data analysis. H2 in bottles can be sold, if it's a good solution. Can be used as heating fuel. We are still testing what we can do with excess of solar and what we can do with hydrogen. Looking what we can do on in-between-scale: not individual houses, but in a neighborhood or SME-zone.

Figure 4, Sophie Loots at the hydrogen fuel cell test pilot

Ann: Do you experience any competition from big energy suppliers?

Sophie: there are a few companies who feel the citizens are losing the contact with the energy market and the company sells it as if it's the consumers' energy too, using the same story as us. They see an opening to earn more clients, connect better and want to try it). We can't beat those 'corporate communities', because they have more money and are not bound by the same rules as us. We can't formally be an energy supplier, and that is frustrating for us. We have the responsibility to invest our money in projects, instead of publicity; every euro we get, we invest in

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RoI. We're legally allowed to turn out maximum 6% dividend. It's like David and Goliath; we still have to find the weak spot of the Goliath. Our goal is to bring the energy market to citizens in a way so everyone can understand it, which is not yet the case.

We can use legislation of Ecopower to provide energy, but it's not direct and instead via a third party. It is difficult for us to explain to people that they can get our electricity via a third party. But we can do this with heat. We have a heat network. We have 2 cooperatives: one for heat; one for electricity. For heat the legislation is different than for electricity: it's much more open. Supplying heat is more new; unlike in the Netherlands we are not going off gas in 10 years. Belgium is still in the gas era. Our main heat source is industrial plant with residual heat. We also have 2 projects with heat from soil. We also want to use the heat from the electrolysis to warm budlings.

There are many pros and cons for H2. Not holy grail, we just want to test and say in objective way if suitable or not or yes: under these circumstances. We don't want to make assumptions, we want to work with real data.

Relevance to SUNER-C

Ann: What do you think the chances are that the cooperative will sell energy to industry?

Sophie: I don't think that will be a model for energy cooperatives, because it's too technical and too far away from our target audience: the citizens. In the future the H2 production will be for more industrial parties, I think, not for energy cooperations to produce and use internally. Maybe if the technology is more suitable to be implemented in neighbourhoods, but we don't want to lose the connection with the citizen. Our drive is not only to make money, but also to involve citizens in the energy transition. Just a little profit is good enough. The legislation says: the dividend cannot exceed 6%. It's more a low-RoI savings account.

Ann: How can the European Commission support energy cooperatives?

Sophie: we are currently participating in EU projects, which allows us to generate knowledge, it's good to open those projects to energy cooperatives and citizens can also participate this way. EC can also ensure directives that consumers have to actively participate, that's what we also try to do, make citizens more active in the energy market and have a say.

Frédéric: Are the shareholders from the neighbourhood?

Sophie: most are from the neighbourhood but there are also early adaptors, and even people from other countries potentially can buy a share. We also have a heating network, but we made a fixed price before the crisis, so they were very happy with the price we asked. They also know us, so it's also an energy community because we work locally. But we have several neighbourhoods, so several energy communities in our cooperative.

Jurgen: I'm a member of an energy community. You showed pictures of PV on roof. Do you also have experience with wind parks? In Germany we had conflict with land for agriculture use (agri voltaics) and also visibility. It's hard to discuss this with citizens. What's your experience?

Sophie: we are operating in urban areas, so no conflict with agriculture. But the windmills, yes, we can't put them but because we have an airport.

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6 Concluding discussion

This report aimed to capture the discussions between the quadruple helix stakeholders (i.e. government, industry, research and civil society (organizations)) on the important cross-cutting socio-technical challenges related to the SUNER-C technology choices (identified in Deliverable 6.1) regarding sustainable fuels and chemicals. During our events, we aimed to place centre stage the actors that currently too often left in the margin of the debate when discussing future technology development and deployment. Still, these actors bring issues to the table that are crucial for a sustainable and circular energy, such as justice considerations, job implications, ecological limits. These actors include unions, NGOs, youth climate organizations, and energy cooperatives. The intended events included:

1. A dialogue workshop in Brussels on the societal impacts of SUNER-C technologies, with a particular focus on the concerns of NGOs;
2. A dialogue workshop in Utrecht between the different technology working groups that are developing the SUNER-C Roadmap;
3. An interview with the founder of an energy cooperative, to explore the potential of other modes of governing the energy transition;
4. Application of the Conversation Tool within the technology working groups, to ensure the integration of societal issues when developing a Roadmap for our future energy system.

This fourth series of events is not included in this report, because unfortunately, the fourth series of events never materialized, despite several attempts by WP6 to kick-start this initiative and putting it on the agenda of the Coordination Team. The goal was for our group of social scientists and NGO employees to engage in a conversation with the technical experts from the working groups, about the societal implications that could be expected from developing focal technologies according to certain designs. These discussions, structured by the Conversation Tool in Deliverable 6.1, would allow us to identify large undesirable societal impacts, profound barriers to implementation, and tensions between technologies' overarching socio-technical systems.

Reasons for the lack of success so far may include the delayed initiation of the working groups, the Deadline of the Roadmap extending beyond the deadline of Deliverable 6.2, and the increased complexity of interdisciplinarily developing a Roadmap that considers societal

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implications of technology development forecasts. We will continue our attempt to kick-start this line of events, but did not manage to succeed before the deadline of this Deliverable 6.2.

