ECONOMIC AND SOCIAL CONSIDERATIONS FOR THE FUTURE OF NUCLEAR ENERGY

Report from the participatory workshops on social dimensions and sustainability assessments of nuclear energy

September 2025

Funded by the European Union

Report from the participatory workshops on social dimensions and sustainability assessments of nuclear energy

Context and introduction

This document collects reports of five international workshops organised as part of the Project "Economic and Social Considerations for the Future of Nuclear Energy in Society" (ECOSENS).

The ECOSENS project (October 2022 – September 2025) overall aim was to create a neutral space where researchers in social sciences and humanities (including economics, sociology, Science and Technology Studies, … among others) and in nuclear energy research and policy could meet, exchange views and collaborate with civil society and other relevant stakeholders in order to:

- develop a societal perspective on the development and use of existing and new nuclear technologies, in the context of major societal challenges: climate crisis, sustainable development and energy security, by opening up the technoscientific issues to the social, political, cultural and ethical context, in order to guide policies in the nuclear field; *(work package 1)*
- research an assessment of nuclear energy sustainability considering the entire life cycle of the current nuclear technologies, possible evolutions of the energy markets and nuclear technologies in the transition toward climate neutrality, and the societal perspective in order to reveal and evaluate the possible roles of nuclear power in the future; *(work package 2)*
- research and develop a new economic model, based on the System of Provision (SoP), for the assessment of nuclear energy, overcoming the key weaknesses of existing economic models, providing a suite of indicators relevant not just for the investors (e.g. equity holders) but for a broad variety of stakeholders (e.g. consumers, governments, suppliers); *(work package 3)*

The research on the societal aspects of energy futures conducted in ECOSENS provided insights into the perceived risks, benefits and potentials of nuclear energy technologies, which were further deepened through studies on citizens' motivations for engaging with the issue in the context of major societal challenges (climate crisis, sustainable energy policies, energy security). Furthermore, the research identified challenges for the uptake of existing recommendations on stakeholder engagement and transdisciplinarity (notably integration of social sciences and humanities) in nuclear research and policy, and developed practical recommendations for these challenges. Last but not least, the international workshops gathered relevant societal stakeholders to explore and co-construct 'possible futures for nuclear energy' taking into account ongoing energy transitions and climate change and other major societal challenges.

All information on, and reports of, the ECOSENS project can be found on the project website https://ecosens-project.eu/

Report from the participatory workshops on social dimensions and sustainability assessments of nuclear energy

Contents

- **The Art and Science of Imagining Energy Futures**
  Brussels, Belgium, 29 March 2023

  authors
  Gaston Meskens, Catrinel Turcanu – SCK CEN
  Claire Mays – Institut SYMLOG de France

- **Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment**
  Brussels, Belgium, 30 March 2023

  authors
  Claire Mays, Yasmine Fourari, Aylin Erden – Institut SYMLOG de France
  Marin Constantin – RATEN

- **Co-development of recommendations on stakeholder engagement in (nuclear) energy governance**
  Online, 11 – 12 June 2025

  authors
  Nadja Zeleznik, Barbara Horvat – EIMV
  Catrinel Turcanu – SCK CEN
  Susan Molyneux-Hodgson – University of Exeter
  Giorgio Locatelli – POLIMI

- **2050 Here & Now Scenario Workshop**
  Dessel, Belgium, 29 August 2023

  authors
  Marc Poumadere, Aylin Erden, Claire Mays – Institut SYMLOG de France

- **Transdisciplinary sensibilities in investigating nuclear research and innovation**
  Amsterdam, 17 July 2024

  authors
  Robbe Geysmans, Gaston Meskens, Catrinel Turcanu – SCK CEN
  Susan Molyneux-Hodgson – University of Exeter

ECOSENS

ECONOMIC AND SOCIAL CONSIDERATIONS FOR THE FUTURE OF NUCLEAR ENERGY

The art and science of imagining energy futures

Report of an International Stakeholder Workshop

Gaston Meskens, SCK CEN

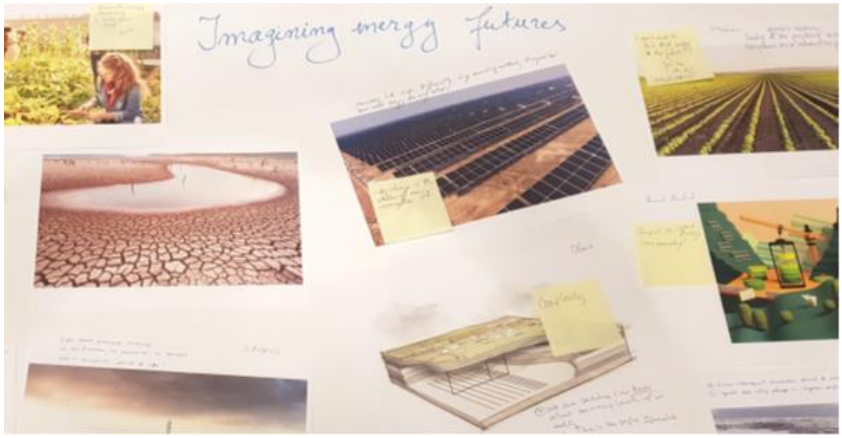
Catrinel Turcanu, SCK CEN

Claire Mays, Institut SYMLOG de France

Funded by the European Union

Synthesis report of the
International workshop

The art and science of imagining energy futures



29 March 2023
Club University Foundation
Rue d'Egmont 11 - 1000 Brussels



Economic and Social Considerations for the Future of Nuclear Energy in Society

Project Number: 101060920

The art and science of imagining energy futures

Work Package 1

Lead Beneficiary: SCK CEN

https://ecosens-project.eu/

ECOSENS is a 3-year project (2022-2025) funded by the Euratom Research and Training Programme. It aims to create a neutral space where specialists in social sciences (including economics, sociology, social psychology, Science and Technology Studies, among others) and humanities and in nuclear energy research and policy will meet, exchange views and collaborate with civil society and other relevant stakeholders in order to:

- *Provide a societal perspective on the development and use of existing and new nuclear technologies,*
- *Provide an assessment of nuclear energy sustainability considering the entire life cycle of the current nuclear technologies,*
- *Provide a radically new economic model, based on the System of Provision (SoP), for the assessment of nuclear energy.*

The present document reports a face-to-face stakeholder workshop conducted on 29 March 2023 under ECOSENS work package (WP) 1. It is an unscheduled deliverable and was reviewed and agreed by the stakeholder participants of the workshop, whom we thank for their rich input.

To be cited as:

Meskens, Gaston, Mays Claire, Turcanu, Catrinel (2023) The art and science of imagining energy futures. Report of an International Stakeholder Workshop held in Brussels on 29 March 2023. Part of Deliverable 1.4 of ECOSENS-project.eu. SCK CEN, Avenue Herrmann-Debrouxlaan 40, 1160 Brussel, Belgium

The work is disseminated under the Creative Commons License CC BY-NC-ND 4.0
(Attribution-NonCommercial-NoDerivatives 4.0 International)

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

Economic and Social Considerations for the Future of Nuclear Energy in Society

Project Number: 101060920

Deliverable 1.4a (unscheduled):

The art and science of imagining energy futures

Work Package 1

Lead Beneficiary: SCK CEN

For the Lead Beneficiary	Reviewed by Work Package Leader	Approved by Coordinator
Gaston Meskens	Gaston Meskens	Daniela Diaconu
		

Project information

Project full title:	Economic and Social Considerations for the Future of Nuclear Energy in Society
Acronym:	ECOSENS
Funding scheme:	CSA
ECGA number:	101060920
Call/topic	HORIZON-EURATOM-2021-NRT-01-14
Coordinator:	Regia Autonoma Tehnologii pentru Energia Nucleara (RATEN) – Daniela Diaconu
EC Project Officer:	Maria Papadopoulou
Start date – End date:	1 October 2022 - 30 September 2025 (36 months)
Coordinator contact:	+40 744 701 476, daniela.diaconu@nuclear.ro
Administrative contact:	+40 744 701 476, daniela.diaconu@nuclear.ro
Online contacts (website):	https://ecosens-project.eu

Document information

Deliverable Title	A collaborative assessment of (imagined) energy worlds
Deliverable No.	1.4a (unscheduled)
Work Package No.	1
Work Package Title	A collaborative assessment of (imagined) energy worlds
Lead Beneficiary	SCK CEN
Contractual Delivery Date	30.09.2023
Actual Delivery Date	30.06.2023
Type	R
Dissemination level	PU
Authors	Meskens, Gaston & Turcanu, Catrinel (SCK CEN), Mays Claire (SYMLOG)

Content

Introduction
- Aim of the workshop
- How the workshop was organised
- Workshop participants
- The ECOSENS Project
- How this report is organised

Summary of key findings

Synthesis of part 1 'Imagining energy futures'

Synthesis of part 2 'Sustainability assessment - a deliberation process in itself'

Annexes
- Agenda of the workshop
- The art and science of imagining energy futures – worldviews / the conceptual landscape

Introduction

Aim of the workshop

What energy future do we desire? What energy future is possible? 'The Future We Want' was the title of the outcome document of the *United Nations Conference on Sustainable Development* in Rio de Janeiro in 2012. The conference marked the 20th anniversary of the historic *Conference on Environment and Development*, known as 'The Earth Summit', held in the same city in 1992. That event laid the ground work on which sustainable development thinking still builds today. What became clear at the 2012 conference is even more evident today: the exercise of imagining 'the future we want' for humanity and planet Earth is first and foremost a tough and complex political discussion, which is steered not only by economic strategies, environmental threats such as climate change and considerations of social justice, but also by conflict and war in which energy is used as a tactical weapon. Within this turmoil, scientists, politicians, activists and citizens alike may disagree on what energy future is needed and possible but, apparently, there is also no consensus on what future we desire. While anyone would reasonably support the idea that energy should be produced in an environmentally friendly way and be affordable for all, different visions exist on how to get there.

Taking into account current societal challenges and opportunities and existing and new energy technologies, the workshop discussed 'the art and science of imagining energy futures'. The idea is that unveiling what references we use to express what we desire, hope, fear and believe may be the first step to come to a more open and effective dialogue on our energy future. From this perspective, this workshop aimed to serve as an illustrative exercise and hopes to provide food for thought for anyone concerned with 'the energy future we want'.

How the workshop was organised

The workshop was organised back-to-back with a second ECOSENS workshop that followed the day after and that was entitled 'Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment'. The idea was that the workshop 'The art and science of imagining energy futures' could provide first insights with regard to 'sustainability thinking', with the emphasis on how to embed sustainability assessment in a context of broader societal concern.

The participants of the workshop came from a wide variety of backgrounds (academic, civil society, policy) and brought various expertises to the table (see 'workshop participants' further down).

The workshop followed a work agenda that developed from more general creative thinking towards more focused considerations on the practicalities of sustainability assessment (see the detailed agenda in annex). After two introductory presentations, the participants were invited into a thought experiment in which they were asked to 'think of the energy future' and write down the first 'thing' that came to their mind. They also received each of them a different printed image that, in one way or another, could be connected to 'thinking energy futures' (see impressions of these images on page 1 and further down in the text). After this introduction, the participants were split up in three groups, to be moderated by one of the authors of this report. All three groups followed the same programme of discussion. In a first discussion round, participants focused on what worldviews and values are behind imagined energy futures and which artefacts (storylines, narratives, concepts, images,

symbols, models, …) we use to 'express' these imaginations. This discussion kicked-off with commenting the images each of the participants received. In a second round, participants discussed the deliberative character of sustainability assessment, with a focus on how to 'translate' worldviews and values into formal assessment approaches. In a final plenary discussion round, participants and moderators looked back on the day and reflected on first lessons learned, also anticipating the work in the second workshop the day after.

Workshop participants

The international workshop was organized by three ECOSENS project members (two social scientists and a theoretical physicist / philosopher; the authors of this report). Twenty stakeholders were registered to attend this session, of whom 17 were finally able to participate on 29 March. The full complement of persons was not present throughout the day (one stakeholder retained by other commitments arrived slightly late and one left at mid-day, all by agreement).

The self-declared sector of persons registered, as well as their self-declared areas of expertise, are shown in Tables 1 & 2 below. Individuals were enabled in each case to declare more than one category. Names and organizations are not provided in this summary report, in respect of both personal data protection and the Chatham House Rule which was explicitly agreed to by all meeting participants. Country of origin and/or work (Table 3) were not formally declared by participants but surmised by organizers from registration materials and correspondence.

Sector	
Civil society - grassroots communities - 4 Embassies - 1 European Commission - 2 Independent energy and environment expert - 1	NGO – 2 Private sector, investment, start-ups – 2 Public sector, public utility, technical organization - 3 Research/academic, universities - 7
Table 1 – Self-declared sector of workshop registrants (individuals cited multiple sectors)	

Expertise	
Energy system modelling - 4 Energy/Environmental Humanities - 1 Environmental management - 1 Ethics of Science and Technology - 2 European Commission representatives - 2 Gender studies - 1 Green transition - 1 History of Science - 1 Investment, innovation, start-ups - 1	Policy research - 1 R&D (tech & social) on nuclear fuel cycle back-end - 2 Science & technology studies (STS) - 1 Science diplomacy - 1 Social communication and stakeholder engagement - 1 Social Psychology, Psychology - 1 Social sustainability - 1 Sustainable finance - 2 Techno-Anthropology - 1
Table 2 – Self-declared expertise of workshop registrants (individuals cited multiple types)	

Country of origin and /or work	
Belgium - 6 Canada - 1 Denmark - 1 Finland - 1 France - 3 Germany - 2	Greece - 1 India - 2 Italy - 1 Poland - 2 Romania - 1 United States - 1
Table 3 – Country of origin and/or work of workshop registrants, including the organizers (as identified by organizers – no self-declaration)	

The ECOSENS Project

ECOSENS aims to create a neutral space where specialists in social sciences (including economics, sociology, Science and Technology Studies, among others) and humanities and in nuclear energy research and policy will meet, exchange views and collaborate with civil society and other relevant stakeholders in order to:

- Provide a societal perspective on the development and use of existing and new nuclear technologies, in the context of major societal challenges: climate crisis, sustainable development and energy security, by opening up the techno-scientific issues to the social, political, cultural and ethical context, in order to guide policies in the nuclear field.

- Provide an assessment of nuclear energy sustainability considering the entire life cycle of the current nuclear technologies, possible evolutions of the energy markets and nuclear technologies in the transition toward climate neutrality, and the societal perspective in order to reveal and evaluate the possible roles of nuclear power in the future;

- Provide a radically new economic model, based on the System of Provision (SoP), for the assessment of nuclear energy, overcoming the key weaknesses of existing economic models, providing a suite of indicators relevant not just for the investors (e.g. equity holders) but for a broad variety of stakeholders (e.g. consumers, governments, suppliers).

The ECOSENS project is a EURATOM funded project involving the following partners:

- Regia Autonoma Tehnologii Pentru Energia Nucleara (RATEN) – Romania – Project Coordinator
- Studiecentrum Voor Kernenergie / Centre D'etude De L'energie Nucleaire (SCK CEN) – Belgium
- Institute Of Sociology Of The Academy Of Sciences Of The Czech Republic Public Research Institution (ISAS Cr) – Czech Republic
- Institut Symlog (Symlog) – France
- Politecnico Di Milano (Polimi) – Italy
- Elektroinstitut Milan Vidmar (EIMV) – Slovenia
- Centro De Investigaciones Energeticas, Medioambientales Y Tecnologicas (CIEMAT) – Spain
- MERIENCE Scp – Spain
- Universiteit Antwerpen (UAntwerpen) – Belgium
- Univerzita Mateja Bela V Banskej Bystrici (UMB) – Slovakia
- Universita Degli Studi Di Cassino E Del Lazio Meridionale (UNICAS) – Italy
- The University Of Exeter (UNEXE) – UK

More on https://ecosens-project.eu/

How this report is organised

The synthesis presented in this report is based on transcripts of the audio recordings made in the three discussion groups. The synthesis text follows the programme of the workshop, and is organised in three parts:

The first part assembles key findings extracted by the authors from the detailed synthesis of the two discussion rounds.

The second part covers the first round of discussions under the theme ‘Imagining energy futures’. As the discussions in the three groups evolved in different ways, we decided to present the synthesis of the three discussions as separate sections.

The third part covers the second round of discussions under the theme ‘Sustainability assessment - a deliberation process in itself’. In the interest of presenting a comprehensive reflection of the discussion points, here we preferred to merge key ideas from the three groups into one text.

Summary of key findings

Imagining energy futures

The thought experiment in which participants were invited to 'think' of the energy future and write down the first 'thing' that came to their mind was evaluated as a meaningful and pleasant way to kick off the workshop. Asking the participants what they wrote down we learned that there is a wide variety of 'things' people picture ('blue sky', 'complexity', 'fear', 'a forest', ' a green field', 'a nuclear power plant', …), unveiling already in a simple way specific individual perceptions, concerns and visions.

Consequently, participants recognised the dialogues around the images as equally meaningful and valuable. Any picture that, in one way or another, refers to energy, nature, ecology, economy, production and consumption, climate change, for instance, may serve as a valid entry point to express any kind of individual critical vision on the debated topic.

The lists of 'worldviews / conceptual landscape' included in the table distributed to participants (see annex) was also considered to be a useful tool to inspire discussion. Many participants came up with additional values than proposed in the table, for instance …. It was recognised that the values originally listed are all 'positive' and that we should not forget that social values in reality encompass also 'negative valences' such as conservatism, individualism and violence.

Using images as entry points for reflection can also unveil the existence of overall 'positive' visions (such as belief in technology) or 'pessimistic' and even dystopian visions on the (energy) future (especially of younger generations). A general observation was that every image discussed by an individual participant immediately triggered discussion with the others around the table.

It was recognised that 'imagining' energy futures or futures in general may be an impossible endeavour in itself. Despite this, any conversation about these futures is a meaningful exercise, as it serves as a learning experience and inspire further reflection.

In imagining energy futures, participants recognised that we constantly have to 'balance' our idealistic visions with considerations on what is 'realistic' or 'pragmatically' possible. Despite that, it remains important to be able to think in an idealistic way, even if only because dialogue could unveil that people's ideals can be different and even contradictory.

In relation to this perspective, it was noted that reflections on how our values shape the 'images' of the energy futures we want (or fear) can also be seen as an 'exercise in reflexivity', as it involves asking ourselves questions such as 'why and how do I know what I know?', 'why and how do I believe what I believe?' and 'why and how do I fear what I fear?'.

The challenge of 'grasping complexity' becomes even more pertinent when taking into account the current information overload people have to deal with, and the cursory way we often deal with it while scrolling through web pages and social media. A plea was made for a 'slower digestion' of information, and for more dialogue about what information is available and how it could be

interpreted and used. It was also noted that, back in time, people had more 'energy literacy', as energy was more 'precious and expensive' and that we should develop that energy literacy again.

Instead of only trying to understand 'what is at stake' and 'how things relate and evolve', imagining (the complexity of) energy futures can also start from a normative thinking, concerned with basic values such as equity, justice, solidarity, well-being and the intrinsic value of nature. Ideally, of course, both 'entry perspectives' should be combined in a coherent 'holistic' perspective. Again here, the importance of formal dialogue in policy and research contexts was emphasised on multiple occasions, as it is the way 'to make values work' in discussions about energy governance in general and with sustainability assessments in particular. From out of that value-driven perspective, it was also recognised that these dialogues should be as inclusive as possible, 'sharing power fairly' by giving also access to those who normally "don't get into the halls of power".

It was noted that our personal imaginaries are not products of our 'pure self'. We think and act as social beings, and our imaginaries and the values behind them are also shaped by the 'frameworks that precede us', being our upbringing, education, local social context and the framing of information and opinion as it is presented to us.

Taking into account this 'fact of social construction', we should also remind ourselves that "the drivers of dominant narratives evolve over time". Important in the context of energy governance in this sense is the recognition that scientific research historically evolved from 'curiosity-driven' to being driven by the problems we created ourselves (as with climate change) and that, today, it is more than ever influenced by socio-political and market interests.

A sense of connection between us, humans, can be of strong influence for thinking energy and the future: the idea that we are connected as well in facing the problems as in our ability to find solutions and act upon them. That important sense of connection is not only there between humans, but also between humans and their natural environment.

In relation to the last point, it is more than ever important to reflect on our 'feelings' towards nature: as something we cannot escape from, as a nostalgic thing to return to or as a consoling place but also as a threatening environment to be scared of. Also the meaning of anthropocentrism was discussed: how it can be understood as a vision that humans possess and rule over nature, but also as a stance of responsibility, realising our power and potential impact, and thus our responsibility towards it.

Making sense of the concepts of sustainability and sustainable development

When talking about concepts such as 'sustainability', we always have to be aware of the differences in our specific understandings, not only as individuals but also as 'groups' or 'communities'. As an example, some visions could be perceived as typically 'Western', not taking into account concerns of the Global South.

The 'three pillar approach' to sustainable development, 'integrating' economic, environmental and social sustainability, remains popular up to the present day. However, while the common idea is that economic and ecological aspects of energy governance can be evaluated through calculation and empirical observation, 'social sustainability' remains open to interpretation. Knowing that also

economic and ecological aspects have social dimensions, the usefulness of the three pillar approach becomes questionable in itself.

The question whether or not Brundtland Commission's definition of sustainable development can inspire concrete action was also discussed. Some participants considered it too vague, although it continues to invite thinking in terms of intergenerational justice. It was recognised that there is no practical reciprocity between us and the people of the far future: we cannot communicate with them as they cannot express their visions on our actions that will affect them. Therefore, we don't only have 'practical authority' but also 'moral authority' over them, which means that we should take that authority seriously and try to deal with it responsibly.

Sustainability discourse has shifted from an anthropocentric viewpoint towards a planet-centred vision, considering planetary limits and welfare. However, it was also noticed that 'we cannot escape our anthropocentric viewpoint', which invites reflection about a new meaning of anthropocentrism, putting central the responsibility we have as humans towards each other, the next generations and our natural environment.

There has also been an evolution of thinking in terms of models: the 'weak' model of sustainability suggests that the environmental and social impacts can be compensated by economy. The 'strong' sustainability model emphasizes instead that economic sustainability is within the social and within the environmental sustainability: there are environmental limits and social minima that have to be considered and respected.

There was an agreement that one should be cautious when using models and that they should be 'opened up' in order to unveil value judgments when constructing the model architecture and its input. In general, in the interest of transparency and usability, model construction and the use of indicators, weighting factors and data should be subject of deliberative dialogue. In order to capture the plurality of views, in these dialogues, not only experts' views, but also those of the various stakeholders should be taken into account.

The paradigm of economic growth

In many of the discussions, the paradigm of economic growth was recognised as the big elephant in the room, although not everyone agreed with it. It was also said that there is nothing wrong with believing in a future where you have abundant energy available and in which energy in no means would limit the way we live or want to live our lives.

However, it was said that in dominant visions of energy futures, our energy footprint and consumption patterns are not considered. In that sense, many participants found the statement of the OECD saying that 'sustainability needs economic growth' deeply problematic.

It was said that 'corporations and other dominating narratives are avoiding the topic of constraints'. More 'just' policy frameworks could reduce corporate influence and profits while meeting individual needs.

There was wide recognition that there is a need to rethink and change our consumption patterns, taking into account the heavy burden on our environment now and in the future. In that line of reasoning, participants discussed our responsibility as individuals, recognising the so-called 'human tendency towards contradiction': we know we need to take responsibility (for instance by limiting our travels and use of flights), but we are not always acting on it. However, it was said that this is a shared responsibility for individual consumers, as well as for corporations, which have the largest footprint.

Inspired by the growth and degrowth discussion, participants also reflected about different lifestyles and how conscious use of energy could inspire these. There were calls for more 'sobriety' and to consider more 'serene' lifestyles – stepping out of the 'rat race' – that can also liberate space and time for what is socially valuable but not economically accountable in life: not only doing more with less and consuming less, but also working part-time, enjoying more quality time with family and friends, travelling, gardening and making art…

The social dimension of sustainability and sustainable development

It was recognised that the traditional understanding of the social dimension of sustainability refers to the assessment of how energy governance (technologies, systems, policies, patterns, …) affects society in general and social groups and individuals in particular. A typical example is the specific vulnerability of developing countries, indigenous peoples or small island states with regard to the harmful effects of climate change. Linked to these are social factors such as globalisation, but also poverty and growing inequality. Other examples are risk perception and aversion, resilience and (hindrances to) empowerment. Especially these latter factors are not 'calculable' or 'measurable' in an unambiguous way, which challenges their integration into formal sustainability assessments.

It was noted that sustainability is not an objective term. Treating it as such shuts down discussion. It's not something which can be decided by scientists or experts, but must be negotiated. In this regard, the 'performative meaning' of the social dimension needs more attention: in order to provide the concept of social sustainability with an evaluative potential, the social would need to refer to the participative character of sustainability assessment, rather than (only) to the social impact of energy governance.

Especially for energy systems modelling, sustainability is often replaced by the narrower criterion of 'carbon neutrality', with a focus on technology and on CO_2 as the most important greenhouse gas. It was said that this approach may be a useful exercise in itself, but remains a very myopic vision on the issues at stake.

The question was asked what it means 'to include nuclear' as a technology in sustainability assessment modelling. Knowing that opinions on it are so polarized, the decision to include it (or not) is already a political decision in itself. It was said that modellers do 'what the client requests them to do'. If they want nuclear to be included, then it gets included. The 'scientifically objective answer' is what the model then produces consequently.

We should take into account the crucial difference between social and market definitions of sustainability, which, according to one participant, holds a key to why advanced technologies

encounter social resistance. Social sustainability (putting people first) differs from market sustainability (putting the resource first). Instead of maximizing profit, social sustainability maximizes the benefit provided to people by the resource. Indicators therefore should include contribution to health and well-being and social inclusion.

In line with this, the proposal was also to think about social sustainability in terms of 'winners' and 'losers' when considering the potential impacts of policies (jobs, access to energy, impact on the local environment, impact on minorities, …) and also take into account relevant categories such as age, gender, education and culture.

Consideration of the social impact of our actions should not be limited to that of technologies. The (lack of) capacity of society to adapt to changes should also be considered. Assessments of the social dimension of sustainability should consider this wider context.

Finally, it was noted that social sustainability is grounded in the belief that we can construct something together, leaving aside 'divisive identity claims'. It integrates the practice of cooperation, and is as inclusive as possible in elaborating energy imaginaries.


+80.01


forward looking activities

Synthesis of part 1

Imagining energy futures

Inspirational questions presented to the participants

- *How to recognise and take into account the existence of multiple possible and desired energy futures?*
- *How do worldviews and values 'work' in imagining energy futures?*
- *Which artefacts (storylines, narratives, concepts, images, symbols, models, …) do we use to 'express' these imaginations and why do we prefer some over others? …*

Group 1

The participants described their imagined energy futures in multi-faceted ways, some referring to particular energy technologies, others describing a broader vision with no reference to specific technologies:

- A "green village" with "self-sustaining units", taking advantage of the "sustainable local ecologies that people built for themselves".

Q__ *"The image that I came up with was a very green village, like it's self-sustaining. [..] Where I come from, what happens is people are displaced. They are pushed into cities where, while they were living relatively okay lives in their villages [..], in the cities they end up living in slums. That itself is unsustainable for cities, which are growing at a very rapid pace. I think that's what came to my mind, to have self- sustaining units and to have energy that can ensure that."*

- An energy system that is more decentralized than it is now.
- Instead of having more centralized energy futures, there has to be more grassroots empowerment.

Q__ *"My sense is that instead of having more centralized energy futures, there has to be more grassroots empowerment*."

- An energy system based on renewables: "*green landscape full of renewables*".
- "*development within the limits of the planet and our life supporting systems*".
- A society where "*everyone is more aware of their own consumption*" and "*consuming less of everything*".
- Responsible society.
- Fair sharing of power within and between countries.
- Democratic energy.
- Mindful of intersections between energy, biodiversity, and ecology.

Q__ "*In addition to humans, we also need to envision other species as part of our energy future. Given the rates of extinction, and the fact that we're all interdependent, whether we like it or not. [..] you don't want a future which has no animals or vegetation or whatever.*"

Some participants referred to the plurality of imagined futures:

- There is a need for contextualized concepts and applications of sustainability. For instance, Western conceptions may not be the most appropriate way for the Global South.

Q__ "*We have to have differently imagined futures, even geographically.*"

Some participants referred to uncertainties related to whether or how it is possible to achieve the desired energy futures:

Q__ *"I'm less optimistic. For me, it's more, like, less consumption in general. It's very ambitious considering the current societal trends, but they are exceeding the limits to growth, I think, in any possible way. For me, the energy future, the sustainable and long term energy future I envision is one where everyone is more aware of their own consumption, where there shouldn't be the strive to buy a new electric car, but rather using less of everything. It's difficult, probably impossible, but that's how I imagine it."*

They expressed concerns about current societal impacts or changes:

Q__ *"We are exceeding the limits in every possible way."*

- There are visible consequences of trespassing limits; global warming is a reality everywhere, also in Europe.

Q__ "*I have this the picture [of dried land]. It's also represents [..] the consequence of trespassing these limits. So perhaps from global warming, we are having this. And it could seem that it happens in far countries, in, I don't know, in Asia. But in reality, it's happening in our countries. In Spain, it is happening. We are facing now these hot summers... So we are facing this problem already, not only due to climate change, but also for unsustainable water management in our countries too. It's the result of trespassing these limits."*

- The current model of development based on economic growth is not sustainable and "*we have to imagine our future in very different ways*".

- Mismatch between the values that drive our society and reality (to what extent they are realized?), or our actions and choices.

Q__ *"I would be a little bit more harsh about our current societies. I would say that we try to some extent to live, or at least we say that we are trying to live according to these values. But if we look at how well they are realized that there's still so much to do."*

- Communities being displaced to cities leading to: i) worsening of their living conditions; ii) unsustainable cities.
- Huge amount of information available, much of it of poor quality.
- Current technologies stimulate/require fast reactions, but this does not allow for reflection on the consequences of actions, it is not conducive to reflection.

They drew attention to social and technical challenges:

- Setting limits on how / how much of environment can be used is hampered by the "*the competition for power*".

Q__ *"[..] we have to set some strict limits on how much of this environment and our life support system can be used. I've been wondering, we've known about these problems for 50 years, and how it is so hard to set those limits. [..] as long as we allow these huge inequalities both between countries and within countries, the competition for power and for everything that*

comes with having power, like recognition and material benefits and so forth. If we can't somehow put some brakes on that competition, then it's very unlikely that we can set a limit. Then the physics would set those limits for us and that would be nice. [..] Energy is literally power to change the world in some way. So how we can set those limits? How does this new energy future consider impacts like distribution of societal power? How does it change this? Is it compatible with the idea of fair sharing of power or is it not? It's actually funny that I got this picture because it reminds of this problem with very powerful technologies that with great powers, there should be great responsibility. Increasing the power of our technologies is becoming a part of the problem, maybe even more so than part of the solution."

- Some countries are favoured geographically as regards particular energy technologies.
- Sustainable energy resources are not equally distributed.
- Need for storage capacity.
- We shouldn't make a green transition only favouring the ones who are already socio-economically privileged.
- There is reluctance to change.

Q__ *"If (energy) transition is going to be fast, it means that a lot of things are going to change fairly rapidly. And that is always going to be difficult. People don't really want change. They want things to stay more or less like they have the things used to be."*

Q__ *"Convincing people that the green transition is beneficial for us in many ways, that we could be among the actual winners for this, even if some jobs are lost, is extremely hard."*

- People often focus on short-term future.
- Fragile society, see e.g. COVID.
- Capacity of society to adapt to respond to social changes (jobs available in different sectors) arising from technological changes.

Q__ "*Therefore, not only the technology is the problem, the problem is the capacity of the society to organize itself and produce other jobs for people that are translated from a technology to another technology. Otherwise, we will say, okay, the solar cannot introduce enough amount of jobs and it is not sustainable from the social point of view, or it is not real. There is a reality in relation with the localization of the production because we have some countries that are producing the cells, the photovoltaic cells, and there are countries that are buying them. The working is in some countries and practically the jobs are in other countries*."

- Uninformed opinions, or opinions based on inaccurate information; oftentimes nowadays it is difficult to trace back the information sources.
- How will the growing use of (AI-based?) information processing technologies change our society?

Q__ *"I think that we are in a world in which it's the action which prevails. You scroll down very fast. You like, you dislike, you like, you dislike, but without any distance from the information, from the knowledge that you have. And this may have consequence on democracy, on policy making,*

on governance. If we create a generation of people, who just click in less than a second. It's not a world which is taking care of the others. I feel this is the danger: without reflection, you act and act without any discernment."

Q__ *"Are we going towards more quantity or more quality?"*

Participants described guiding factors for decisions concerning energy futures, some of them pointing to the necessity of anticipatory reflection:

- Consider how and for what we will use the energy produced, with what cost, with what impact on the environment and society? E.g. is it a necessity or a leisure that will have negative outcomes?
- Keep our development within the limits of the Planet, of our supporting systems.
- Consider the concept of absolute environmental sustainability.
- Several elements should be included in the analysis and the effects of scaling up should considered, e.g. the amount of material produced, amount of land used, energy efficiency, constraints on what production capacities are feasible and acceptable give the cumulated effects, transport, waste.
- Social justice: are these systems and energy sources contributing to fair outcomes? We shouldn't attempt to maintain current systems, or current situation, that is in many ways deeply unfair.
- The perspectives and viewpoints of those "who don't get into the halls of power" should be emphasized and included.
- Pace of change should be slow enough so that societies can adjust, so that dignity for all members can be retained and enhanced.

They expressed uncertainties regarding several factors related to sustainable long-term energy futures:

- "How to achieve a balance" between local self—sustainable ecologies and outflow of people [to make place for high capacity energy infrastructure?].
- Changes in the structure of consumption, e.g. "*how much will we consume and how the society will react?"*
- Changes in the structure of jobs, occupation, daily behaviour, due to decreasing demographics in Europe, aging populations, disruptive technologies.
- How we can set [those] limits on "*how much of this environment and our life support system can be used"*?

Q__ *"How does this new energy future consider impacts like distribution of societal power? How does it change this? Is it compatible with the idea of fair sharing of power or is it not?"*

- Transport of electricity at large distance or move the industry at the production location?
- That is a big thing because no one really knows how this thing is going to unfold. How this transition is going to unfold. We can make educated guesses about how much wind power, solar power and nuclear power we're going to be building, but no one really knows.

They referred to the worldviews / conceptual landscape – table (see annex) and pointed out:

- Missing elements:
  - Reflection (value): lack of reflection has implications on democracy, policy making, governance; reflection should take into account care for others, long term consequences of your actions.
  - Sobriety (value or normative lens): related to limiting consumption.
  - Responsibility: not only individual, but especially collective; not only for the daily actions but also for what we transmit to future generations.
  - Religion.
  - Trust.
- Mismatch between values, the values that we agree should drive our society and reality (to what extent they are realized), or our actions and choices we make.
- Models (e.g. American model), symbols (e.g. EU flag) were clear in the past; what replaces those, especially for young generations?

Some participants also referred to feelings of pessimism, especially of younger generations. Others expressed confidence in technological progress and belief, or cautious optimism, that it is difficult but possible to have lower emissions and less consumption. They also referred to social media, misinformation and disinformation and the lack of role models, reference models and discussed the impacts of globalization.

Group 2

(For information: the group was not invited to elaborate energy futures, but instead to have a 'methodological' conversation.)

Images

The participants analysed the images that were distributed to them, mentioning something positive/a critique. In brief these polarities were:

- A farm field: Enough food to feed all the people we have/Biological imbalance introduced by monoculture; high external costs.
- Urban transport: Opportunity (developing transport options)/Challenge (how to do it sustainably).
- Green city: A utopian vision of a very dense city providing services and resources/Inequalities and dystopian loneliness it creates.
- Underground repository: A triumph of human intelligence, knowledge and mastery of many levels of reality and our earth/an oversimplified generic representation. (This sparked discussion of a) the supplementary 'aura' of meaning surrounding subjects like RWM and b) the possible value of simplified information to allow non-specialists to access technical content).
- Fast food: Cheap fast nutrition for the American family/Bad impacts on quality, health, and tradition; loss of connection to the effort and the reality of production; "produce too much, consume too much".
- COP21[1]: The agreement was signed, a huge success/It was not enforced, an empty promise. (This led to discussion of the need to take into account actual social and economic differences between countries, including in the Global North and South; these are insufficiently acknowledged, leading to conflict).

The group commented on interferences between sustainability analyses, political decisions, and their actual implementation:

Q__ *"The COP is a platform for creating and generating scientific advice, but sometimes politics prevail. Is the desired utility of such a platform to come to good science-based decisions, or to foster diplomatic or political discussions?"*

Q__ *"Elected people with democratic mandates work at national level in the global scheme to make sustainability decisions. But something even larger impacts the decisions and blocks them from translation into practice: Corporations and the flow of capital."*

Statement on artefacts

[1] The Conference of the Parties to the United Nations Framework Convention on Climate Change, known as the UN Climate Change Conference. COP21 took place in Paris in 2015 and resulted in the 'Paris Agreement'.

The group then considered the statement '*We imagine energy futures based on/as part of our worldviews, influenced by our observations and perceptions of "reality" and the values we find important, and we use "artefacts" to express these imaginaries, for ourselves and towards others.'* While the basic principle was accepted, members of the group challenged the formulation, saying it corresponded to a 'kind of dream world'. A participant argued that imaginaries are not purely personal. They are shaped also by frameworks that precede us: dominant discourses.

Q__ *"This statement seems to say that everything depends on us: it's our values, our norms, our imagination, our choices of the future. This is too narrow because it forgets about the frameworks we live in: material reality, but also dominating narratives. Besides our choices and our free will and our values, there are very powerful social actors who (intentionally or not) create an offer of iconic symbols and pictures of the future which influence our worldviews – for example, utopian imagery of the green future city. This is not a completely deterministic process, but what we think, what we believe in, what we value is dependent partially on what's offered to us in terms of the dominant narrative."*

A participant pointed out that the drivers of dominant narratives evolve over time, and today are largely complex.

Q__ *"At the height of the scientific revolution of the Renaissance, science was curiosity-driven. The steam engine then motivated different imaginaries of energy futures. Today we are at questions about climate change, abundance and shortage. Alongside that we have geopolitics, policy horizons, and a nexus of factors resulting in energy futures being riddled with more (or different) constraints than 30, 40 or 100 years ago. Today even innovation is trapped inside the notion of intellectual property, which leads to questions of indigenous rights and equitable distribution of progress. There is no simple picture of the right energy mix."*

It follows that energy decisions are complex, and solutions must be customized to country specifics.

Q__ *"The question remains: "What do you pick? What do you take forward? It can't either be just solar or just nuclear. What is the mix? How do you come up with an optimal mix?" Cultures and societies would have to come up with solutions based on their needs, what works best for them."*

Another pointed out that the statement translates a post-modernist view, but for the sake of justice we have to address material constraints, including energy shortage.

Q__ *"We can imagine a perfect, democratically discussed energy production system; but in reality we have third world countries where every person is responsible for energy creation and generation on their own. Such a contradiction is not what we want. We have physical constraints in the material world that we live in and we need to take them into account and realize that it's not only the observations and perceptions that shape us, but also the material reality that we live in."*

- Imagined projections of future unavailability of energy are qualitatively different from the experience of freezing at home without access to heating fuel. This is a real lived experience of persons from Eastern Europe. It can focus people on the goal of developing energy abundance because "you know you need it".

The group continued to discuss the dynamics between imaginaries and reality:

Q__ *"When you ask me about an energy future, I'm thinking: "Is it what I want, or is it what I expect to happen?" For me they are not the same."*

Q__ *"But even in imagination, you are setting a direction where you want to go. Even if you don't achieve it, you have actually identified what you don't want to achieve. While you know the actual reality might be different, in your brain you have still narrowed down your options, policy, resources and the kind of action you want."*

Q__ *"But then you have this reality check. For my desired energy future, I would say, "Okay, a vision of energy system totally based on renewables without nuclear would be beautiful. So why should we take any risks if we don't have to?" But in terms of expected future, I am realistic enough to know that we have to go into some risky controversial businesses like nuclear because reality has some constraints and desired imagined vision is not reality proof."*

- Countries enjoying abundant energy have ignored underlying realities. 'It's true when we switch on the light, we have electricity; we live with abundance. But we cannot wait until the moment that we won't have it. We need to plan ahead. In France, we haven't been doing any energy planning for 30 years, and now we are facing huge problems' in coming to democratic decisions on the energy mix.

Participants focused again on dominant discourses. Influencing our desires for consumption, corporative marketing discourses push us towards unsustainable behaviours. An extended discussion concluded that justice would reduce corporate influence and profits, while meeting individual needs.

Q__ *"Corporations and other dominating narratives are avoiding the topic of constraints. Very optimistic and naive portraits of the green future are trying to tell us that we can keep consuming as much as we consume now. In dominant visions of energy futures, there is no question of reducing our energy footprint or consumption. No one will tell us frankly that we should be prepared to eat less, to have no car, to consume less."*

Q__ *"This framework for discussion on consumption is unfair. Simply because it's not us as individual consumers that have the largest footprint, it's the corporations. Our consumption is for their profit and they are the drivers. Why are we to pay for the fact that we have not been able to rein them in? Their profits and benefits should be fed back to the collective."*

Q__ *"It could be organized that global consumption will be reduced at the cost of corporations, not at the cost of individuals."*

The 'worldviews / conceptual landscape' table

The group discussed and enriched the 'worldviews / conceptual landscape' table (see annex). It may be used to consider the following questions:

- Which normative lenses, stances and values are behind the dominant discourses? Which are missing? (Use the grid as a tool for deconstructing narratives).
- Are there 'vehicles' or 'artefacts' that could take us towards a better outcome for humanity (away from the pessimistic vision of the preceding conversation)?
- Which elements are needed to construct a sustainable platform for energy futures? (A participant claimed that all the elements are there, to be arranged in a strategy; each can be assessed empirically or qualitatively.

Elements were added to each column of the grid:

- Values
  - Democracy
  - Empowerment
  - Equity
  - Proportionality
  - Responsible science; responsible conduct; responsibility
  - Openness
  - Stability
  - Predictability
  - Tradition (as a cultural good)
  - Progress
  - Development (as opposed to economic growth for the benefit of corporations)

The values appearing in the grid at present are all positive. We must not forget that social values in reality encompass also negative valences, which are just as active in shaping energy imaginaries:

  - Conservatism (opposition to change)
  - Power, hierarchy and domination
  - Individualism
  - Legalism
  - Violence and destruction

- Stances
  - Gratitude, positive thoughts, self-care (to counteract toxic discourses)
  - Hope (while already listed, it's particularly important, as it contains an imagined positive future)

- Normative lenses
  - Survival; survival value of energy; survival not of 'the fittest' but of everyone

- Artefacts

Normative instruments themselves must not be forgotten in the list of artefacts:
- Laws
- Regulations
- Policy
- Strategy

Material artefacts embody and carry on the energy vision that created them:
- Power plants, installations
- Energy systems and infrastructures
- Investments

Further non-verbal or cultural artefacts include:
- Art
- Dance
- Music

Artefacts have been used in negative manners to support dominant discourses tending toward overconsumption and alienation. However they could be converted to prompt progress towards a fair and sustainable energy context:
- Social media algorithms: Forcing toxic stories on the consumer/Directing to more virtuous narratives
- Disinformation/Information
- Manipulative advertising/Responsible nudges, presentation of actionable futures

Action itself holds a symbolic power that can influence change in others:
- Global activism

The group discussed the fact that awareness does not translate into action. An example is awareness of aviation's contribution to CO_2 levels, yet failure to reduce holiday flights or regulate the use of private jets. It's important for citizens to be aware of climate change, of energy production systems and consumption. This awareness can be raised directly by information or indirectly by cultural approaches. However, constraining laws and regulations will still be necessary to overcome the human tendency towards contradiction: holding knowledge and not acting on it.