As summarized in the Table 1 below, we (i.e. all the quadruple helix actors) discussed the following themes:

- The impacts of the transition towards sustainable fuels and chemicals, in terms of social, environmental, economic, infrastructural and landscape impacts;
- The allocation of limited resources (to different production processes) as well as the limited sustainable fuel and chemical (intermediary) products (to use different sectors and applications);
- The roadmaps and visions created on what technologies and applications should generate what levels of outputs, when, in what types of energy systems;
- The just and inclusive governance arrangements that underlie these visions and roadmaps and that their pursuit.

As the table shows, numerous topics underlie these themes, which illustrates the complexity of the decisions to be made in the transition to sustainable fuels and chemicals, and the profound and different impacts these decisions will have on our society. When developing a Large Scale Research Initiative, such topics and questions need to be dealt with to ensure SUNER-C's impact towards a societally desirable outcome of the ongoing transition process.

Table 1: Overview of topics raised in the multi-stakeholder dialogues of WP6.2

Theme:	**Underlying topics:**
Transition impacts: - Social - Environmental - Economic - Infrastructural - Landscape	- Renewable and sustainable CO2 source and the preconditions for sustainable CCU(S) - Assessing rebound effects of sustainable fuels and the role of behavioural change in reducing sustainable fuel demand (e.g. more flying on solar fuels vs. flying less first and what demand remains is met by solar fuels[5]) - Assessing global social, economic, environmental, infrastructural and landscape impacts (of imports/*neo-colonialism)* on people and regions affected by the transition and ensuring *just transitions* – meeting all SDGs - Balancing different societal needs: energy security / strategic autonomy, sustainability, affordability - New business models may be necessary like prosumer models of energy cooperatives in which local citizens benefit

[5] See CLEVER (2023) roadmap: "Climate neutrality, Energy security and Sustainability: A pathway to bridge the gap through Sufficiency, Efficiency and Renewables

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	- Energy communities enable feelings of co-ownership and community in the energy transition - Technology performance indicators may differ per continent (efficiency, EROI in EU; ease of manufacturing; affordance of materials in developing countries)
Allocation of limited resources and (fuel and chemical) outputs	- *Trade-offs* in allocation of scare resource (H2, CO2, lipids, rare materials etc. and even fresh water): under what conditions is allocation acceptable? - Resource and energy *efficiencies* vs. 'difficult to abate' applications (e.g. waste lipids for bio-diesel or kerosine) - Prioritization of sustainable fuel use sectors and applications - Prioritization of applications beyond fuels and chemicals (food over fuel) and the associated public support/legitimacy
Roadmaps & Visions	- Technology selection and competition for the next dominant design - How is the selection of technology designs progressing at EU level? Is convergence taking place? - How to select amongst the plurality of sustainable fuels in different TRL? How many dominant designs to select for what consumer markets? (e.g. electrification for passenger transport, H2 for long distance trucks, solar kerosine for aviation?) - The preference for centralized vs. decentralized (and more democratic, locally-owned and just) energy systems[6] - How to deal with claims of continued growing demands vs. demand reduction measures in line with planetary boundaries? - Size (order of magnitude) of sustainable fuel & chemical markets - The rate of transition: when to achieve what targets? - How to deal with different energy storage solutions and their systemic integration? - What is the role of intermediate transition technologies (like hybrids and blue hydrogen)? - Be mindful of the danger of hypes (and the associated decline/through of disappointment) - Are visions and roadmaps consistent across technology fields (/working groups)?
Transition Governance	- How to involve different stakeholders when making decisions on 'roadmap & vision' topics? - Aligning technology development with what is societally accepted and brining this largely industrial transition into a quadruple helix debate that involves the broader public (instead

[6] Current preference seems to be for centralized; but it also depends on the technology field

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	of only asking people to generate societal acceptance for the visions of technical scientists) - What is the role of energy communities & cooperatives; how can they involve citizens in a just and sustainable energy transition, and how can they recombine renewable energy technologies to match local energy supply and demand? - How to deal with different technology pathway perception, within and outside of SUNER-C? (e.g. within technology fields) - How to align visions and policies at different levels of governance (local, national, EU, global)? - The role (dirigiste vs hands-off), level and preconditions for public policy, investment and regulation - How to organize defossilized circular value chains and valorise fossil waste without sustaining long-term lock-ins of fossil fuel technologies? - How to deal with information asymmetries: industry monopolizes data and expertise and can claim authority more easily than NGOs, while today's industry's interests typically don't align with those of a sustainable society) - How to enable (e.g. infrastructural and value chain) network externalities? - How to move beyond TRL, to e.g. manufacturing (or society-readiness) levels? - Opening industrial facilities to the public may increase local public acceptance (e.g. DAWN tower) - Who will have the power in the envisioned solar-fuel-based energy systems? - Overcoming chicken-and-egg problems: technology investors wait for guaranteed off-take and energy & resource supply (e.g. large scale electrolysers) - How to anticipate the global and EU direction and rate of the sustainable fuel transition? - What is the role of SUNER-C in this transition and in the selection of technology alternatives? (move beyond informing towards proactive lobbying?)

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