- Formal methodologies
  - Political elections, selecting a candidate after assessing their/party energy platform
  - Referendum
  - Public consultation processes
  - Consensus conferences, public debates (whose content adds to artefacts)

Group 3

The discussion started with a round of reflections on 'images'. At the start of the workshop, participants were asked to 'think about energy and the future' and grasp and write down the first 'thing' that came up in their mind:

- A nice nature landscape with 'energy generation technologies' integrated in the landscape.

Q__ *"… for me, they're in the future indistinguishable. Also because I personally believe in a future where you have abundant energy available. I don't want to believe in a future where energy is a scarce good that leads to power or monopolistic behaviour."*

- A 'solar punk image', referring to a specific sci-fi aesthetic that was called 'steam punk' and that was fascinated by 18th and 19th century technology, 'wheels turning and smoke popping'. A more recent version is a kind of 'solar punk aesthetic' where people problematise this romanticisation of fossil fuel energies
    - This led to a reflection on the problem of misinformation and disinformation and the growing scepticism that comes with it. Reference was made to the introductory speech about the EU Taxonomy and to the fact that it was not mentioned that this Taxonomy was (and still is) topic of controversy. Visions like the Taxonomy or 'the green economy' and any other 'net-zero' approach were said to be very aspirational, although not always with care for the pathways to reach the goals and realise these visions. It was said that business plays an important role in this, as it 'learned' to leverage that very human desire to see things on the bright side.

- A 'person and the light coming from that person', as in an aura, as in yoga:

Q__ *"I think I imagined an aura, but I thought it would be too, how do you say, non-scientific to share. But when I think about energy and the future of energy, I also think of 'synapses', so about the energy that we have in ourselves, in our biology as living beings. I also thought about computers as a metaphor for energy. Back in time we needed an entire building for one computer and now we have a computer on our wrist. So maybe the energy production systems will also go that way."*

    - In reaction to this, it was said that the picture of the person in the light and the connection to yoga can also refer to the need for some more reflection and serenity, more reflective and even Buddhist attitudes, in thinking how to deal with energy.

- Electricity, although from out of a critical stance:

Q__ *"… energy might mean a number of things, like heat, impact, speed, propulsion, fire, …. We as humans used to interact with energy in a much more diverse way. You don't need necessarily electricity to cook your food. You need heat. You don't need electricity to shower. You need a certain speed of water. What has happened is that we are now increasingly accomplishing all these ends through electricity. And is that trend going to continue? Are all our energy futures and options going to be pivoted on this loss of diversity of forms of energy? So if we first pivot*

everything in the form of electricity, as with solar. Is that sustainable? Is that ethical? Is that equitable? Does that bring more justice? These are big questions and I'm agnostic about a lot of them."

Q__ *"But that focus on electricity means that it brings with it not just a new form of energy, but also a new aesthetic. For instance, there's an aesthetic involved when you consume your water or heat your water, switching a button or putting on a stove. And there's question of materiality, there's question of temporality. Channelling all other forms of energy into electricity also means that things happen in a certain aesthetic, in a certain speed of time. So electricity gets things done very quickly. Probably that is why unconsciously or consciously, we have all started consuming a lot of electricity."*

- However, not everyone agreed with that:

Q__ *"I have difficulties to accept the statement that we should be more conscious about energy. I would actually argue the opposite. For me, in the ideal world, energy in no means limits the way we live or want to live our lives. For me it sounds very dystopian to assume that energy should dictate the way society and humans operate. […] if you go that route, you get into a lot of ethical discussions. Because for some people, that could mean nobody should fly anymore while going on travel. Or you can't have certain hobbies anymore or you are not allowed to keep pets because they consume meat. I think it's a very difficult topic, because how do you define what accommodates everybody's needs?"*

  - In reaction to that participants reflected on the image of the human we have, what hopes and dreams humans have. Can we still decide for ourselves on how to consume energy in our daily lives? It was noted that, back in time, people had more 'energy literacy', as energy was more 'precious and expensive'. It was said that we should develop that energy literacy again. One part of that literacy would be the need to be able to imagine the limits of physics for what we actually can and want to do. For example, innovators think of charging batteries through wireless electromagnetic radiation, which comes down to 'fighting' with the limits of physics.

Participants were then invited to comment on the printed images that were handed out at the start of the workshop:

- A picture of a 'cute' artificial world, reminding of the 'solar punk aesthetic', representing gravity as an alternative to energy stored in batteries.
- A picture of a forest fire, evoking mixed feelings. Controlling fire helped the human to evolve. Wildfires help to renovate the forest. But there are of course also the fires that are seen as a consequence of human induced climate change.
- A picture of a gigantic dump where a man is looking for food to feed his children and his family:

Q__ *"… to me, it looks like walking in ruins. That's one of the phrases the philosopher Isabel Stengers uses. It feels like there's no pristine nature to go back to. So when we talk about sustainability, we have to reckon the limits of physics, we have to reckon the limits of ecology*

we have reached. So this represents a future that is very complicated, very messy. But also hopeful at the same time, because there are no handrails, there's no nostalgia."

- A picture representing a child in Fukushima undergoing an ultrasound measurement of the thyroid. This lead to a discussion on the possibilities of and limits to science in its role of advising policy on actual situations or trends. It is known that in normal populations, thyroid cancer can remain largely undetected, unless revealed through systematic screening. Scientists now claim that, if there would be a rise in thyroid cancer in children due to the nuclear accident, it would probably be too small to be detectable.

- A picture of a sea with icebergs and the text 'We cannot negotiate with the melting point of ice':

Q__ "The positive thing about the picture and the quote is that indeed these current limitations on our ecosystem make it very clear that something needs to happen and also what needs to happen. But the negative thing with this picture or with the typical polar bear on a small floe is that, while they can be powerful in stirring a big community into action, it's also dangerous because it overly simplifies the issue, the problem."

  - In the discussion that followed, participants reflected on the way these images can steer emotions, not only 'motivational', but also anxiety. The discussion then evolved into a reflection on the environmental movement that often make use of these images. It was said that this movement is not 'homogeneous', and that there is also awareness of the problematic nature of this kind of messages. It was also recognised that the image with the quote is produced by a scientific research organisation that wanted to support the strong message on the state of the cryosphere the report contains.

Participants were then invited to engage into to more 'philosophical' reflections on how our values shape the 'images' of the energy futures we want (or fear). It was said that it could be seen as an 'exercise in reflexivity', asking ourselves questions such as 'why and how do I know what I know?', 'why and how do I believe what I believe?' and 'why and how do I fear what I fear?'. It was also suggested that the participants could make use of the table 'The art and science of imagining energy futures – worldviews / the conceptual landscape' that was distributed at the start of the workshop (see annex).

Thoughts from the discussions include:

- The way we are raised as children and adolescents shape our values and interests, not only through the upbringing by our parents and our education, but also by the social circles in which we live and act. The decision to study economics origins from a complex interaction of factors, but may have a decisive impact on how we look at issues such as energy.
- It was noted that also religion shapes values, especially of the older generations. European culture is in a way still rooted in Catholic values, although resistance against the Church as institute is now also part of that culture.

- There is anyway need to be concerned about the public understanding of science and about the growing indifference towards science, especially taking into account the influence of social media on young people.
- A sense of connection between us, humans, can be of strong influence for thinking energy and the future; the idea that we are connected as well in facing the problems as in our ability to find solutions and act upon them. That sense of connection is not only there between humans, but also between humans and their natural environment.

Q__ *"I am deeply saddened by the loss of what we call biodiversity, which are living beings all over the planet Earth that are dying at an incredible rate. It makes me sad. And that doesn't come from anything anyone ever told me. I grew up in Texas, in a pretty conservative society that didn't care about that at all. So I feel connected and I feel pain, literally pain. And another value that I want to talk about and that is in the 'conceptual landscape' table is 'agency'. So part of what I try to do in my work is connect our sense of beings in the world, beings in nature, as part of nature and agency."*

Q__ *"I don't know if it comes from my religious social background, my family, or maybe from my education, but I have some feeling that things resonate. I have always felt as if actions have butterfly effects and that things are interconnected. So the political intellectual ethics investment does not necessarily always come from being a do-gooder, but from the fact that everything is so interconnected that we have a responsibility we cannot escape from. My agency is tied with everybody else's agency and my testimony or predicament is tied with everybody else's testimony or predicament. So the sense of responsibility comes from this reckoning of being tied in all directions with so many things, and there is no escape. The only way I can move ahead is by thinking of other entanglements and then think hard what is the most responsible way of moving ahead."*

Q__ *"I was thinking about which of the values from the table resonate most with me. Where do our views, our visions, come from? I was raised by parents who were very aware of social justice issues, and environmental issues have become social justice issues. So I think that's a trajectory. And that's also why I underlined agency in the table. And then also a personal experience. I grew up in the Alps where climate change is incredibly visible and tangible. And so it's also that direct experience of seeing things change."*

- Participants then discussed various 'feelings' towards nature: as something we cannot escape from, as a nostalgic thing to return to, as a consoling place but also as a threatening environment to be scared of. Also the meaning of anthropocentrism was discussed; how it can be understood as a vision that humans possess and rule over nature, but also as a stance of responsibility, realising our power and potential impact, and thus our responsibility towards it.

Q__ *"For me personally, the thing I fear most about climate change is what it will make humans do. Basically, if you can't have agriculture or crop growth anymore, or basically a decent way of living, we will probably get a very large migration of people, especially in other continents where you have a denser population. And if you see the stress and the problems that migration now already brings, imagine two billion people migrating. I'm afraid of what it will make people do because you will get scarcity of materials. I expect wars and that kind of things to*

happen. That's actually what I fear much more than what nature itself will do, because that's something we will be able to manage if we work together."

- Although participants recognised the relevance of this perhaps dystopian picture, the final thought was about the value of humour for imagining energy futures.

Q__ "… If we lose our sense of humour, we lose also... We go crazy…"



Synthesis of part 2

Sustainability assessment - a deliberation process in itself

Inspirational questions presented to the participants:

What is the meaning of 'sustainability' in the theory and practice of sustainability assessment (SA)?

And what is the meaning of social sustainability and how can it be taken into account in SA knowing one cannot rely on quantifiable information?

What values are usually missing in traditional SA approaches?

How can we ensure that sustainability assessment criteria are reflective of a diverse range of worldviews and values? …

The discussions in the three groups can be synthesized through four 'entry points':

Reflections on

- The understanding of the concept of sustainability / sustainable development in general
- Specific understandings of social sustainability
- Rational approaches to 'model' and 'measure' sustainability
- Engagement and involvement in making sense of sustainability

Reflections on the understanding of the concept of sustainability and of sustainable development in general

Some participants questioned the underlying conceptual basis of sustainability, pointing out that:

- Sustainability discourse has shifted from an anthropocentric viewpoint towards a planet-centred vision, considering planetary limits and welfare.
- Evolution of thinking also in terms of models: the weak model of sustainability suggests that the environmental and social impacts can be compensated by economy, but this is not always the case; the strong sustainability model emphasizes instead that economic sustainability is within the social and within the environmental sustainability; there are environmental limits and there are social minimums that have to be satisfied.

Q__ *"There has been an evolution from the initial concept of sustainability [..]. There is a weak concept in the sense that the environmental impact can be compensated, and the social impact can be compensated, and perhaps it is not the case in many cases. Then the concept [..] evolved to this [model where] economic sustainability is within the social and within the environmental sustainability."*

- There is now also more consideration / recognition of indigenous communities, local level, shared knowledge.
- Sustainability discourses and applications have shortcomings:
    - We are still far from a holistic concept that is not monetised:

Q__ *"There's, I think, an improvement in terms of social sustainability as well. But then the way it is dealt with, trying to understand it in practice according to system dynamics, so measuring sustainability, assessing it, measuring, for example by having in place something like the emission compensation, allowing big companies to produce and then try to measure it, allowing them to compensate for their emission, for example. This indicates clearly that we are still very far away from holistic concept of sustainability that is not monetized."*

Q__ *"But there's really not a question of what do we use our material, energy for? The motivation is driven by marketing more than needs."*

    - Short-term vision: "we are producing sustainable energy sources, but it's always a consumption and an explosion of the material".
    - Post-colonial perceptions reflected in sustainability discourses and distribution of renewable energy resources: divide between Western countries, who are driving the sustainable revolution, they keep on growing and monetising solutions, and the Global South; these impacts are not considered.

Q__ *"And there's a lot of divide because the Western countries are driving the sustainable revolution and they keep growing and monetizing sustainable solutions as well. While instead the impacts on the, Global South are relevant and they're often not taken into account. So*

there's this post-colonial perception of how the sustainability debate is taking place and also how the renewable energy sources are distributed."

Q__ *"I really like what you said about the global south, which means that we also have to think about energy futures which are more situated in the realities of, for example, the Global South, where we come from, where we face very different problems compared to the Global North. And for a truly sustainable future, I think it's very important to take into context what you said about how you will be even sustainable, how even sustainability is being marketed now increasingly in the west. And maybe that's not the most appropriate way to go forward for the Global South. We have to have differently imagined futures, even geographically."*

- Participants discussed whether or not the original Brundtland Commission definition of sustainable development can inspire concrete action. Is it workable or too vague?

Q__ *"I don't think it's too vague. However, I don't think, from a psychological cognitive perspective, human beings are sufficiently motivated by future generations' problems. I think it's demonstrated that that's an ineffective way of motivating action."*

Participants also discussed about the (lack of) balance between sustainability aspects:

- Not all damages, e.g. dignity, can be compensated with money.
- It is necessary to keep the balance (between the three dimensions) and keep the system functional.
- Especially for energy systems modelling, sustainability is often replaced by the narrower criterion of 'carbon neutrality', with a focus on technology and on CO_2 as the most important greenhouse gas. Linear optimization models such as the Times model work with one overall function ('least cost') and one overall goal (CO_2 neutrality). Times has a high number of technologies modelled and, for example only for the Belgian system, it already generates up to 100,000 equations and a few millions of variables. It seems very subtle, but it remains 'narrow' in its assessment of sustainability of energy systems.

Q__ *"One of the fallacies of Life Cycle Assessment modelling is that it's based on currently observable factors. For example, current CO_2 emissions of steel production factories. But of course, by 2050, the system will have to change, but LCA does not take into account how these factories would evolve in limiting their emissions. So the assessment is not valid for the future. That's why we try to work with an integrated assessment model that includes technologies and the interactions between them."*

- As a reaction to this, the question was asked what it means 'to include nuclear' as a technology. Knowing that opinions on it are so polarized, the decision to include it (or not) is already a political decision in itself. It was said that modellers do 'what the client requests them to do'. If they want nuclear to be included, then it gets included. The 'scientifically objective answer' is what the model then produces consequently. However:

Q__ *"When people then ask me which technology should be used, then my answer is: all of them. You will need everything that is available to basically make it work. Beyond the discussion of*

whether or not we need nuclear, or whether or not we need wind or solar or heat networks or waste incineration or CCS, my answer is: if you really want to exclude one of them, it becomes even more expensive than it already will be."

- Sustainability currently is too much linked with economic growth, "we are scared about stagnation because we are using a financial reference"; however the current economic model has failed.

Q__ *"Another thing I want to say, our development, our sustainable development, is too much linked with the economic growth. [..] We are looking each year, how much is the rate of growth? And practically, we are scared about stagnation. We are scared about the decrease of the economy. And why? Because this is the monetary system that we use. We are using money and we are using banks and we are using debts and so on. And if in the future we may move to another system, more stable, probably we can reach the sustainability."*

- In another discussion, the paradigm of economic growth was recognised as the big elephant in the room. Participants found the statement of the OECD saying that 'sustainability needs economic growth' in a way deeply problematic, although not everyone agreed with it.
- The weak model of sustainability suggests that the environmental and social impacts can be compensated by economy, but this is not always the case; there are environmental limits and there are social minimums that have to be satisfied.

Q__ *"Now I'm more in favour of this absolute environmental sustainability. We have all the planetary limits and then we have the social minimums, so we have to move to this [..] donuts [model] in which the economic activity can be sustainable, absolutely sustainable in environmental terms and also socially sustainable."*

Q__ *"Sustainability assessments generally address three pillars: economic development, social development, and environmental protection. It's two pillars for humans, and one for the environment…"*

Q__ "Should we keep the pillars and do something better with it? We can also imagine that economic, ecological, social sustainability can be in conflict with each other."

There is a crucial difference between social and market definitions of sustainability, which holds a key to why advanced technologies encounter social resistance:

- Social sustainability (putting people first) differs from market sustainability (putting the resource first). Instead of maximizing profit, social sustainability maximizes the benefit provided to people by the resource. Indicators include contribution to health and social inclusion. The product is designed from the ground up based on what will be socially acceptable, harmonizing product specification and the needs of the people.
- Failing to establish a social license (including prior agreement on the actual need for a technology) and failing to adjust the value debate at the start, creates negative externalities: polarizing debate and blockage.

Q__ *"This is why we have the negative perception of nuclear or biotech: these products are inherently made from the market sustainability perspective, not from the social sustainability perspective."*

Q__ *"It's the original sin for nuclear, and we've been dealing with the aftermath for decades…even if the product itself is sustainable and contributes greatly to sustainability as such."*

Sustainability must be defined by the persons concerned:

Q__ *"On the normative level, I agree that we should put the people first, but I see a very big challenge on the political level. In the context of Poland's coal mining regions, putting the people first means that we continue mining coal the way their fathers did, and thus continue unsustainable energy production."*

Q__ *"People do accept externalities that they have gotten used to or that they have built narratives around to absorb them emotionally and socially."*

Q__ *"Sustainability is not an objective term; treating it as such shuts down discussion. It's not something which can be decided by scientists or experts, but must be negotiated. It's very rarely possible to fulfil all three goals (social, economic and environmental). Allowing one factor to dominate the decision, such as the sheer climate change/environmental impact of energy, is a form of technocracy. A democratic procedure should clarify where we put the cursor and how we balance between social, economic and environmental outcomes."*

Q__ *"This debate should be about how much risk and what kind of (new) risk are we ready to accept."*

- However, participants also recognised that sustainability – thinking has to take into account high degrees of complexity, beyond our cognitive capacities and our capacities of 'imagination', which makes it very difficult to evaluate concrete actions in 'the bigger picture'.
- However, it was stressed that it remains ultimately important to care for literacy in science for everyone. *"We all have to be able to acquire enough knowledge in the interest of a participative process".*

Parts of the discussion on possible understandings of the concept of sustainable development concentrated on the future generations, and on what that could possibly mean.

- If we put people central in sustainability thinking, how can we think of our fellow humans far away, geographically or in the far future?

Q__ *"Who are the humans we have to ethically connect with? I think in talking about the future, I feel sometimes the future is 'in the way'. We can think about ethical relations towards nature or towards humans here and now, but how about those humans far away? How would those make us behave versus how would we behave towards future generations that have a vague*

relation to us? Forgive me, but I feel it's very hard to really make us think normative with the future as a reference... To think and act normative, ethically, with the future as a reference. I think the normativity that the future includes is a problem in itself."

Q__ *"If it's too abstract to think in the interests or even from out of the position of the future generations, Should we then not only... Could we then not refer to what we do today? The simple idea that in the interest of the future generations, what is most important for us is that we do our best today and that we explain them why we thought this was the best we could do. That sounds very superficial, but doing our best today, what would it mean?"*

Q__ *"The first thing we have to do is to be honest about what we're doing. If we're going to be able to tell any story of how we did our best, it means not being idiot about it and being honest about the challenges. And then trying to do something about it."*

Q__ *"Sustainability here to me means two things. One is, of course, timelines and different things are sustainable at different timelines. And the second thing is not things, but relationships. Different relationships between things are sustainable on different timescales. And then what is the best way to think about those relationships? Do we think about it in a very techno determinist singular way? Or do we think in a much more diverse way? Because even a very thought provoking or shocking picture of an iceberg or a very emotionally moving picture of a child can become a problem because it's tying you to this fixed notion of future. And that's deeply problematic."*

- Inspired by the growth and degrowth discussion, participants also reflected about different lifestyles and how conscious use of energy could inspire these: doing more with less, consuming less, working part-time, enjoying more quality time with family and friends, travelling, gardening and making art…

Reflections on specific understandings of social sustainability

Various aspects of social sustainability of energy systems were highlighted and discussed:

- Social sustainability should not mean sustaining current, bad and unfair practices, i.e. sustaining societies that shouldn't be sustained.
- The need to assess positive and negative impacts for the various stakeholders, including specific population groups.

Q__ *"We need to have a picture on the impacts of policies, who are the winners and who are the losers, how are they distributed; are there groups (age, education, culture, living somewhere) that benefit or loose."*

  - Impacts on jobs, not only how many jobs it [the new energy system] brings but also how many jobs it threatens; also what kind of jobs, i.e. well-paid?
  - Access to energy.
  - Minimal harm on environment, minimal human displacement.
  - Impact on minorities.

- Long-term impact – for example impact of installations on communities that have been developing around it.
- Need to have "self-regenerating, self-sustaining ecologies of energy".
- Need to preserve the dignity of people.

Q__ *"It would be a good goal not to prevent change, but to try to keep the pace of change slow enough so that the people in societies can adjust. [..] But I would also add somewhere the requirement to uphold the dignity of people. Even though societies might change, the change should be somehow constrained or buffered so that some basic dignity for all members of society would be retained and enhanced. Pace of change is such that all members of society can adjust and preserve their dignity ."*

- Need for responsibility at all levels: individuals, countries, companies.

Q__ *"Practically, sustainability is, in my view, responsibility. The responsibility of each people, of each company, of each industry for what's happened."*

- Empowerment for communities, agency.

Q__ *"When I say self-sustaining communities, my sense is that they have some form of agency over their immediate surrounding that sustains them [..] what I'm aiming for is more dialogue, more agency for these communities."*

- Participatory decision-making
  - it is important to engage communities at the very initial stages of decision-making regarding energy developments; however this is not always the case in practice.

  - The example of the geological disposal in Finland is given and the importance of communities to have a veto right till the very end is emphasized; with wind power this example hasn't been taken up and it's causing problems. If communities do not have a real option to say no, then it cannot be said that their choice is truly free. Another example refers to SMRs in Romania: multistep decision; communities have the right to say no.
  - For renewables in Spain decision-making it is different because the process is not centralized: the decision power rests with the landowner who can construct energy infrastructure even if the rural community opposes; the community doesn't have a voice.

- Impact is not only due to the technologies, but also to the (lack of) capacity of society to adapt to the changes; therefore the assessment of the social sustainability should also consider the wider context.

Q__ *"In practice, it will be very difficult to estimate what's happening. I will give you an example from Romania. The government decided to close the gold mine. [..] And the question was, what the miners will do in the future? And the consultant company that produced the report said, Okay, we'll involve them in [..]. But how many miners work there because the number of jobs is little compared with their work in the mines. Therefore, not only the technology is the problem, the problem is the capacity of the society to organize itself and produce other jobs for people that are translated from a technology to another technology. Otherwise, we will say, Okay, the solar cannot introduce enough amount of jobs and it is not sustainable from the social point of view, [..] There is a reality in relation with the localization of the production because we have some countries that are producing the cells, the photovoltaic cells, and there are countries that are buying this. The working is in some countries and practically the jobs are in other countries. This is a global issue."*

- A central element of social sustainability would be that the different value options and viewpoints within the group point in a similar direction. Thus social sustainability reflects a consensus or a coherency.
- Social sustainability grounds in the belief that we can construct something together, leaving aside divisive identity claims. It integrates the practice of cooperation, and is as inclusive as possible in elaborating energy imaginaries.
- The social contract formed by such a group provides that 'even if we disagree, we need to accept others that we disagree with;' this provides stability.
- Nonetheless it's impossible to prevent individualists or contrarians from staying outside the consensus group and defending their special interests.

Concerning the evaluation of social sustainability, the participants pointed out the difficulty to have a complete picture:

- There is a need for methods capturing the newer models of sustainability (e.g. the donut model – with planetary limits and social minimal standards).
- Difficult balance between having only a small number of fixed indicators so that assessment can be adapted to different contexts, versus having clear pre-established indicators that can hold companies and individuals accountable.

Q__ *"Other people, instead have the opinion that it's better not to define it too closely or not to have too many fixed indicators so that it can be applied to different contexts. But at the same time, it is tricky because it also means that many activities can be defined sustainable if you are creating your own indicators, let's say. So if you are accountable only to yourself, if there's not a clear measure for sustainability then how can companies and individuals be held accountable for it?"*

- Technocratic expert-based assessments are problematic: the expertise and knowledge systems of communities should be recognized.

Q__ *"I think this whole notion of who is the expert and who decides and where does this expertise come from, I think it's very problematic if it doesn't involve communities. Because communities, like she said, like Indigenous communities, we're only beginning to recognize that they have their own knowledge systems which they have inherited over generations. And that is how they interact with their ecologies and make them sustainable, make them work for them for generations. To ignore that by saying that we are the experts and we will tell you what is good for you or not, I think is hugely problematic."*

- As there are time constraints, it is difficult to take into account changing values and norms: taking all social dimensions into consideration is a lengthy process; to account for changes in trends or global issues this process would need to be repeated, but then it becomes unfeasible from a practical point of view.
- The aspects included in the normative lens are fairly measurable: most of these can somehow be measured at least qualitatively, but values (e.g. justice) are interpreted differently by different people.
- Storylines are able to capture some social aspects.
- Sustainability assessment for new technologies, e.g. SMRs, may be questioned as some impacts are still unknown.

However:

Q__ *"With the social dimension of sustainability, the biggest problem is that there are unknowables at stake. What is the best way to deal with unknowables in the case of society is perhaps much more complex than, for instance, predicting the future of technology."*

- In the context of finance, it was noted that there is an extended body of 50 years of social indicator research with a focus on 'measuring' social sustainability.
- The UN Sustainable Development Goals were mentioned as a workable approach to thinking social sustainability, as well as the capability approach.

- Economic and ecological aspects have social dimensions too.

Q__ *"Pollution, energy access, … all those things are social dimensions of energy. So why don't we just start by concretely trying to solve that?"*

Reflections on rational approaches to 'model' and 'measure' sustainability

Some participants advised caution when using models and argued for "opening them up" in order to render value judgments and indicator-based assessments transparent:

- Models or single figure indicators for sustainability can be misused if value judgments are hidden behind decision algorithms and not made transparent.
- Value judgments are also needed when constructing indicators, but for combined indicators, the raw values (before any aggregation) should also be shown, for transparency.
- We should not rely on methods or models to make (concealed) value judgments and balances between winners and losers; whether certain trade-offs are acceptable should be a subject of public debate.

Q__ *"I would be really cautious about even trying to develop methods that aim to somehow make the judgment for us. But these are value questions. There is no right or wrong answer as such. The answer needs to be reached through popular discussion in democratic politics. What this assessment should do, in my opinion, is to provide the data or at least educated guesses to help with those discussions and for making those decisions. But they shouldn't try to conceal these value questions under some kind of algorithm that is incomprehensible to those people and that hides these value assessments, for instance, about which job is better than other under the hood. I would keep these tools on the level of analysing who are the winners, who are the losers, and what are the impacts... Then use that in public debates: are these trade-offs acceptable? If they are not, what must be done so that they are?"*

They further discussed the use of weights in modelling exercises. An argument was given that average weights, representing experts' and stakeholders' views could be used to capture the plurality of views. A counter-argument was formulated that models should instead provide all the data necessary to allow different stakeholders to make their own assessments, or use the same methodology but with their own weights:

Q__ *"Whatever methodologies are used, the goal should be to have all the data published as open data to enable people and interest groups to verify them and make their own models and calculations. This is not some miracle cure for all problems, but it would help a lot in some cases."*

Q__ *"Instead of trying to reach the single number, why can't we try to figure out, let's say, three or four different assessments using the same methodology, but for industries with different weighing factors about the stakeholder judgments or something like that. So that we get a range instead of a single figure."*

At various moments, the discussions addressed energy system assessment and the evaluation of single technologies vs. portfolios, and the local versus the global level. The argument was given that more resources should be dedicated to make assessments at system level and that social impacts should be considered also in the country where raw materials are coming from.

- Some participants argued that there is a need for system level assessments.

Q__ *"But on the other hand, it [assessing portfolios] adds complexity but also the upside is that looking at the impacts of the single energy sources or installations is also misleading.. Or can be quite misleading if you look at all of them in isolation. Maybe even the goal should be instead of devoting a lot of resources on assessment of the single installation, maybe devote more, and this is just an idea, but maybe devote more resources on the assessment at the system level."*

- Capturing social impacts and deliberation may be easier at local level; however impacts that are not local risk being discounted.
- At the heart of assessment is creating equilibrium between technological transactions (market logic, intellectual property, private interests…) and social transactions (carbon credits, net zero economies, consultation and conversation…). Today these are siloed; diplomatic tools could make them communicate.
- Instead of debating the technology, society could debate and prioritize the main indicators (e.g. carbon emissions, land footprint, social aspects, jobs…).
- Or preferably debate the social values (first column of the grid) because indicators are based on those.
- There should be a way to set objectives and write possible pathways such that they will not be altered by events - geopolitical shifts, political shifts, pandemics, etc.

At the same time participants recognized that an overall positive impact at global level may have huge negative social impact at local level.

Q__ *"Thinking about where the raw materials are coming from [..] Very rare in the past. Also, for example, if I think about the circular economy, it can be good for us at a global level but then [...] it's a huge impact at the local social level, despite the global... The global scale is good, but it's also promoted. There's [..] the issue of justice."*

They concluded that solutions should be good at global level, but acceptable at all levels of decision making.

Reflections on engagement and involvement in making sense of sustainability

Models for public debate and roles for scientists and experts were considered:

- Scientists should provide knowledge as a basis for the discussion, informing of what is possible or impossible, and the downsides of a given solution.
- The 'public understanding of science' model places experts in a guiding role.
- By contrast 'public engagement' creates a meaningful conversation about people's concerns, aspirations, visions and hopes for the future, and how these can be accommodated in a balance with economic reality and environmental concerns. (The Power to X facility project in Danish harbour areas follows this storyline, engaging with employees and the local community about e.g. ownership and co-benefits of the power infrastructure).

However, some participants objected:

Q__ *"At this point in the climate crisis we lack time to go through full engagement to choose energy options."*

Q__ *"Debate has been taking place for many years, but the fact that it has been marked by interests on all sides means that social trust has disintegrated."*

Q__ *"Very broad, open, bottom-up public engagement often naïvely assumes that people are honest and think in terms of the public good. The procedure has so many weak points in terms of protecting the process from influence and misuse. There is no responsibility or accountability. The debate is shaped by interested people speaking out on behalf of the whole community without any democratic mandate."*

Q__ *"Public debate can be polluted by opposing political parties. You can ask if all those debates are not in fact intended to stall and prevent action. Most citizens don't even really care. At some point you don't have to ask them - not everyone wants to be involved.*"

Attempting to draw lessons from experiences of public debate:

Q__ *"People appear not to care but it is because of their disenfranchisement from siloed decision making. Rather than reducing engagement, we need more of it: as end users people are entitled to reap the value of engagement."*

Q__ *"Experts more often speak for industry than for public safety. We need to create a "good" new technocracy and a corps of "public experts" through basic science education and socialization, strengthening public skill."*

The guardians of processes creating resilient pathways could be:

- Good technocrats & strong benevolent political leaders (those two categories however could produce counter-reactions among the citizenry).
- The general secretary of the UN (depending on the national context, an external authority might have more success).
- The People (people change opinion, but they 'need to experience that there will be improvements and then they will like walking that path').

How to move with hope to where we want society to be? A final optimistic wrap up:

Q__ *"We can redirect expertise so that experts are not perceived as being in the pocket of someone, for example. We can apply some of the diplomatic tools to reconcile between different competing interests. We can accept that we will never fully, fully agree, but that we need to live with the differences in a nonviolent way, preferably, and a respectful way. There's hope in influencing the private sector, so they also take responsibility. Corporate social responsibility is taking this direction. I think there are some handles that we can grab to have this transition."*

Q__ *"Find the equilibrium between social and technological transactions, and whatever tool that will make it work. Demonstrate that we can have both good engagement and innovation."*

Annex - Agenda of the workshop

Date & time 29 March 2023, 14h00 – 17h30

14h00 – 14h10 Welcome & introduction to the ECOSENS project
Catrinel Turcanu, SCK CEN

14h10 – 14h25 Welcome address
Domenico Rossetti Di Valdalbero, Deputy Head, EURATOM Research Unit, DG RTD

14h25 – 14h45 The art and science of imagining energy futures – introduction
Gaston Meskens, SCK CEN & Ghent University

14h45 – 15h45 First discussion in 3 groups
Imagining energy futures

How to recognise and take into account the existence of multiple possible and desired energy futures? How do worldviews and values 'work' in imagining energy futures? Which artefacts (storylines, narratives, concepts, images, symbols, models, …) do we use to 'express' these imaginations and why do we prefer some over others? …

15h45 – 16h00 break

16h00 – 17h00 Second discussion in 3 groups
Sustainability assessment - a deliberation process in itself

What is the meaning of 'sustainability' in the theory and practice of sustainability assessment (SA)? And what is the meaning of social sustainability and how can it be taken into account in SA knowing one cannot rely on quantifiable information? What values are usually missing in traditional SA approaches? How can we ensure that sustainability assessment criteria are reflective of a diverse range of worldviews and values? …

17h00 – 17h30 Summary of key ideas for the second workshop & wrap up
Claire Mays, SYMLOG

Annex

The art and science of imagining energy futures – worldviews / the conceptual landscape –				
values	intellectual / spiritual / emotional stances	normative 'lenses' or 'entry points' to look at energy governance	artefacts used to express value perspectives and (relevance of) normative lensens or entry points	formal assessment methodologies
justice equality solidarity freedom safety security precaution / prudence informed consent dignity beneficence / non-malificence inclusiveness transparency accountability pacifism peace […]	concern hope fear care belief confidence skepticism irony […]	economic growth (questioning / supporting) energy consumption (minimising, maintaining, …) energy independency climate change the next generations (freedom / protection, …) affordable access to energy for all the value of nature natural resources depletion cost optimisation environmental harm (reparable / irreparable, …) job creation robust/resilient systems innovation financial profit the nation state the community energy as political/diplomatic tool perspective (local, national, global, …) agency (individual, collective) minimal impact recycling cooperation […] holism transdisciplinarity inclusion	narratives stories storylines symbols models concepts philosophies images objects texts actors authors networks systems calculations hypotheses scenarios […]	technologies to consider existing/new methodologies time horizon scale (local, regional, global) criteria indicators qualification / quantification experts to consult stakeholders to include/consult methods for inclusion and participation […]
…… …… …… …… …… ……	…… …… …… …… …… ……	…… …… …… …… …… ……	…… …… …… …… …… ……	…… …… …… …… …… ……

ECONOMIC AND SOCIAL CONSIDERATIONS FOR THE FUTURE OF NUCLEAR ENERGY

Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment

Report of an International Stakeholder Workshop

Claire Mays, Yasmine Fourari, Aylin Erden

Institut SYMLOG de France

Marin Constantin

RATEN

ECOSENS Deliverable D2.1b, June 2023

Funded by the European Union

Economic and Social Considerations for the Future of Nuclear Energy in Society

Project Number: 101060920

Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment

Work Package 2

Lead Beneficiary: SYMLOG

https://ecosens-project.eu/

ECOSENS is a 3-year project (2022-2025) funded by the Euratom Research and Training Programme. It aims to create a neutral space where specialists in social sciences (including economics, sociology, social psychology, Science and Technology Studies, among others) and humanities and in nuclear energy research and policy will meet, exchange views and collaborate with civil society and other relevant stakeholders in order to:

- *Provide a societal perspective on the development and use of existing and new nuclear technologies,*
- *Provide an assessment of nuclear energy sustainability considering the entire life cycle of the current nuclear technologies,*
- *Provide a radically new economic model, based on the System of Provision (SoP), for the assessment of nuclear energy.*

The present document reports a face-to-face stakeholder workshop conducted in March 2023 under ECOSENS work package (WP) 2. It is an unscheduled deliverable and was reviewed and agreed by the stakeholder participants of the workshop, whom we thank for their rich input.

To be cited as:

Mays Claire, Fourari Yasmine, Erden Aylin, Constantin Marin (2023) Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment. Report of an International Stakeholder Workshop held in Brussels on 30 March 2023. Deliverable 2.1b of ECOSENS-project.eu. Institut Symlog de France, 262 rue Saint Jacques F-75005 Paris.

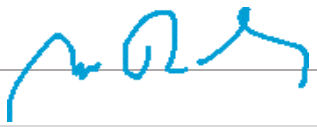
The work is disseminated under the Creative Commons License CC BY-NC-ND 4.0
(Attribution-NonCommercial-NoDerivatives 4.0 International)

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

Economic and Social Considerations for the Future of Nuclear Energy in Society

Project Number: 101060920

Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment
Work Package 2
Lead Beneficiary: SYMLOG

For the Lead Beneficiary	Reviewed by Work Package Leader	Approved by Coordinator
Claire Mays	Marian Constantin	Daniela Diaconu
		

Project information

Project full title:	Economic and Social Considerations for the Future of Nuclear Energy in Society
Acronym:	ECOSENS
Funding scheme:	CSA
ECGA number:	101060920
Call/topic	HORIZON-EURATOM-2021-NRT-01-14
Coordinator:	Regia Autonoma Tehnologii pentru Energia Nucleara (RATEN) – Daniela Diaconu
EC Project Officer:	Maria Papadopoulou
Start date – End date:	1 October 2022 - 30 September 2025 (36 months)
Coordinator contact:	+40 744 701 476, daniela.diaconu@nuclear.ro
Administrative contact:	+40 744 701 476, daniela.diaconu@nuclear.ro
Online contacts (website):	https://ecosens-project.eu

Document information

Deliverable Title	Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment
Deliverable No.	2.1b (unscheduled)
Work Package No.	2
Work Package Title	Assessment of the sustainability of the whole cycle of nuclear power
Lead Beneficiary	SYMLOG
Contractual Delivery Date	30.09.2023
Actual Delivery Date	30.06.2023
Type	R
Dissemination level	PU
Authors	Claire Mays, Yasmine Fourari, Aylin Erden (SYMLOG) Marin Constantin (RATEN)

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

International workshop

Decarbonizing Europe's energy system:
Checking and choosing indicators for a sustainability assessment

Thursday 30 March 2023, 10h00 – 16h00
Club University Foundation, Rue d'Egmont 11 - 1000 Brussels

Executive summary

Effective and widely accepted evaluation methods are necessary to guide complex energy mix decisions in Europe's Green Transition. When assessing energy technologies for 2030 and beyond, it is crucial to consider their sustainability in the long term and their ability to withstand multiple pressures.

To that end, the Euratom/Horizon Europe ECOSENS-project.eu is tasked with the development and testing of a sustainability assessment methodology, incorporating a societal perspective, for future energy systems in Europe. This report examines the findings of the full-day workshop titled "Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment" which was held in Brussels on 30 March 2023. The workshop engaged 15 stakeholder participants in three collective tasks around selecting an appropriate combination of methodologies, high-level objectives, criteria, and indicators for the actual assessment to be carried out by the project coordinator in 2023-24. A background working paper, ECOSENS deliverable D2.1a, was circulated to attendees prior to the workshop.

In Task 1 "Selecting Among Existing Energy System Assessment Methodologies" stakeholders were provided with selection criteria and worksheets to rate three candidate methodologies: NESA-IAEA (Nuclear Energy System Assessment), KIND-IAEA (Key Indicators for Innovative Nuclear Energy Systems), and LCA/LCIA-JRC (Life Cycle Analysis/ Life Cycle Impact Assessment), respectively M1, M2, and M3. The purpose of this task was to determine the best methodology, or to identify the most beneficial components from each to combine in the future ECOSENS assessment exercise. Each selection criterion was to be assigned a score by each individual participant indicating how well each of the three methods was thought likely to perform. Only a small subset completed this scoring (the outcome upon calculation confirmed the pre-decision-in-principle to combine M2 and M3; see Annex I).

During this selection Task 1, all participants discussed in detail their views on the adequacy of the generic methodological approaches. They pointed to particular aspects seen to be positive (e.g. ability to take account of country specifics and stakeholder input). They also identified negative features (e.g. inability to take into account cumulative stresses on ecosystem boundaries, or, to account for the differing feasibility of various low carbon energy production methods). Participants reflexively considered the social and technical feasibility of engaging non-specialists in such assessment, in view of democratizing energy decision making at scale. They pointed notably to the willingness (or not) of authorities to seek and apply adequate involvement methods.

The comparative assessment of technologies, scenarios, or energy systems is usually performed with reference to a set of high-level objectives (HLO). Task 2 "Scoping and Bounding: Selecting High-Level Objectives (HLO) for the European Energy System to 2030 or 2050" engaged the participants in identifying such objectives. Based on the stakeholder input, the project assessors designated the following HLOs for the life cycle assessment (LCA) on the Environment, Economic and Social pillars respectively: contribution to planetary wellbeing; reliability and resilience of supply; social feasibility. Discussion brought into view the tension between achieving a holistic assessment (undivided into pillars), and the need to operationalize such concepts as sustainability (thereby breaking them down into components). The energy-food-water security triangle was acknowledged: outside Europe energy may not be the primary concern.

Task 3 “Selecting and Weighting Assessment Criteria at Indicator Level” requested that stakeholders appraise the relevance of the typical criteria employed for LCA as well as weight the proposed indicators and sub-indicators for each pillar. Only indicators belonging to the Environment pillar were in fact weighted (see Annex I).
Discussion sparked by Task 3 revealed that technologies must be measured against actual contribution to achieving decarbonization and eliminating fossil fuels, as well as against bioplanetary limits. An indicator-based approach should tally both costs and benefits, and should distinguish between intrinsic benefits of an energy production technology and co-benefits of its application (such as increasing employment). Indicators might best be formulated in terms of impact (rather than of emissions). Impacts should be appraised not in the absolute but taking account of their real interactions (additionality). To facilitate societal interpretation and deliberation, expected individual-level impact of each indicator could furthermore be described in terms of loss or gain of life years or wellbeing. For certain indicators a hard threshold value of acceptability must be set, by policy makers who do request empirical specialist findings and recommendations (e.g. in public health): it must be possible to entirely eliminate a technology from consideration if it surpasses that limit, even if that technology appears to come out ahead of others on the long list of weighted indicators. This “show-stopper” status does not, however, necessarily signify that the particular indicator is considered the overall most important to society.

Experience was shared regarding the actual transfer of research and assessment results into political decision making. Sensitivity analyses revealing the divergence of multi-criteria assessor judgments may result in eliminating all but a very small minority of indicators. Reduction *in fine* to a short list of proxy indicators distances us from the complex reality that we seek to grasp. Even when a large amount of well-supported research information is retained, the political negotiation process may then remove much of it (as when reports to be published by international organizations are whittled down in light of participant countries’ present interests). In implementation, dual-use technologies may come under several licensing regimes, and actual access to different technologies is unequal across nations. All in all, framing the regulatory and public policy decisions to come, settling the means to balance outcomes of both technical and social licensing, may be more crucial than the apportionment of indicator weights. Thus, the ECOSENS LCA could be performed without weighting, then an interdisciplinary expert/stakeholder group could be convened to rank resulting decision options.

Facing such constraints, the participants again expressed confidence in the value of a democratized approach to societal energy mix decisions. Realistically, ideological positions, values, and aspirations will intervene, as well as the level of confidence in the gathered data. A transdisciplinary collective decision approach could target not consensus, but rather a compromise that the assembled actors can live with. A capsule process could convene a panel including different types of expertise, citizens, and representation of all those who should be at the table. The workshop invoked a process in which raw data is collected and analytic and decision-making processes are combined to help the actors understand sustainability and learn to use the indicators and the data. At a broad societal level, citizens and politicians need to be – and can be – educated to become more sophisticated in connecting assessment to phenomena in the real.

In sum, key qualitative findings across the full workshop were rich. Participants highlighted the narrow path between quantifying assumptions and “gaming” the numbers. They underlined the need to perform iterative energy system life cycle sustainability assessments to capture effects of earlier actions. They debated how such assessments and resulting decisions and implementation may be democratized, in order to approach an ideal of social sustainability. They eloquently and patiently argued for whole-system approaches capable of taking into account cumulative risks and bioplanetary limits. The participants contributed guidance for the next steps of the ECOSENS assessment activity, and demonstrated the need for stakeholder engagement also at the later stage of interpretation. This report presents their verbatim input as well as summarized points, and points to the follow-up activities open to registration through the ECOSENS-project.eu website.

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

Table of contents

EXECUTIVE SUMMARY 0

1. INTRODUCTION AND OVERVIEW 1

1.1 Workshop attendance 1

1.2 Agenda and proceedings 3

2. TASK 1 - SELECTING AMONG EXISTING ENERGY SYSTEM ASSESSMENT METHODOLOGIES 4

2.1 Plenary report of subgroup discussions 2.1-5

2.1.1 Comments on the candidate methodologies 2.1-5

2.1.2 Proposed improvements to the selection criteria 8

2.1.3 Reflections on involving stakeholders in assessment 2.1-8

3. TASK 2 - SCOPING AND BOUNDING: SELECTING HIGH-LEVEL OBJECTIVES (HLO) FOR THE EUROPEAN ENERGY SYSTEM TO 2030 OR 2050 11

3.1 Plenary report of subgroup discussions 12

4. TASK 3 - SELECTING AND WEIGHTING ASSESSMENT CRITERIA AT INDICATOR LEVEL 3.1-15

4.1 Report of subgroup discussions 4.1-15

4.1.1 Proposed improvements to the indicators 4.1-16

4.1.2 Reflections on involving stakeholders in weighting 4.1-19

5. FINAL PLENARY; NEXT STEPS FOR ECOSENS 23

6. CONCLUSION 4.1-24

ANNEXES 26

Annex I - Taking into account the stakeholder judgments – Communication by M.Constantin 26

Annex II – Slides introducing the candidate methodologies 30

Annex III - Definitions of Selection Criteria for Task 1 37

Annex IV – Worksheet 1 : Selecting Methodologies 39

Annex V – Worksheet 2: Weighting indicators – En-LCA 40

Annex VI – Worksheet 2B&C: Weighting indicators – Ec-LCA & So-LCA 44

Annex VII – Workshops Evaluation by the Participants 49

Apologies, an error in the source file disturbed the number format in this table. Links however do function properly.

1 Introduction and Overview

The European Green Deal is the ambition to create the first carbon-neutral continent by 2050. To get there, Member States commit to cutting greenhouse gas emissions into less than half by 2030. This interim target depends on achieving changes in the energy mix: a higher share – 40% – should be supplied by renewable energy sources. How should that mix be composed? Which are the favored technologies? Are they available and how will they perform? What may be the place for nuclear generation technologies, old and new, in the mix? What are the criteria for proposing and evaluating respective shares? Who has a voice in selecting those criteria and in checking whether they are met?

Horizon Europe ECOSENS-project.eu activities include the **development and testing of a sustainability assessment methodology, integrating a societal perspective, for a future energy system in Europe that includes advanced and innovative technologies (comparing renewable and nuclear sources)**. The sample assessment is to be completed by September 2024 by ECOSENS project staff at the coordinating institute, RATEN.

On 30 March 2023 project partners RATEN and SYMLOG convened specialist and non-specialist stakeholders in a face-to-face workshop to review the proposed methodological approach, high-level objectives, and assessment criteria to be employed. Stakeholders were asked to help refine the approach through critical perspective and judgments. The workshop also requested that stakeholders attribute quantified weights to indicators and sub-indicators. Not all participants chose to complete these weighting exercises, whereas each and every one provided remarks and feedback (written and/or oral) to each task.

The present document reports the work achieved during the full-day 30 March workshop in Brussels, which was entitled "**Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment**". The outcome of the workshop as reported here includes participants' critical observations and recommendations regarding the proposed methodological approach and underlying sets of criteria and indicators. Where available, attributed weights are reported, along with organizer reflections on this incomplete dataset and its potential use for the formal ECOSENS assessment (**Annex I**). Participant evaluations of the workshop are reported in **Annex VII**.

This document was reviewed and agreed by the participants, to whom we renew our admirative thanks for their insightful and lively contributions to the workshop.

Follow up will include short webinars to which the same participants and others will be invited. The activity will culminate in recommendations to European policy makers, regarding both the substantive observations derived from stakeholder discussion and the formal energy system assessment, and the processes used to engage specialists and non-specialists.

1.1 Workshop attendance

The international workshop was organized by four ECOSENS project members (three social scientists plus a reactor physics/safety expert, all with energy governance expertise). Eighteen stakeholders were registered to attend this session, of whom 15 participated on 30 March. All were not present throughout the day (two stakeholders retained by other commitments arrived slightly late and one left at mid-day, all by agreement). The workshop was held back-to-back with a previous ECOSENS workshop, which all persons (except two) had attended as well.[1]

The self-declared sector of persons registered, as well as their self-declared areas of expertise, are shown in Tables 1 & 2 below. Individuals were enabled in each case to declare more than one category. Names and organizations are not provided in this summary report, in respect of both personal data protection and the Chatham House Rule[2] which was explicitly agreed to by all meeting participants. Country of origin and/or work (Table 3) were not formally declared by participants but surmised by organizers from registration materials and correspondence

Sector	
Civil society - grassroots communities - 4	NGO – 2
Embassies - 1	Private sector, investment, startups – 2
European Commission - 2	Public sector, public utility, technical organisation - 3
Independent energy and environment expert	Research/academic, universities - 7

Table 1 – Self-declared sector of workshop registrants (individuals cited multiple sectors)

Expertise	
Energy system modelling - 4	Policy research
Energy/Environmental Humanities	R&D (tech & social) on nuclear fuel cycle back-end - 2
Environmental management	Science & technology studies (STS)
Ethics of Science and Technology - 2	Science diplomacy
European Commission representatives - 2	Social communication and stakeholder engagement
Gender studies	Social Psychology, Psychology
Green transition	Social sustainability
History of Science	Sustainable finance - 2
Investment, innovation, startups	Techno-Anthropology

Table 2 – Self-declared expertise of workshop registrants (individuals cited multiple types)

Country of origin and /or work	
Belgium - 8	Greece - 1
Canada - 1	India - 2
Denmark - 1	Italy - 1
Finland - 1	Poland - 2
France - 3	Romania - 2
Germany - 2	United States - 2

Table 3 – Country of origin and/or work of workshop registrants (as identified by organizers – no self-declaration)

[1] "The Art and Science of Imagining Energy Futures" on 29 March 2023 engaged participants in discussing current societal challenges and opportunities in regard to energy production, and possible and desired energy futures. In particular the notion of "social sustainability" was elaborated. The analogous report is: **Meskens Gaston, Turkanu Catrinel, Mays Claire (2023) The Art and Science of Imagining Energy Futures.** Report of an International Stakeholder Workshop held in Brussels on 29 March 2023. Work package 1. SCK-CEN

[2] https://en.wikipedia.org/wiki/Chatham_House_Rule

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

1.2 Agenda and proceedings

Revised agenda 30 March 2023, 10h00 – 16h00

10:00 – 12:00	Task 1 - Selecting Among Existing Energy System Assessment Methodologies With reference to the circulated working paper, sections 1, 2, 3 • Introductions by Claire Mays (SYMLOG) and Marin Constantin (RATEN); plenary comments • Review and appraisal in assigned subgroups • Plenary feedback of subgroup outcomes
12:00 – 13:00	Task 2 - Scoping and Bounding: Selecting High-Level Objectives (HLO) for the European Energy System to 2030 or 2050 With reference to preceding 29 March 2023 Workshop findings on worldviews, values and sustainability; and the circulated working paper, section 2 • Introduction by Claire Mays • Appraisal in new assigned subgroups • Plenary feedback of subgroup outcomes
13:45 – 15:30	Task 3 - Selecting and Weighting Assessment Criteria at Indicator Level With reference to the circulated working paper, section 4 • Introduction by Marin Constantin • Sub-group deliberations on Environmental, Economic, Social Life Cycle Assessment criteria/indicators and weighting • Plenary feedback of subgroup outcomes
15:30 – 16:00	Plenary Debrief, and Next Steps for ECOSENS Including invitation to follow-up online short workshops in 2023 • Moderation by Claire Mays • ECOSENS next steps by Marin Constantin

***Table 4** – Revised agenda (timing and task sequence adjusted to the actual proceedings of the day). The timing includes unstated breaks for transition, coffee and lunch.*

The workshop addressed three collective tasks (see *Table 4, Revised agenda*). Background was presented in a working paper (draft project deliverable report D2.1a)[3], which most participants had read prior to the workshop. Each task was introduced by a brief PowerPoint presentation drawn from that content (cf. Annex II). Paper worksheets were provided for the first and third tasks (see Annex III-VI).

In the large workshop room, stakeholder participants were divided across three separate tables to discuss and confer in subgroup. Each subgroup counted about 6 members and was lightly facilitated by an ECOSENS social scientist (C. Mays, SYMLOG; C. Turkanu and G. Meskens, SCK-CEN). Stakeholders were assigned to tables and invited to rotate at each task. No sectoral rule of assignment was used. During Task 1, one facilitator called for particular stakeholder expertise to come to join their table (leaving the originally assigned subgroup), as it was felt that the task required knowledge not yet represented at the table. This "problem" of missing knowledge and expertise was not expressed again for subsequent tasks.

After each subgroup discussion, approximately 15-25 minutes were spent in spontaneous plenary feedback of subgroup outcomes. These plenary sessions were audio recorded to support the present report of each discussion. Worksheets were collected at the end of the day; the obtained written ratings, comments and recommendations are transcribed or summarized in the present report as well.

[3] ECOSENS Deliverable D2.1 (first part), *Sustainability Assessment for Electricity Generation Systems: Overview of some existing methodologies and the selection process for the ECOSENS project*. Author Marin Constantin, RATEN. Final delivery date: September 2023.

2

Task 1 - Selecting Among Existing Energy System Assessment Methodologies

The first task undertaken during the 30 March workshop addressed the selection among three candidate methodologies to be employed for the later ECOSENS energy system sustainability assessment exercise (to be conducted by M. Constantin, RATEN). Working paper D2.1a referenced and briefly described these candidate methods, defined selection criteria, and (as a pre-decision-in-principle) proposed a combination method. *Box A* below briefly identifying the candidates is drawn and revised from D2.1a (which may be consulted for the omitted references). The slides presented at the workshop for task 1 are provided in **Annex II.**

The workshop sought stakeholder feedback on selecting among these methodologies, and on the pre-decision-in-principle to use a method combining elements of M2 and M3. **Annex III** presents the selection criteria defined in D2.1a and **Annex IV** the selection worksheet (provided on paper to each workshop participant). The worksheets had space to rate each methodology from 0-3 (*does not fulfil – entirely fulfils*) in regard to each selection criterion.

Box A – **Candidate methodologies to be used/combined for the ECOSENS energy sustainability assessment** (from D2.1a, Constantin 2023)

Sustainability assessments generally address three pillars: economic development, social development, and environmental protection. In the literature, various electricity generation technologies have been assessed from the point of view of sustainability, including inter-comparison of alternatives based on a range of methodologies. Considering the objectives of the ECOSENS project to assess the sustainability of the whole cycle of nuclear power at European level, three candidate methodologies are discussed in order to select the most appropriate one or to extract from each the most valuable elements to be combined in the proposed assessment exercise. These candidate methodologies, labeled M1-3, are the following:

> **(M1) NESA-IAEA** (Nuclear Energy System Assessment) developed by the International Atomic Energy Agency (IAEA). The holistic methodology examines all components of the nuclear cycle, structured in seven areas of investigation: Economics, Infrastructure, Waste management, Proliferation resistance, Physical protection, Environment impact (Stressors, and Depletion of resources, and Safety (Safety of nuclear reactors, and Safety of nuclear fuel cycle facilities).
>
> **(M2) KIND-IAEA** (Key Indicators for Innovative Nuclear Energy Systems) developed by IAEA in the frame of INPRO-KIND with the purpose to introduce more flexibility in selection of the criteria and indicators.
>
> **(M3) LCA/LCIA-JRC** (Life Cycle Analysis/ Life Cycle Impact Assessment) developed by the European Commission's Joint Research Centre (JRC) in the frame of the Taxonomy Regulation debate to assess the entire cycle of nuclear power.

M1 was developed by IAEA INPRO (International Project on Innovative Nuclear Reactors and Fuel Cycles) starting in 2000. The purpose of **M1** is to evaluate a national or global nuclear energy system with regard to its long-term sustainability according to the INPRO defined set of basic principles, user requirements and criteria; to identify the gaps in the assessment areas for existing or planned nuclear energy systems (NES) sustainability; and to recommend follow-up actions to close these gaps.

M2 is devoted to the comparison of the sustainability performance of different nuclear technologies or NES development scenarios. It is a comparatively streamlined approach and includes "country specifics" among the suggested indicators.

M3 was developed in the context of establishing the EU classification of environmentally sustainable economic activities ("EU Taxonomy" for the assessment of financial investments). LCA/LCIA-JRC aims to assess the nuclear sector considering the entire life cycle, and to compare the sustainability performances of the most relevant energy production alternatives.

Some individuals found it difficult to perform the selection task, as they felt they had insufficient knowledge of the candidate methods, of the selection criteria, and/or of the boundary conditions and externalities that would enter into actual performance on each criterion. The facilitators did not insist on conformity with the task as designed, but sought to enable stakeholder input according to any means they preferred. Thus, a minority of persons scored the methodologies from 0-3 on the selection criteria (or a subset of criteria) as requested, while others used a system of stars, and/or wrote out comments, views and suggestions on the worksheets which were collected at the end of the day. Other persons did not use or fill the worksheets.

In practice, this particular sequence in the 30 March workshop was evaluated post hoc by a small subset of participants as the least enjoyable feature of the two days of ECOSENS meetings (although an equivalent number subset found it among the most enjoyable; see **Annex VII**. Nonetheless, all participants seriously addressed the task, providing their reflection and critiques – in some cases, challenging the value of the targeted methodological domain. Sections 2.1 and 2.2 below report the gathered input.

2.1 Plenary report of subgroup discussions

No rapporteur was formally selected for each subgroup. Instead, the moderator called on spontaneous volunteers to share comments and experience from the subgroups, and the plenary discussion developed organically.

The following text is derived from the recording of the plenary feedback session. The oral input is also completed by comments written by participants on the task worksheet. Speeches (indented, in black font) are lightly edited. The individual speaking is not identified. The author/moderator has added header text in blue font, identifying the dominant topics of each intervention; these may be read as a quick summary. Occasional moderator comments from the live proceedings are included as well.

2.1.1 Comments on the candidate methodologies

We switch gears, from a qualitative discussion of sustainability (previous day's workshop) to a semi-quantitative task. Do individuals respond to this switch in light of their different expertise?

It is difficult to compare three candidate methodologies which are contrasted in approach (systems vs. lifecycle). My ideal would be a combination between M1 & M3.

> From yesterday's conversation – which was very value-based, abstract, conceptual – to getting down to specific numbers today is a big switch for me. And it will be interesting to see how each person in this room coming from diverse backgrounds makes this switch. So somebody is an anthropologist or sociologist or physicist. What are the differences? This is something that I'm immensely interested in understanding. For me personally, the task was a little bit of challenge because the first candidate method has a systems approach. The third method has a life cycle approach. And the second method about which I was most confused, was very specific to specific technologies. I am not a technical person. So in most of these columns under M2, I am still struggling to find what to write. But my ideal method would be a combination of M1 and M3. And again, that's a challenge to think about how to think about those things. I also think a little bit of elaboration of specific selection criteria would be helpful here. I have written down some subjective comments here. So this is my reflection, but it was a really interesting and inspiring exercise.

M3 is most adequate to compare nuclear, fossil and renewable energy production systems.

Scientists are capable of calculating anything, but the main issue is to produce a credible story for assessment by the public, and to convince the public authorities.

> I wasn't here yesterday, but I have background in nuclear research. Say I want to intercompare different energy production systems. M1 and M2 are typically nuclear-based evaluations. M3 is potentially general and so this is my strong preference. I completed my ratings in the third column on M3. I have a basic problem in assessing the weight of the key indicators, which will depend very much on the stakeholders and authorities, whose views in any country can be completely different. My main priority is to have meaning to compare the value of, for instance, nuclear energy with fossil energy production and renewables. This is what happens now in Belgium. At this time I'm personally part of a public platform [to locally debate and assess] the disposal of waste in Belgium. Scientists can calculate anything, but the next step is to have a credible story in the view of the public, and to have public acceptance: this seems to be the main issue to my opinion. I think most of us here are more scientists. But then you need to convince public authorities. So that's completely different.

Our judgments have been based on our interpretations of limited information.

Combining methods is fruitful given their differing advantages and disadvantages.

The requirement for stakeholder input to a given method is a major advantage. This input should cover the current situation and a future projection – with assumptions clarified in scenarios or pathway proposals. To meet this dynamic condition – particularly in regard to assessing the social pillar – the exercise must be repeated again and again as time passes and more facts become available. The methods could also be used in sequence, moving from an integrated assessment that generates scenarios, to impact assessment exercises.

First a small disclaimer. We too found it difficult to do the scoring. Our scoring is probably primarily a reflection of our interpretation of the document and of what we read here today, because we are not experts in any of these three methodologies ourselves. So we base any evaluation on limited information. Now, as to the content itself, I think we too concluded that you definitely need to combine methods because the different methods have different advantages and disadvantages. I think M1 & 2 need user input, which is very good thing. Basically because you ask input from stakeholders in that way, they are perhaps more valuable than M3. But if you do ask input from stakeholders, probably you need to ask their input not only for the current situation but also for their envisioned future. Their evaluation can be different in future, but in order to do that you first have to give them a narrative or a pathway towards the future on which they can base their own assumptions.

And probably you also need to do that for different scenarios, which in combination makes for a very large exercise, different time steps in the future and different scenarios. Then we also discussed that a sustainability assessment from the social aspect side should probably be repeated more often in the future. It's not something you do once and then you can't safely assume that it will work out like that and stay the same. So you could repeat it in the future and maybe a last one.

You could also see these three methodologies and the one that you will develop that you take from the combination of the three as one of multiple steps in a complete exercise. You could first start with an integrated assessment where you generate technology scenarios that you do with other models. Then you could make an impact assessment based on those scenarios, like I first mentioned before.

It would be beneficial to compare the outputs of the three candidate methods when each is run on a single real-world case.

I think maybe there's an exercise somewhere here where we do a case study. If we picked the three methods, we take the three and we go apply that to a case somewhere. Maybe we run them through different impact assessments. That would be very satisfying for me to see it go through to an end use in the real world and think, "Okay, now I see where this got to".

Many sustainability and impact assessments fail to account for cumulative effects across industries, indicators, and ecosystems. This is a serious lack.

Just a couple of super brief comments. One thing that I find doesn't come up in impact assessments or in sustainability assessments ever and that we, for the moment stink at figuring out is cumulative effects across industries, across indicators, across ecosystems. So I am frustrated with any system that doesn't talk about a cumulative effect across an ecosystem – the marine ecosystem or whatever land ecosystem nuclear has to deal with.

The methodologies do not take into account the fact that the feasibility of different low carbon energy production methods is not equivalent. A long-term study is needed to explore feasibility pathways.

The energy market evolves very quickly and unpredictably. We can nonetheless assess the difficulty of balancing the energy system and the potential unique contribution of nuclear to that goal.

The total life cycle of energy systems is also affected by non-energy related issues, such as the political will to maintain nuclear power (e.g. in France its military double use is determinant). Such issues are perhaps not identified here.

So the goal is to explore the role of nuclear power in our system and throughout its lifecycle. Just there is something maybe I'm not seeing here in this methodology. It's all about the feasibility of the power system in the long term, because the methodology is maybe trying to compare nuclear power to the other low carbon energies, but they are not equivalent. And so there is a need for a long-term study in which you will explore the different pathways and which will explore the feasibility of those pathways. And this maybe is not present here. You were talking about the energy market. Sure, this is an important aspect, but well, the electricity market is hugely evolving, in particular these days. So we don't really know what the energy market will be. But we can assess today how difficult is it to balance the power system and nuclear energy has something to contribute to this balance, something that the other technologies have not. So this is maybe an important aspect that isn't present enough, maybe here, I don't know if it was hidden somewhere, but I didn't find it.

And the other thing is that here we are looking at what we want to base our decisions on, the total lifecycle of particular technology. And this is very important. But there are other non-energy related issues that are maybe not identified here. I'm thinking, for example, in France it's a political goal to keep nuclear energy because it is in somewhat form linked to the military complex industry. And so I don't think France is going to abandon nuclear energy, in fact, because of this, because we need to keep the technology to power our submarines, for example. And this is a decision aspect that isn't present here. So I wanted to add it.

Moderator *– So the method is holistic "as far as it goes". Policy options can be entered in M2 as Country Specifics.*

The methodologies should be able to capture and differentiate between global and local influences and impacts. For instance, rare earths mined in China or in Switzerland are not equivalent in terms of environmental safety.

"Yeah, we have been discussing also the methodologies should be able to differentiate between the impact that are global in nature and in scope from those that are local and affected by local situation and context. For example, we are referring to mining, uranium mining, for example, or rare earth mining that can produce different

impacts depending on whether & where they are produced or located. So if the rare earth are mined in China, perhaps they are producing a lot of environmental inputs which in Switzerland they are not going to be produced. So this method should be able to capture these differences.

There needs to be an understanding of the local context. Depending on the material, some are more valuable, abundant, polluting than others. For example, knowing the volume toxicity as well as long lived mobile nuclides would have an impact on the use and location of repositories.

2.1.2 Proposed improvements to the selection criteria

Moderator *– The authorities differ in their willingness to be inclusive, i.e. to take methodological output as one element in a democratic decision process.*

The indicators of social sustainability could be discussed, improved, augmented.

It's difficult to assess abstract (under-operationalized) criteria.

A missing criterion concerns liability and responsibility, which are significant factors in nuclear sustainability. It's important to maximize the inclusion of the actually affected (and often most vulnerable) stakeholders, in an environmental justice perspective; this appears to depend on the willingness of the expert assessor.

My challenge really was that a lot of the criteria were very abstract, so it makes it hard for one to assess them. For instance, what does 'socioeconomic economic impacts', or 'attractiveness of technology' mean exactly? I found a gap, too, in regard to safety criteria: the liability of nuclear suppliers and operators. There is a discussion on how liability also inhibits nuclear suppliers; at least, it is an important element in this whole question of whether nuclear technology can be a sustainable long term energy system.

It's important to define who the stakeholders are, and simply say that we need to have lots of stakeholders giving their input. It's been our experience, at least in our part of the world, that the communities whose land and resources are taken over for setting up of these plants are the most neglected. So will the expert continue to operate in deciding who the stakeholders are?

The criterion of adaptability is key but specific indicators for each methodology should be thought out. The rating is related to the adaptability of the evolution of technologies and not to the evolution of the energy market.

An important additional criterion to consider would be the adaptability to local contexts.

The methodology shall be able to assess impacts at local level (different activities can have different impacts depending on where they are implemented e.g Europe vs other countries with less stringent environmental regulations).

2.1.3 Reflections on involving stakeholders in assessment

The methodological selection task requires a judgment of objective nature. As a non-technical expert, it should be recognized that my input is subjective.

This selection activity asks questions requiring a judgment of objective nature. Therefore, technical knowledge is needed to answer.
Replying to such technical questions needs a careful study of papers. I could transfer

knowledge from papers to guide, but it is very technical, and I don't feel competent. My input as a non-technical expert could lead to losing information and will not add value. It will be subjective because guided by my opinion, judgments, values, norms, expectations, interest, wishes etc... Here, a pertinent output requires factual replies to factual questions.

The task of compressing very complex questions into indicators and weighting them can result in "gaming" behavior, where participants of different backgrounds or roles quantify a choice, report it, and move on [without further examining or validating the number]. This can be observed in sustainable finance. This behavior may actually inhibit our ability to solve complex problems. From this perspective, the difficulty of the ECOSENS workshop task is positive – it highlighted the frustration [and danger] of not being able to better justify a quantified choice.

One of the ways that we test things in the social sciences is to give people an exercise that's too hard or dense and see how they handle it. I felt like this is a really good example of that because I was very impressed at how my table did and I really loved everyone's contributions. So I think I would call this a really successful exercise. I did have an asterisk, which is I work in sustainability indicators and across, let's say, all of sustainable finance. So all of the taxonomy, all of those different categories. And in every day in my work, I see finance people especially, but also corporates doing this exercise: really trying to compress some hard, hard, complex questions into indicator work. And I would say that for now I see them erring on the side of kind of gaming the reporting, quantifying a number, sticking it in the Excel sheet and going forward. And I just want to caution us all of something which I'm sure we're all already thinking about: there's a problem in that gaming the reporting inhibits our ability to solve complex problems. So I love that it frustrated us a little bit to not be able to go deeper.

We must not forget that policy makers must ensure the step of implementation: creating legislation to enact the assessment/decision findings. These actors probably request from scientists not only scenarios and assessments, but also concrete policies and measures.

What is bit missing here in the entire discussion, while aligning with the comment that was just made. You never mentioned an implementation plan: basically, with which policies and measures will you make sure that society moves to the right direction and accepts the evaluation that you make here? It's very nice to say 'this would be the best solution based on the impact assessment and an integrated assessment'. But then, of course, what then? Somebody needs to issue laws to make this happen. I think especially the policymakers are also looking towards science to 'tell us, what should we do? Give us a suggestion on act on concrete policies and measures. Which legislation would enact the scenario that you evaluate here?'

Moderator *– Recall that in e.g. M3 LCA, the last obligatory step is interpretation and recommendations.*

Social sustainability must embrace the involvement of society in making sense of sustainability. All methods can be adapted to this ambition, depending on the willingness of the actors applying them.

Criterion n°8, 'suitability to the involvement of a large group of stakeholders for certain assessment steps', has a connection with our discussions on social sustainability yesterday. Social sustainability is also your care of including society in making sense of sustainability. And so I would say there's no difference between the three methods. If you really want to be inclusive to involve society, then you can discuss using all these methods, taking the technical challenges of course, but also making the methodological content more descriptive. It really depends on the willingness of the organization, the expert group, the authority that wants to apply these methods.

Stakeholder participation does not lead to neat consensual conclusions.

The European taxonomy exercise was not participatory, because otherwise it would

have ended in chaos, not in a pro-nuclear conclusion.

Decisionmakers may be willing or unwilling to involve stakeholders. It is important to consider the degree of unwillingness, because it can result in eliminating complex dissenting voices, or in undemocratic decisions. When organizing stakeholder participation the first question to ask must be: "Is everyone present who should be?".

I want to end by underscoring the point that in this group of very super smart people, unwillingness doesn't come up very often. If a group that holds the power to make a decision is willing to bring on stakeholders, it happens. Do we think that that's mostly the case or less often? Do we believe that we are bringing in complex dissenting voices and taking those decisions democratically? I'm pretty skeptical of that. That's what I would like to see. But I want to give a little bit of a voice to the unwillingness that might be involved in the conversation.

I'm sure that the first question you asked when you organized stakeholder participation for this workshop was: is everybody here who should be here?

3

Task 2 - Scoping and Bounding: Selecting High-Level Objectives (HLO) for the European Energy System to 2030 or 2050

The second task of the 30 March workshop addressed the identification of high-level objectives (HLO) to guide the later ECOSENS energy system sustainability assessment exercise. Working paper D2.1a referenced and briefly presented HLOs that had been used for assessments organized by IAEA. ***Box B*** is drawn and revised from D2.1a (which may be consulted for the omitted references). At the workshop, task 2 was introduced by ***Figure 1*** (below).

Box B – High-level objectives to be met by energy production systems under assessment (from D2.1.1, Constantin 2023)

Generally, a comparative assessment of technologies, scenarios, or nuclear energy systems is performed with reference to a set of high-level objectives (HLO). These are defined by the experts and stakeholders involved in the assessment, who then select areas of assessment to be grouped respectively under each HLO.

An example may be given from an existing application of M2. In a set of studies performed by some countries three HLO are used:

(1) Cost (reflecting economic performance; the nuclear energy system should be competitive on the energy market);

(2) Performance (integrating waste management, proliferation resistance, environment, and some possible country specifics);

(3) Acceptability (reflecting the maturity of the technology, and acceptability at societal level).

The next level, Area, allows the grouping of indicators in a consistent sub-set.

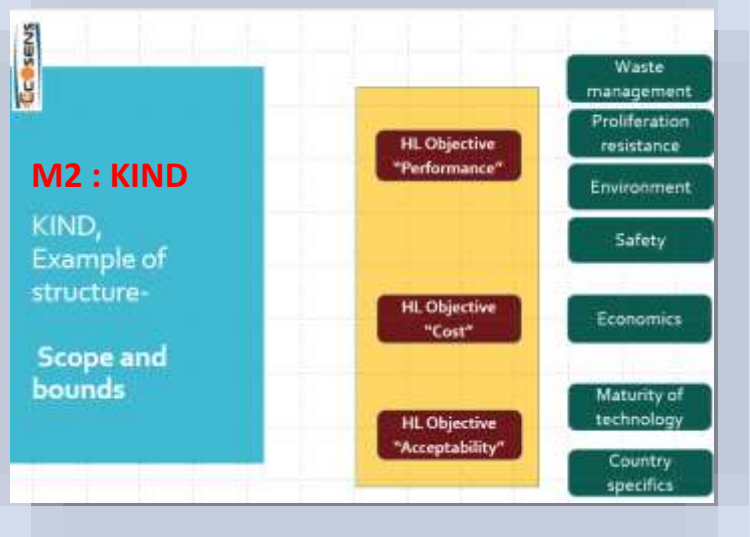


Figure 1: High-level objectives (yellow column) and corresponding areas of assessment (green boxes), representing the scope and bounds of an assessment conducted using M2 (KIND).

3.1 Plenary report of subgroup discussions

Participants were divided into three new subgroups to identify desired high-level objectives for the future ECOSENS sustainability assessment. No rapporteur was formally selected for each subgroup. Instead, the moderator called on spontaneous volunteers to share comments and experience from the subgroups, and the plenary discussion developed organically.

The following text (indented, in black font) is derived from the recording of the plenary feedback session. The individual speaking is not identified. The author/moderator has added header text in blue font, identifying the dominant topics of each intervention; these may be read as a quick summary.

To facilitate communication, assessment 'areas' themselves could be taken as high-level objectives. [Assessment results would be interpreted in regard to whether the studied energy system delivered an acceptable performance in each area.]

Additional high-level objectives include:

- *Robustness and flexibility: of both the technology, and the overall energy mix.*
- *Ethics: of the decision-making process to select the technology, and of intergenerational outcomes.*

Good performance on ethical objectives aids in the acceptance of technologies.

> In M2, the column in the yellow box displays high-level objectives, followed by associated assessment areas in green (*see* ***Figure 1***). We discussed whether the areas are in the right high-level objective. One possibility to solve this would be to use the *areas* as high-level objectives. I think these are also clearer to explain to people not attending this workshop who have to apply the methodology later.
>
> Before all that, we had discussion on other high-level objectives that could be additional to these. We had "robustness and flexibility" of not only the technology but the energy mix as an additional objective. And also some things about "ethics". For example, the intergenerational aspects of technologies and also on the decision making itself which helps the acceptance of the technology or the choice of the technology.

An integrated or holistic assessment would be preferable to one separated into three pillars. This abstract objective could be discussed throughout the assessment process.

Assessment should not take "economic growth" as a necessary good, but as a feature to be questioned.

> Regarding the "social sustainability" discussion we had in yesterday's workshop, we were questioning whether we could get rid of the three-pillar approach to substitute something more integrated. I think holism would be a good word. It's also in the grid used yesterday, not as a principle to follow because of course it's ultimately abstract, but as something that can be discussed as a criterion throughout the exercise you want to do.
>
> The big elephant in the room, especially when we talk about the European energy system, is economic growth. We think we should have economic growth as a criteria. We should question it as a criterion. Look, we'll smile because we had a good discussion about that yesterday. But the criterion is – don't misunderstand me – questioning economic growth.

A general HLO like "sustainability" is not well enough defined. It is difficult to achieve an excellent formulation, but we specified concern for environmental impact.

Further desirable objectives include "accessibility and reliability" of energy: abundant, sufficient and affordable for the consumer.

> We discuss to have high level objectives, very general. For example, "sustainability". But this formulation is not very well defined; people

cannot understand from this what sustainability means. We introduced some variants, for example, to define something about the "accessibility and reliability" of the energy. For the consumer, that means abundance, enough energy and an affordable price. After that we wanted to have something related to the impact on the environment. That means some sustainability related to the environment. But we didn't succeed to have a good formulation. We have to go on thinking.

A brainstorming approach led to the identification of four areas of importance when selecting an energy mix. The corresponding high-level objective is a desirable performance on criteria such as:

- *Social sustainability: social progress – at global as well as at EU level; social feasibility (what kind of behavioral changes may be required); effect on social disposition (sociability); social exclusion; political stability and regulatory certainty.*
- *Environment: CO2 emissions; use of resources; other impacts; toxic waste emissions; compatibility with circular economy; respect of planetary limits; systemic approach to energy-water-food triangle.*
- *Economics: Internal and external costs; investor risk; value chain autophy.*
- *Technological: supply security; technology readiness level; technical feasibility (e.g. adaptability to climate change scenarios); resilience to unforeseen events both internal and external; vulnerability linked to degree of energy system distribution.*

We used a combined bottom-up and top-down approach. First we had an open brainstorming on what is important when selecting a certain energy mix. We felt that they more or less fit under four categories: environmental, social, economic and one which is technology related and we couldn't really classify it anywhere else. And so we thought about very different aspects. In the social sustainability part dimensions such as social progress, social feasibility were mentioned in the sense of "what kind of societal changes are needed for a certain energy scenario" like for instance, behavior of people. Does it need to change in this circumstance or not? We talked about reducing social disposition and risk of social exclusion from whatever it may come from. And then we talked about political stability: some energies maybe are more subject to political instability and regulatory uncertainty. In the environmental part we discussed low CO_2 emissions, use of resources, of course environmental impact, respect of planetary limits and here it was mentioned that it is worthwhile thinking about energy not only alone – disconnected from water and food – but also considering sort of more systemic approach.

Low toxic waste compatibility with circular economy were also mentioned. For economic I forgot to say that social progress was felt that it should be not only at EU but also at global level. So we should really keep this in mind. So for economics we talked about internal/ external costs. Low investor risk was felt as something that should be considered and low risk value chain autophy – I understand it's a term that is used in energy studies. And then for the last dimension, technological so some aspects were secure supply, technology readiness level so it was felt that this should be as high as possible; feasibility, technical feasibility because maybe some technologies exist but they are not so feasible. For instance in connection to their capacity to adapt to climate change scenarios. And then an important aspect was resilience both external and internal, how resilient they are to unforeseen external events but also to internal uncertainties. And then a last point was sort of, I think a vulnerability distribution. Like if you have energy in a more distributed system it's less vulnerable than if you have one or two main, let's say, power sources. So this is, I think, a summary from this table.

Europe should not forget the importance of the energy-water-food security triangle. At global level, energy is often not the highest priority.

Maybe from my side, simply on the nexus point that the water and food I think often it's not much thought about in Europe but especially when you go outside of Europe it

becomes a much bigger issue. I think if you want to make a methodology that is globally applicable then it's certainly something to take into account that for a lot of countries energy is not even the highest priority of those three. It's often food and combined with water.

4 Task 3 - Selecting and Weighting Assessment Criteria at Indicator Level

The third workshop task considered quantifiable indicators for use in M3, life cycle impact assessment, as presented in D2.1a. At the workshop, after a PPT presentation in plenary (**Annex II**), three worksheets were provided (**Annex V-VI**). The indicators are grouped by environmental, economic and social pillars. The meaning and relevance of these indicators, and moreover the weight to be given in the future ECOSENS assessment to each indicator and sub indicator, were discussed and appraised by workshop participants. ***Box C*** briefly explains the logic of the exercise.

Box C – Weighting indicators for use in the ECOSENS sustainability assessment (drawn and revised from D2.1a, Constantin 2023)

The ECOSENS assessment is proposed to appraise indicators characterizing the typical pillars of sustainable development, thus structuring the life cycle analysis (LCA) in three chapters:

(1) En-LCA, Environmental life cycle assessment,
(2) Ec-LCA, Economic life cycle assessment,
(3) So-LCA, Social life cycle assessment.

In the worksheets, the indicators proposed for En-LCA are presented together with some sub-indicators. The relevance and definition of these indicators will be discussed during the workshop, as will be potential weights for the agreed indicators and sub-indicators. Weighting is a manner of indicating how important a role in the assessment should be played by each indicator, by attributing (on a scale of 0-100) its desired share of influence on the result. The weights are expressed in percentage. The sum total of percent weights w_i should therefore amount to 100%. The sum of weights w_{ij} will likewise total 100% for the set of sub-indicators respectively associated with one principal indicator.

During the actual assessment work to be performed by ECOSENS partners, each indicator (or sub-indicator) will be quantified on the basis of the literature (official reports, research papers) and summarized in dedicated fiches (29 fiches for Environment, 17 for Economics, and 16 for Social).

Final interpretation of the assessment will be performed with the involvement of experts and stakeholders (in 2024 workshops). Interpretation consists of individual scoring of the investigated nuclear technology's performance on each quantified indicator/sub-indicator by each expert/stakeholder involved in the process, compiled in a converted value (such as an overall average and statement of variability per indicator), with discussion and debate.

4.1 Report of subgroup discussions

Participants divided themselves into three new subgroups to discuss and weight indicators to be appraised in the future ECOSENS sustainability assessment. No rapporteur was formally selected for each subgroup. Instead, the moderator called on spontaneous volunteers to share comments and experience from the subgroups, and the plenary discussion developed organically.

The following text (indented, in black font) is derived from the recording of the plenary feedback session. The oral input is also completed using comments written by participants on the task worksheet. The individual speaking is not identified. The author/moderator has added header text in blue font, identifying the dominant topics of each intervention; these may be read as a quick summary. Occasional moderator comments from the live proceedings are included as well.

4.1.1 Proposed improvements to the indicators

We had difficulty completing this exercise (filling in percent weights next to each indicator) and have several observations or suggestions:

- *The assessment must take care to retain absolute values on indicators, providing a zero pivot point or scale neutral.*
- *Some indicators cannot be independently assessed, but may be strictly intercorrelated (meaning that altering the weight of just a single indicator, without reflecting the resulting change in another indicator, introduces error).*
- *Some indicators should be labeled with an absolute threshold: if this level is surpassed, the whole show is stopped. For example, on human health impact, a certain statistical life loss could disqualify the technology.*
- *Benefits/costs (as an inherently important feature) and co-benefits of a given technology should be specified and distinguished. For example, health impact would be a strictly limited cost, whereas the creation of more jobs is a nice co-benefit, not an objective in selecting a technology.*
- *Benefits as well as costs (as seen here) should be tallied, because economic decision making will compare those.*
- *The actual meaning or outcome of observed or predicted worst and best performance on each indicator should be specified on the worksheet, to communicate scale of impact and to calibrate the indicators. For example, a particular indicator might be bounded by removal of two statistical life years (worst) vs. gain of one life year (best).*

It is not simple to perform this exercise at EU level. Although bound by certain mitigation targets (CO2 reduction, renewables target), each country has its own energy system.

> We started the discussion and looking at how to fill out the percentages but we got stuck. We have several observations that we want to share. First observation: because you ask a weight from one to ten, the item should be phrased in such a way that there is always a neutral position. You have ten as being better and one as being worse. So you need a neutralization of the scale distinction.[4]
>
> I think too that sometimes combinations of these things, of these aspects are important that you can't evaluate each one independently of the other one. Sometimes there is a strict intercorrelation between some of them.
>
> Probably it's also useful to allow the definition of an absolute threshold for some of these aspects. Meaning that you could say if you go above this level then it's a no go anyway, independent of all the rest of this course. For example, the impact on health. Maybe it's statistical life loss that there can be an absolute gap that disqualifies the technology.
>
> Then fourth, it might also be worthwhile to allow for indication of what is truly inherently

[4] Later comment by moderator: The task at hand requests proportional weighting, i.e. signifying the degree of influence of one indicator (to the detriment of other indicators) to be requested in the overall calculus. The task does not request a 1-10 ranking of desirability or of performance on each indicator. The scale associated with each indicator (expressed in e.g. PPM or mortality or any other unit), and the direction of "good" performance (high or low), must be taken into account by a conversion step.

an important aspect of an energy technology and what is more a nice co-benefit. Like again, maybe health can be strictly important, it can't harm other people. But jobs created. Yeah, if you have the perfect energy technology that does not create jobs then it's still a very good energy technology. Having additional jobs is more a co benefit of an energy technology but is not a goal in itself.

For the economic part, I think you forgot actually the benefits. It's a long list of costs, but nowhere does it say what the value is of the generated electricity. So as an economist, I always look for a tally of cost and normally an economic decision is a comparison between cost and benefits.

And then fifth, to do this in the EU context is also very difficult because you don't really have an EU energy system; you have country energy systems and we are together bound by certain mitigation targets like CO_2 reduction and the renewable target. So it's very difficult to do this really on a complete EU level.

And then lastly, as a constructive criticism, what we think could be helpful is if you would add two columns at least and in the first column indicate what the one score would mean. Saying like for example, again for health one means that we all lose two statistical life years and ten means that we don't lose any or maybe gain one or something, I don't know. But basically make it explicit in two forms what's the worst option and what's the best option? And then at least we could try to give a score of the importance. But now it's completely you ask me how do you score this health thing? But does one mean that at worst I lose one statistical healthy month of my life or does one mean that I lose 20 statistical healthy life years. That makes a big difference. So I think you need calibration and you need to provide it as a consortium before you can ask us to fill out percentages.

***Moderator** – We may have a moral obligation to state those impacts at micro level, to identify particular vulnerabilities, rather than stating impacts averaged over a population.*

Decision makers have to be able to indicate which options are unacceptable for society. A technology could be well-rated for everything except a horrendous performance for human health, and yet still come out on top because of the distribution of a large number of weighted criteria. That is why a threshold is necessary.

Some criteria may be of key importance for the description of an energy technology, while others are simply describing co-benefits. Both types could require a threshold, perhaps absolute, perhaps subjective.

There can be multiple of these criteria where you can define a bar scale that might go off that threshold. There are certain things that you can't instigate in society. Also as a politician, policy maker, some things are just unacceptable and you should be able to indicate it. Imagine you have this technology that is perfect for everything except for maybe human health. Or any other thing, like completely horrendous for that one specific thing, but by the means of weight it could still come out on top. Obviously that will never work. That's why you need a threshold for some of these things. Probably the thresholds also come together with the fact that some of these categories are really intensely important for an energy technology and others are more like good benefits. It stands to reason that the two thresholds will be linked to the actual key aspects of the energy technology and the good benefits. And probably more than an absolute threshold.

Then I could reflect for myself. I mean, if tomorrow we say that we can solve the climate crisis, for example, if I lose one month of my life, then I could actually think about it from my own personal perspective. I wasn't comparing people here.

The value of statistical life in Bangladesh is a thousand times lower than in the US or Europe. We must remember that country studies will have different outcomes.

The value of statistical life in Bangladesh is thousand times lower than the US or Europe. So also something to take into account if you do national studies. If there are authorities on Bangladesh to do the exercise it would be

done differently from how it would be done in Europe or in the US.

It's important that the ECOSENS project be neutral in performing the assessment, and transparent or honest in its conclusions (even if no conclusive result is achieved).

One of the recommendations was that the project should be honest in its conclusion. Even if the project can't conclude anything or only a few things, it should be clearly set for such a project is supposed to be neutral. That's very important. Even if you can't reach a conclusion, please do that. That can be also very valuable conclusion.

Assessment should not focus on just one energy system, but on the combined and cumulative effects of all energy decisions measured against a bioplanetary hard limit (e.g., biodiversity).

Another criterion is additionality: does the assessed production method add low carbon energy to the mix? The technology should not be evaluated in terms of how clean it is in the abstract, but rather its contribution to accomplishing decarbonization and putting fossil extraction out of business.

We should not disaggregate beyond a certain point. Philosophically we should not have to choose between saving birds and avoiding cancer; moreover such a tradeoff is false, because ultimately there's a high probability that what's killing the birds is also not good for you.

Assessment should not weigh how much mortality is acceptable. If the system is killing people, the option to reject it should be available. A hard thumbs down on a particular metric like human health is useful; this does not signify that human health is identified as the most important metric.

We are still confronted with the difficulty of capturing cumulative effects producing an overall no-go system.

We added some indicators, one of which was cumulative effects. So that to make sure that we are not evaluating simply one energy system or production plant, you have to be evaluating all of the different decisions made on that energy collectively towards a bioplanetary hard limit, as it were. So adding a way to capture cumulative effects was important.

Weightings need to reflect current situation and should be redone periodically, e.g. putting more weight to biodiversity if diversity is more threatened.

We also added other indicators. One was additionality, evaluating an energy for its actually accomplishing decarbonization. We're not evaluating it how clean it is in the abstract. We are saying "is it putting fossil extraction out of business"? That may already be integrated in some of the criteria presented in the worksheets.

We should not be evaluating whether or not we prefer cancer or less cancer or losing birds, because not only is it a choice we shouldn't philosophically have to make, but it's ultimately a high probability that what's going to give you cancer is what's killing the birds is also not good for you. So that disaggregating to that point is not a good. SG#1 had an elegant economic way of also rejecting the risk weight. You reformulated the assignment, which was to do the risk weights, and you came up with an elegant way to get around the risk weights.

At the same time you have to have the ability to put a hard cap on something: we're not going to talk about how much death we want. We're going to decide that if your energy kills people, we're not going to do it. So you get to have a hard thumbs down on a given metric, which I don't take to mean that you've agreed that it's the most important. What I heard SG#1 saying is that you get to eliminate something based on a metric that you decided is a no-go. I completely agree with that part, but I also say your whole system is a no-go and it's harder to capture.

Get the policymakers in first to help frame the inquiry and then it will be a more qualified opinion.

Regulatory aspects are lacking here. Regulation for the technologies in question is debated and evolving. Dual use components lead to different types of licenses. Access to technologies will be different according to countries, inside and outside Europe. How are the costs or limits imposed on energy projects by licensing taken into account? How are technological and social licenses to be weighted

together? These framing issues may be more important than assigning a quantitative portion to indicators.

> Perhaps we need to look at how we're framing things with weights. One model I had in mind was this: get the policymakers in first and then it will be a more qualified opinion.
>
> The other aspect I thought was lacking was the notion of regulatory aspects. These technologies are on a horizon where regulations are evolving and they have been discussed and debated on. And since some of them have dual use components, it will really alter what kind of licenses are given. So how does that cost configure in the project altogether? There will be some countries in Europe, or outside Europe as well, that do or don't have access. So how does the licensing portion work? How would you classify that risk? You've got a technological license and a social license. So how do you weigh them all together? These debates were not present. So I thought it was more of a framing thing, less of assigning a quantitative portion to it.

In a mixed list of criteria, giving weight to emissions performance is equivalent to reducing the weight of impacts. The list of indicators would be better expressed in terms of impacts.

If emissions are judged, all relevant ones should be included, such as ionizing radiation.

> Environmental indicators are missing out of it because we should be considering emissions and also impact. And there are only emissions considered. There are many ones and these emissions are reducing the impact. So perhaps we are overlapping or double counting with these two types of indicators. So I would definitely go for impacts and not emissions. And also there are emissions that are missing that are important for some cycles. For example, ionizing radiation emissions are neither in the emissions nor impacts.

Why assign subjective weights at all? This can lead to manipulation of outcome scores when comparing technologies. There could be an interest in learning which weights are assigned by different demographics, but less trust in weights assigned by a specific expert or institute.

> I just wonder why we should do weighting after all as a subjective exercise. Why would we need to manipulate desired share of influence of indicators on the result? Because if you do that and you do it in a comparative assessment, of course we do the same weighting, then you can manipulate the result. So why are we doing that? It's a more existential open question. I can see it as a valid exercise, but only as a demographic, not as a specific choice of an institute or an expert or a tolerance.

4.1.2 Reflections on involving stakeholders in weighting

In multi-criteria decision making, you assign weights and appraise values of each indicator, then perform a sensitivity analysis: vary the weights to assess the sensitivity of outcomes to change in one or more variables. If you have more or less the same outcome, you might say that the weighting exercise was unimportant, but it has helped demonstrate the robustness or reliability of the outcome.

If shifting weights changes outcomes considerably, this highlights the subjectivity of the exercise. Some kind of (democratic) procedure is needed to order the results. This may be achieved by setting thresholds for a subset of indicators considered to be critical (show-stoppers). Such adjustments can result in abandoning the majority of indicators in order to get a robust (but oversimplified) result. This is a present risk when a large set of indicators is engaged.

> I participated or saw reports of a few multi criteria analyses. Weight is used for the outcomes. Outcomes differ a bit quite sometimes. They do the exercise as it should be done, they have the assigned weights, they assign values to the indicators and they weight the whole thing to come to a result. They do sensitivity analysis by shifting the weights back and forth. If you're lucky, you have more or less the same result independent of the weights. And then, in fact, you could say the

weighting exercise was not that important. But you have an outcome that is quite robust and reliable, something that you can use.

If you're unlucky the different weighting changes the order of the results completely. And then, of course, you're in a very subjective exercise and then you need something, some democratic process to come to an order of preference. And in some cases I saw that they did the exercise come to some kind of order with sensitivity analysis. And then they say, "yeah, we cannot go around or we cannot avoid this criterion". This one is so important that every indicator that scores less than this within that criterion you have to take it out, and then you did the whole exercise but at the end you do not really keep the result and you pick one criterion that you say "yeah, this one has to be fulfilled".

In that one particular case I'm thinking of, 80% of the indicators that dropped out. So. And especially with this high number of indicators, I think it's a very difficult and risky exercise to do.

A large set of indicators provides a desirably fine grid directing attention to many dimensions of the energy transition. Experts and stakeholders can be asked to provide quantitative or qualitative appraisals. This will provide decision-making material, which must be systematized and weighed.

Operating on the weight of the key indicator is in the hands of authorities with specific intentions. The decision-making process itself must therefore be explored, knowing that ideological positions, values, and hopes for the future may intervene, as well as the degree of trust in the gathered data. Decisions will be more or less political. How to deal with this uncertainty?

Rather than deciding according to a fixed norm, we would prefer a more transdisciplinary collective decision making, producing a perhaps not full consensus, but something that the assembled actors can live with.

But on the other hand, the fine grid of indicators, we kind of like that. And we even added more because it will direct your attention to many different dimensions of this transition of energy systems. So we appreciate the thorough work of identifying many different indicators. It and also when you have these indicators you can then ask experts or anyone else experts in different areas to provide some data. It can be quantitative, but it can also be qualitative data. And then you have it. Okay, so this would be the influence on jobs. What will jobs will be lost, which one will be gained, what will be the skills needed, et cetera, things like that. Similar for water supply. What will be the effect there? So you can have many. The important thing is to have the indicators and that can help us generate the data, the input, the expected outcome on these different indicators.

And then you kind of have what you need to make a decision. But then of course, you need to systematize and weigh and quite often what will then be the criteria to make that decision. Operating on the weight of the "key indicator" is in the hands of authorities with specific intentions (e.g stakeholders, authorities, etc...).This may be very "uncertain". How to deal with uncertainty? Are we able to firmly discuss ahead the energy issues? Often there will be ideological positions or values or hopes for the future, whatever that will actually trust in the data that you have that you find in these documents. And that's a political decision, more or less. And how will you make that decision? And then we go back to that. It should not be like a norm in a way that makes that decision, but it should be a more transdisciplinary collective decision making, maybe not fully consensus, but something that they can live with. But we need to then explore the decision process also, that this will feed it.

Perhaps we should not assign weights. Impacts should be described and handed to policy makers who will apply their own model values to select a technology.

We also have this question maybe you should not weight. You then give the impact, all the different impacts, and you give basically to the policymaker or whoever asks for the LCA analysis, and they decide on their own model

values, like which of the technologies they choose. Of course by definition we think that we [as neutral experts] would do a better job.

Only a fully democratic weighting process would be trustworthy.

I know it sounds naive. But the only way you can possibly do this in a trustworthy way is in a full democratic way. If you want to do a weighting, then do it fully democratically, which is, of course, an abstract idea. Well it's not that abstract, it's possible.

Moderator: Input to that democratic process would itself have to be weighted to achieve fair representation, given different vulnerabilities and the power differentials in society.

In terms of risk communication, do some stakeholders need a simplified system enabling a more manageable comparison of options?

I mean, we still have power differentials in society. We can have every single person in the world vote, but you'd have to weight their vote if you want it to be fair. For example, give greater weight to the voices of those who have been excluded or who are more vulnerable to the impacts of the energy decisions.

But we also discussed at our table whether some of us someplace in society need a simplifying methodology? Do some of us need for things to be expressed in numbers from one to ten that we can easily compare in order to participate in this democratic or other process? And one participant was expressing confidence that we don't need such simplification.

The more we abstract the indicator into a proxy or a composite, the farther away we move from understanding what it is we're actually talking about. At the workshop we suggested a process in which we collect the raw data and combine analytic and decision-making processes to help us understand sustainability and learn to use the indicators and the data. Citizens and politicians need to be educated to become more sophisticated in connecting assessment to phenomena in the real. We need to understand CO_2, methane, and water toxicity to some degree, to be able to solve our sustainability.

I'm not fully against it, but I do believe it takes us a bit into a dangerous area. I think the more that we abstract the indicator into a proxy or a composite, then we get farther away from understanding what it is we're actually talking about. And what what we came up with resembles what I like to think towards. We sort of agreed that indicator sets, raw data, as another participant very eloquently explained, raw data can be provided, and then we teach ourselves and combine decision-making processes in ways that we can gain understanding and sustainability so we can use those indicators and data. Then if as a citizen, we go into an acceptability workshop or discussion, we are much more informed. Maybe politicians are more informed. We educate the populace to have not necessarily all become experts, but become more sophisticated in their connection of impact in the real to exercises of assessment. I believe that's a key gap, and I think when we abstract things too much into those kinds of indicators, we forget that what we're really trying to do is something that we get right out here in the real. So we need to understand CO_2 and methane. We need to understand water toxicity to some degree. I feel like we're going to have to learn that to be able to solve our sustainability.

The underlying assumption of assessment exercises tends to be that if only we could find some better way to calculate our way into the best decision, then we could make better decisions. However political decision making doesn't work that way.

In one context politicians said that scientific expertise and expert judgment are highly valued, but they don't have time to read through the studies. What actually has an impact on decision making are policy briefs made by researchers including an expert recommendation. It could thus be helpful to provide such a concrete empirical basis for political decisions, including a clear statement of how the experts derived their recommendation.

In this kind of exercise I think the underlying assumption tends to be that if only we could find some better way to calculate our way into the best decision, then we could make better decisions. And it's a commendable goal. But

like many others have said already, like, how this works in politics in actuality, that doesn't quite work that way. And now I've been in the political side of things for all of six weeks, so please don't think I'm an expert, but we did happen to have a really interesting event about the use of research in political decision making. And this was in Finland, so this was Finnish experience. In other countries it might be different, but at least in this event, both politicians and researchers who had studied how this is working said that politicians really value it. But the problem for politicians is the lack of time to read through their studies. So what the politicians want and what actually has an impact on decision making are policy briefs made by researchers and some kind of, like, expert recommendation that this is our expert judgment, that we should be doing this.

And I think the greatest value of tools like this would be in facilitating those kinds of expert judgments and putting them into slightly more concrete basis and in those situations, getting like numbers and saying that "this is the result of what expert panels weighted, it's a judgment based on these criteria" that could be quite convincing and helpful. Like convince politicians to adopt a certain kind of policy or certain kind of energy source choice or whatever. So that's at least so far what I've been told.

In an international context, when scientific expertise and recommendations are handed over to political actors the latter then review the work and fight over what they get to delete, usually altering the final document considerably.

In this workshop we proposed an alternative, utopian model: a transdisciplinary decision-making panel including different types of expertise plus citizens plus whoever needs to be represented.

I worked for years with the OECD and now have a bird's eye view of how sustainable finance has come to be. So the last step of what you describe is the politicians as in with the IPCC arguing over what to leave out. The experts have come, they've written the report, they've said you should do this. And then the politicians fight over what they get to delete and usually win a lot of those arguments. As the experts, we used to always laugh about how the researchers would do reports and then it's always all to be reviewed by the countries. And so a lot changes in that last little step of the sausage. Which gets us back to our new utopian decision-making model. Our transdisciplinary diverse different types of expertise plus citizen plus whoever needs to be on a decision-making panel. Would you like to add anything to our utopia?

To avoid dangerous misuse of such data and subjective alteration of expert judgment, a proposal is to perform the LCA without weighting, then reconvene an interdisciplinary expert/stakeholder group to rank the options. This ranking is then transferred to the politicians.

I also want one thing actually – a valuable exercise to the policymaker. I do agree that they would probably easily use it, maybe also deeply misuse it because that's the danger, definitely. Because then again, behind the methodology which they can quite subjectively insert data in. If you would indeed want to give true advice as a scientific community, then I would maybe do it otherwise and see that you get your LCA scores without weighting on paper the different technologies. Then reconvene this group and ask us to rank the different options based on discussion and interdisciplinary thing here. And then we will give the ranking to the politicians. And that's much less prone to misuse than giving them a blank check with a methodology which we can fiddle with.

5

Final Plenary; Next Steps for ECOSENS

In closing, moderator Claire Mays (SYMLOG) judged that the stakeholder input over the course of the day, while diverse, was internally coherent. As such, it can be used to enrich and render more complex the ECOSENS analytic framework or methodological proposal.

Marin Constantin (RATEN) shared his gratitude to all the participants. As assessment task leader, he spoke of how he might take the workshop opinions into account:

> There are a lot of good elements of information for me. First of all, you didn't outright reject the methodology. Therefore, I can construct, work and improve based on your suggestions. I appreciate a lot all the interventions, because each intervention includes some very valuable elements, and I will try to apply them in a new version. I want to reflect more about the weighting — whether to have weighting in the first phase or to do an exercise with conditions based on weightings supplied by some experts.

Meanwhile, in summer 2023 RATEN staff draw on public databases to develop detailed inventory fiches allowing quantification of the indicators retained for the LCA.

Subsequently to the workshop, M. Constantin provided **Annex I** illustrating how the stakeholders' structured input will be employed.

Annex VII contains the participants' evaluation of the two ECOSENS workshops conducted back-to-back (29 and 30 March).

Box D – New opportunities for participation

On 26 June 2023 a webinar will take place to obtain stakeholder judgments regarding future trends in energy demand. Up to a dozen participants will reflect on potential evolutions in demographic, environmental, economic, technological, political, and cultural drivers. This exercise will inform the assumptions used to bound the ECOSENS LCA.

Findings of both the 30 March workshop and the 26 June webinar will furthermore be presented and debated at the 28 August 2023 ECOSENS Scientific Event held in the run-up to the RICOMET Conference, to be held at Tabloo (Dessel, Belgium; ricomet.eu/#programme). Information on all public events including registration may be found at ecosens-project.eu.

As a further step, certain participants suggested "testbeds" to involve students (e.g., in Denmark, Finland, Spain) in weighting, calculations, or interpretative exercises. These will be arranged.

5

6 Conclusion

Overall, the 30 March 2023 ECOSENS workshop provided valuable insights and recommendations for refining the methodological approach and approaching indicators for the sustainability assessment of Europe's future energy system.

Participants highlighted the narrow path between quantifying assumptions and "gaming" the numbers. They underlined the need to perform iterative energy system life cycle sustainability assessments to capture effects of earlier actions, and to find manners to democratize these assessments and resulting decisions. They eloquently and patiently argued for whole-system approaches capable of taking into account cumulative risks and bioplanetary limits.

In Task 1 "Selecting Among Existing Energy System Assessment Methodologies" stakeholders were provided with selection criteria and worksheets to rate three candidate methodologies. Only a small subset completed this scoring (the outcome confirmed the pre-decision-in-principle to combine two classical methodologies; see Annex I).

Participants communicated their appraisal of positive and negative aspects of the proposed methods: e.g., ability to take account of country specifics and stakeholder input; e.g. inability to take into account cumulative stresses on ecosystem boundaries, or, to account for the differing feasibility of various low carbon energy production methods. They reflexively considered the social and technical feasibility of engaging non-specialists in assessment, in view of democratizing energy decision making at scale.

Task 2 "Scoping and Bounding: Selecting High-Level Objectives (HLO) for the European Energy System to 2030 or 2050" resulted in the assessors' designation of the following HLOs for the life cycle assessment (LCA) on Environment, Economic and Social pillars respectively: contribution to planetary wellbeing; reliability and resilience of supply; social feasibility. Discussion brought into view the tension between achieving a holistic assessment, and the need to operationalize (break down) such concepts as sustainability. The energy-food-water security triangle was acknowledged: outside Europe energy may not be the primary concern.

Task 3 "Selecting and Weighting Assessment Criteria at Indicator Level" requested that stakeholders appraise the relevance of the typical criteria employed for LCA as well as weight the proposed indicators and sub-indicators for each pillar. Only indicators belonging to the Environment pillar were in fact weighted (see Annex I).

Extremely detailed discussion of indicators was nonetheless sparked by Task 3. Technologies should be measured against actual achievement of decarbonization and eliminating fossil fuels, as well as against bioplanetary limits. Costs and benefits (intrinsic and co-benefits) might best be formulated in terms of impact (rather than of emissions). Their real interactions (additionality) must be taken into account. To facilitate decision making, impacts could furthermore be described in terms of loss or gain of life years or wellbeing. For certain indicators a hard threshold value of acceptability must be set, allowing elimination of a technology if it surpasses that limit - without necessarily implying that the particular indicator is the overall most important to society.

Experience was shared regarding the actual transfer of research and assessment results into political decision making. Divergence in judgment may result in retaining only a very short list of proxy indicators, distancing us from the complex reality that we seek to grasp. Political negotiation may then remove more information in light of participant countries' present interests. Framing implementation, settling the combination of technical and social licensing, may be more crucial than the apportionment of indicator weights. Thus, the ECOSENS LCA could be performed without weighting, then an interdisciplinary expert/stakeholder group could be convened to rank resulting decision options.

Facing such constraints, a transdisciplinary collective decision approach could target not consensus, but rather a compromise that the assembled actors – experts, citizens, and representatives of all those who should be at the table – can live with. The workshop invoked a process in which raw data is collected, and analytic and decision-making processes are combined to help the actors understand sustainability and learn to use the indicators and the data. At a broad societal level, citizens and politicians need to be – and can be – educated to become more sophisticated in connecting assessment to phenomena in the real.

In sum, the participants contributed guidance for the next steps of the ECOSENS assessment activity, and demonstrated the need for stakeholder involvement also at the later stage of interpretation. The participants are thanked here for their rich reflection and their collegial collaborative approach to the discussions.

Follow-up activities (26 June 2023 webinar; 29 August 2023 face-to-face activities; university "testbed" case studies; etc.) are open to registration via the ECOSENS-project.eu website.

The findings from the ECOSENS workshop "*Decarbonizing Europe's energy system: Checking and choosing indicators for a sustainability assessment*" will contribute to the development of recommendations for European policymakers in view of enhancing both energy mix decisions and engagement processes with specialists and non-specialists.

7 Annexes

Annex I - Taking into account the stakeholder judgments – Communication by M.Constantin

The lead investigator of the ECOSENS energy mix life cycle sustainability assessment provided this feedback regarding RATEN's planned uptake of the 30 March 2023 stakeholder appraisals.

Task 1: Assessment of the three candidate methodologies

Only 6 stakeholders submitted quantitative appraisals addressing all the proposed selection criteria and methods; one participant limited replies to judging M3.

Based on existing replies, the method M1 is seen to be quite far from the ECOSENS objectives and resources.

M3 earns the highest score, but it is quite close to the judgment rendered on M2; therefore the pre-decision in principle, i.e. to combine M2 and M3, would seem to be very acceptable for the stakeholders who expressed their judgment.

INDIVIDUALS	Method		
	M1, MCDA-NESA-IAEA	M2, MCDA-KIND-IAEA	M3, LCA/LCIA-JRC
1	0.875	2.375	2.75
2	2.3	2.44	1.6
3	1.75	2	2.75
4	1	1.375	2.75
5	0.875	2	1.875
6	1.625	1.875	1.5
7	-	-	2
Average	**1.40**	**2.01**	**2.18**

Task 2: Discussion on High-level Objectives (HLO)

The ECOSENS assessment will appraise indicators characterizing the typical pillars of sustainable development, thus structuring the life cycle assessment (LCA) in three chapters. Taking into account the workshop discussion, RATEN proposes the following high-level objectives respectively:

1. En-LCA, Environmental life cycle assessment, HLO **"Contribution to planetary wellbeing"**
2. Ec-LCA, Economic life cycle assessment, HLO **"Reliability and resilience of supply**"
3. So-LCA, Social life cycle assessment, HLO "**Social feasibility**".

Task 3 – Weighting indicators

Judging by the incomplete output of the third task, the time devoted to weightings was probably too short given the need to perform many comparisons and judgments, and in light of the knowledge held by the diverse stakeholders. However, a number of participants completed the task. The most pertinent result was obtained for the ranking of indicators belonging to the Environment chapter, with 6 respondents.

It remains to be discussed whether the exercise was considered by the stakeholders to be very difficult, or insufficiently interesting or relevant?
To extract some valuable elements from the appraisals, a simple baseline reference case was defined attributing equal weight to each higher-order indicator, thus: 1/10 for each Environment main indicator, 1/9 for each Economic indicator, and 1/13 for each Social indicator. In a second step, the stakeholder judgments were averaged on each indicator. Finally, these averaged values were compared with the reference case values.

The most relevant *deviations* found are identified below.

1. In the event of *greater importance* attributed to an indicator by stakeholders compared to the values of the reference case:
   - indicator 3.2 Impact on local/regional business (partner with other business), with +115%
   - indicator 2.3 Cost, with +62%
   - indicator 2.4 Cost for system integration, with +62%
   - indicator 3.7 Impact on health improvement, with +56%
   - indicator 3.1 Jobs created, with +50%
   - indicator 1.1 Carbon emissions with +50%,
   - indicator 2.7 Macro-economic impact, with +26%,
   - indicator 1.4 Impact on resources with +20%.

2. In the event of *lesser importance* attributed by stakeholders than seen for weighted indicators in the baseline reference case:
   - indicator 3.6 Contribution to the reduction of inherited burdens (toxic wastes, military stocks), with -48%
   - indicator 3.9 Societal-level adoption of the technology, with -48%
   - indicator 3.10 Existing investment in RDI to develop the technology, with -48%
   - indicator 2.1 Capacity factor, with -37%
   - indicator 2.8 Applicability for cogeneration, with -37%
   - indicator 3.4 Value of the knowledge generated and maintained for the future, with -35%
   - indicator 3.11 Dependency on government support (funding or incentives, such as tax credits or subsidies), with -35%
   - indicator 2.9 Level of standards generated, rules and control, with -28%
   - indicator 3.3 Additional goods and services created, with -22%
   - indicator 3.13 Equality of opportunities, with -22%
   - indicator 1.3 Energy returned on investment, with -20%,
   - indicator 1.10 Mitigation of accidents, with -20%.

The values for all indicators are presented in the following Table:

		Stakeholder appraisals (averaged value over 6 participants)	Average, normalized to 100% and rounded	% deviation from equal distribution
Env	1.1 Carbon emissions	15	**15**	+50%
	1.2 Land occupation and power density	8.75	**9**	-10%
	1.3 Energy returned on investment	8.33	**8**	-20%
	1.4 Impact on resources	12.08	**12**	+20%
	1.5 Potential material recyclability	8.33	**8.5**	-15%
	1.6 Emissions (other than C - Carbon)	8.33	**8.5**	-15%

	1.7 Impact on life and ecosystems (under normal operation)	10.83	**11**	+10%
	1.8 Impact of generated wastes	10	**10**	0%
	1.9 Impact of accidental situations	9.58	**10**	0%
	1.10 Mitigation of accidents	7.91	**8**	-20%
		99.14	**100**	
Eco	2.1 Capacity factor	6.25	7	-37%
	2.2 Global efficiency	8.75	9	-19%
	2.3 Cost	17.5	18	+62%
	2.4 Cost for system integration	17.5	18	+62%
	2.5 External costs	8.75	9	-19%
	2.6 LCOE	10	10	-10%
	2.7 Macro-economic impact	13.125	14	+26%
	2.8 Applicability for cogeneration	6.875	7	-37%
	2.9 Level of standards generated, rules and control	7.5	8	-28%
		96.25	100	
Soc	3.1 Jobs created	11.67	11.5	+50%
	3.2 Impact on local/regional business (partner with other business)	16.67	16.5	+115%
	3.3 Additional goods and services created	6.33	6	-22%
	3.4 Value of the knowledge generated and maintained for the future	5	5	-35%
	3.5 Impact on education	6.67	7	-9%
	3.6 Contribute to the reduction of inherited burdens (toxic wastes, military stocks)	4	4	-48%
	3.7 Impact on health improvement	11.67	12	+56%
	3.8 Impact on poverty	10	10	+30%
	3.9 Societal-level adoption of the technology	4.33	4	-48%
	3.10 Existing investment in RDI to develop the technology	4.33	4	-48%
	3.11 Dependency on government support (funding or incentives, such as tax credits or subsidies)	5	5	-35%
	3.12 Risks	8.67	9	17%
	3.13 Equality of opportunities	5.67	6	-22%
		100.01	**100**	

Remarks on the assessment of qualitative indicators

The observed difficulty to quantify some indicators, especially those found in the Social chapter, is of importance for the development of the assessment methodology. In this area, any indicator may be quantified with the monetization of different socio-economic benefits.
https://www.epa.gov/sites/default/files/2017-09/documents/ee-0568-07.pdf

Remarks as we advance towards testing the proposed methodology

The most important outcomes of the workshop in the view of the assessors:

- critical comments highlighted the need for even more holistic and integrative assessments in societal decision making, which can be interesting guidance during the ECOSENS interpretation step;
- distinctive advice was received for formulating high-level objectives;
- the stakeholders did not reject the pre-decision in principle of combining two candidate methodologies;
- certain participants propose testbeds to involve students (in Denmark, Finland, Spain).

Box E - Moderator's critical comment on the raw weighting data collected from workshop participants

The moderator collected participants' worksheets from all workshop tasks, containing both qualitative statements and quantitative judgments. Upon transmission of the raw data to the assessor, she formulated the following comments on data quality and the response to the task. She expressed her reserves regarding the utility of the task and the adequacy of the data for integration into the ECOSENS assessment. These observations were well received. Annex I above contains the considered response of the assessor.

Resistance to the task/inappropriate character of the task:

- There is very little quantitative data gathered on the Task 1 and 3 worksheets: maximum 6 judgments out of 16 guests.
- The appraisals do not always address all parts of the task (e.g., a person judges indicators but not sub-indicators).
- Several persons comment in writing that the actual expertise of the guests is not well used.
- Others comment that the tasks were not obvious to complete with existing knowledge (example: they are not aware of the extent of "planned resources" invoked in selection criterion 1).
- Some explain their belief that weighting is in itself inappropriate at an early point in an assessment process, or, that it can mask important issues.

First observations on the data:

- It appears to me that only 2-3 persons addressed the weighting task in what might be called a skilled, consistent, or differentiated manner. It appears that the others who replied might have "broken down" in the course of completing the complex task, tending near the end to distribute equal weights over indicators.
- Interestingly, there is in some places a noticeable range of judgments (= interrater disagreement) – It would be useful to have mathematical description of the dispersion.

Encouraging responses:

- Several written comments offer direct advice or recommendations regarding methods or indicators. These are integrated in the synthesis report.
- One guest took the worksheets home and checked weights with NGO colleagues interested in energy systems; therefore the completed scanned form returned by email held a "rich" opinion (consensus of several specialists).
- We are aware that several guests offered to conduct a "test bed" in their own teaching context.

Annex II – Slides introducing the candidate methodologies

Selecting Among Existing Energy System Assessment Methodologies

M.Constantin, RATEN ICN

Considered methodologies M1, 2, 3

NESA (IAEA)	KIND-INPRO (IAEA)	LCA (JRC)
to assess **Nuclear Energy System (NES)** capabilities to meet **national** sustainability requirements	to assess the sustainability of **some nuclear technologies** by using a common set of indicators	to assess the potential **sustainability impacts** of nuclear power considering entire life cycle

- *M1 was used to assess different national NESs*
- *M2 used for national or regional level, comparing different technologies*
- *M3 was used for assessing nuclear energy ("taxonomy" process)*

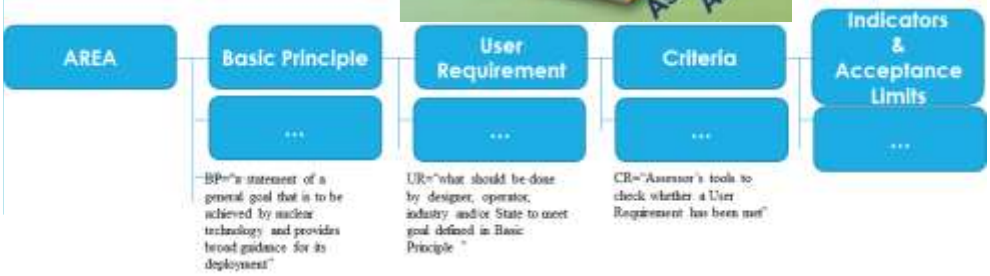
M1: NESA
Nuclear Energy System Assessment *(MCDA)*



- Developed by IAEA in the frame of INPRO project, reference document TECDOC-1575, 2009)
- Multicriteria decision analysis (MCDA)
- Holistic, including all components of nuclear cycle
- 7 areas investigated based on specific indicators:
  - (A1) economics,
  - (A2) infrastructure,
  - (A3) waste management,
  - (A4) proliferation resistance,
  - (A5) physical protection,
  - (A6) environment,
  - (A7) safety
- Main outputs:
  - (1) Identification of gaps in existing or planned Nuclear Energy Systems (NES),
  - (2) Definition of follow up actions to close these gaps.

NESA
Structure





NESA,
Basic Principle, Examples

Economics

Nuclear energy products must be **competitive against alternative energy sources available** in the country. Energy and related products and services from NES shall be **affordable and available**.

Infrastructure

Country shall be able to adopt, maintain or enlarge an NES for the supply of energy and related products **without making an excessive investment in national infrastructure** consisting of:

(1) Legal and institutional frame work,
(2) Industrial and economic infrastructure,
(3) Socio-political infrastructure (Public acceptance, Human resources)

NESA, Complexity

- Divided into Areas A.
- Overall:
  - 14 basic principles BP,
  - 52 user requirements UR,
  - 125 criteria CR.



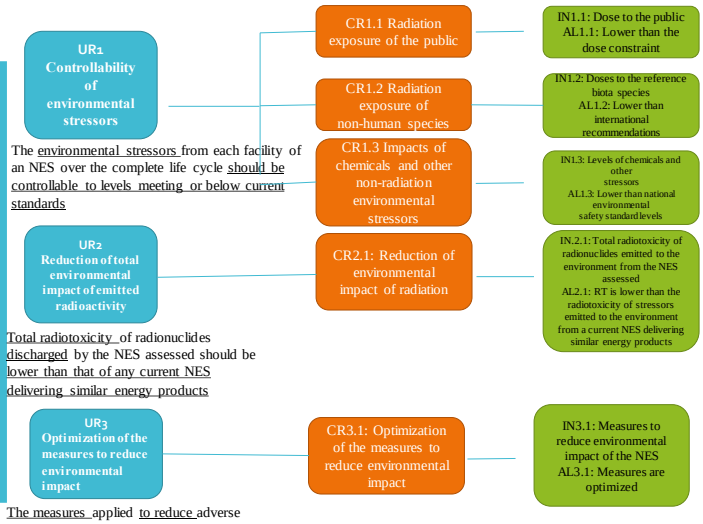
Two types of indicators for the INPRO criteria:

- (1) **numerical (measured or calculated value** of a property, for example the estimated probability of a major release of radionuclides to the containment obtained from combined deterministic and probabilistic analysis),
- (2) **logical** (usually associated with some necessary feature of a NES and usually presented in form of a question)

NESA, Example

Environment

BP: The expected adverse environmental effects of an NES should be well within the performance envelope of current NESs delivering similar energy products



NESA, Steps

- **Step 1:** Familiarize with INPRO methodology
- **Step 2:** Collect input data
- **Step 3:** Check whether designers and/or national organizations meet all INPRO User Requirements (UR).

- if all UR are met the NES is sustainable
- if at least one Criterion is not met follow-up actions are to be defined

M2: KIND Key Indicators for Innovative Nuclear Energy Systems (MCDA)

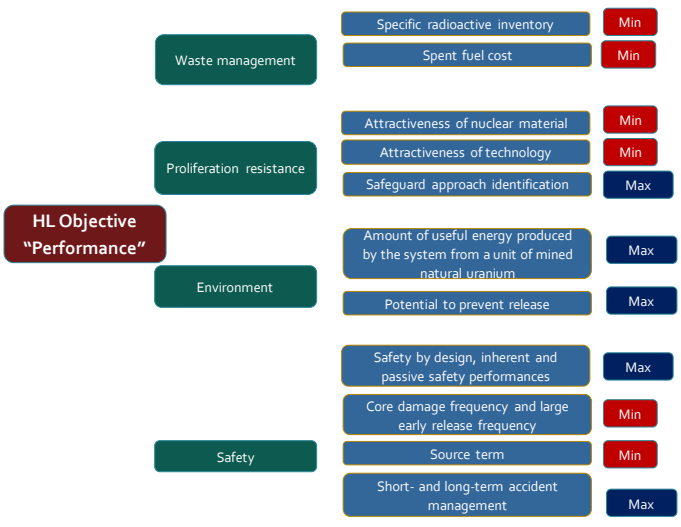
- A set of **Key indicators (KIs)** is used to assess how a system performs in a particular area (defined for the purpose of a comparative assessment)

(A1) Safety
(A2) Economics
(A3) Waste management
(A4) Proliferation resistance
(A5) Environment
(A6) Maturity of technology
(A7) Country specifics

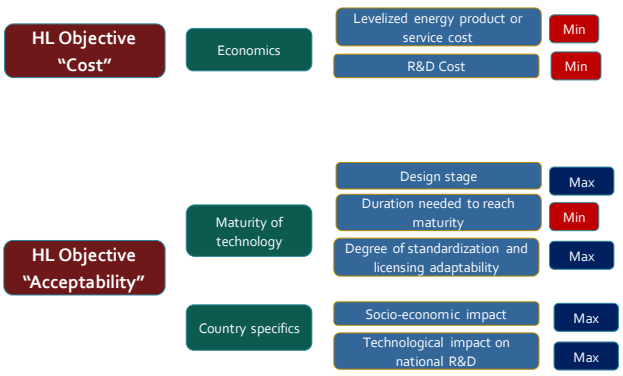
- *Flexibility*
- *Simplification*

KIND, Example of structure

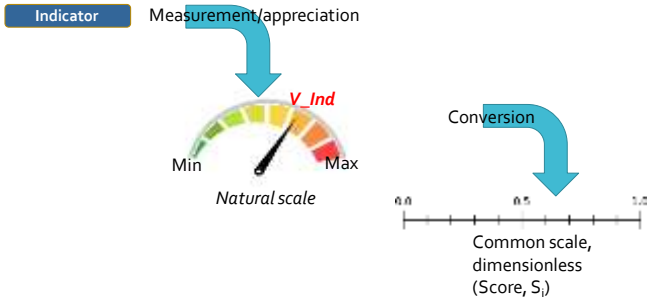
High-Level Objective specified with Areas, Criteria, Indicators (level)



KIND, Example of structure

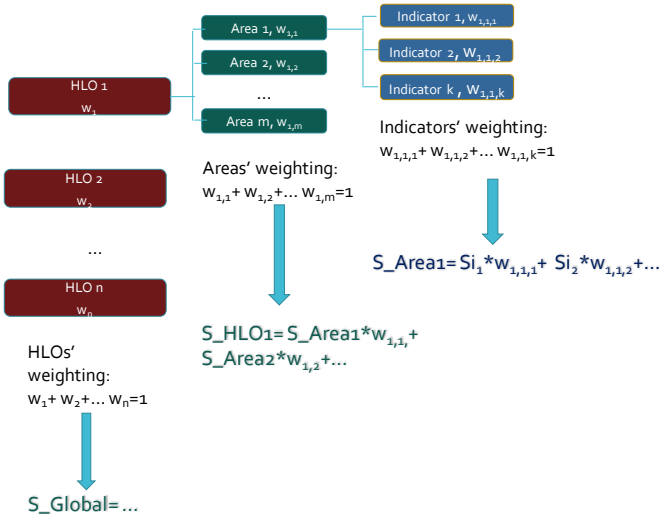


KIND, Assessment, Indicator level



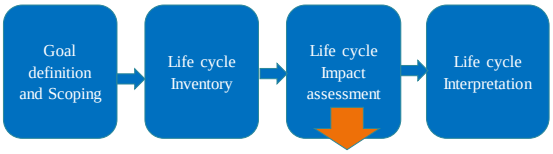
The indicator values are weighted according to their importance (prioritization).

KIND, Weighting



M3: LCA
Life Cycle Assessment

- Developed in the 1960s to assess the potential environmental impacts of an activity/product taking into account all phases of production and use across the entire lifespan.
- Compare products (or processes/actions), select most appropriate from point of view of e.g. environmental impact and human health.
- ISO 14040:2006 standard (Environmental management- Life cycle assessment- Principles and framework) indicates 4 obligatory steps:



- Sub-step WEIGHTING: assignment of relative weights to each impact category, producing a ranking according to the perceived relevance or importance of each category.
- Optional but very useful when comparing alternatives.
- Enables collection and discussion of stakeholder judgments.

LCA,
Life Cycle Assessment

- Potential **impact on human health and environment** is calculated. The estimation includes the resource depletion.
- In ISO 14040:2006 the step is formalized in four sub-steps:
  (1) selection and classification of the relevant impacts according to the impact categories,
  (2) characterization of the potential impact using science-based conversion factors,
  (3) normalization of the potential impacts in a manner that allows comparison,
  (4) **weighting according to the [perceived] most important potential impacts**.
- Impacts are divided into **impact categories**, the most common being:
  - (1) climate change,
  - (2) ozone depletion,
  - (3) photochemical ozone formation,
  - (4) respiratory inorganics,
  - (5) ionizing radiation,
  - (6) acidification,
  - (7) eutrophication,
  - (8) human toxicity,
  - (9) ecotoxicity,
  - (10) land use,
  - (11) resource depletion

LCA,
Step 3, Impact Assessment

- **Inventories per category are calculated**

Impact category	Examples of inventories
Climate change	Carbon Dioxide (CO_2) Nitrogen Dioxide (NO_2) Methane (CH_4) Chlorofluorocarbons (CFCs)
Stratospheric ozone depletion	Chlorofluorocarbons (CFCs) Hydrochlorofluorocarbons (HCFCs) Halons Methyl Bromide (CH_3Br)
Acidification	Sulfur Oxides (SOx) Nitrogen Oxides (NOx) Hydrochloric Acid (HCL) Hydrofluoric Acid (HF) Ammonia (NH_4)
Eutrophication	Phosphate (PO_4) Nitrogen Oxide (NO) Nitrogen Dioxide (NO_2) Ammonia (NH_4)
Photochemical smog	Non-methane hydrocarbon (NMHC)
Terrestrial Toxicity	Toxic chemicals with a reported lethal concentration to rodents
Aquatic Toxicity	Toxic chemicals with a reported lethal concentration to fish
Human Toxicity	Total releases to air, water, and soil
Resource depletion	Quantity of minerals used Quantity of fossil fuels used
Land use	Quantity disposed of in a landfill or other land modifications
Water Use	Water used or consumed
Particulate Matter/ Respiratory inorganics	Sulphur Dioxides (SO_2) Nitrogen Oxides (NOx) Solid and liquid particulates Non-methane volatile organic compounds (NMVOC)
Ionizing radiation, human health	Routine atmospheric and liquid releases in the nuclear fuel cycle
Ionizing radiation, ecosystems	Radioactive releases to freshwater and its sediments

LCA,
Inventories, conversion, weighting, final score

Quantitative models

Input data &
Computer tools



Inventories Conversion

Representative indicators (determining the impact scores)

Weighting

Final score

LCA,
Example, Nuclear and "EU Taxonomy"

Life cycle components to approach the **entire life**:

(1) uranium mining and uranium ore processing,
(2) conversion to uranium hexafluoride (UF6) gas,
(3) enrichment of uranium,
(4) fabrication of UO_2 nuclear fuel,
(5) reprocessing of spent nuclear fuel,
(6) production of MOX fuel,
(7) nuclear power plant operations (this includes construction, electricity generation and long-term operation of NPPs, as well as NPP decommissioning and site remediation),
(8) management and disposal of radioactive and technological waste

Six environmental objectives considered:

(1) climate change mitigation,
(2) climate change adaptation,
(3) the sustainable use and protection of water and marine resources,
(4) the transition to a circular economy,
(5) pollution prevention and control,
(6) the protection and restoration of biodiversity and ecosystems.

Annex III - Definitions of Selection Criteria for Task 1

The following selection criteria (SC) were developed and used by the author to make a pre-decision-in-principle to combine and employ elements of M2 (MCDA-KIND-IAEA) and M2 (LCA/LCIA-JRC). The same SC are proposed to form the basis for a workshop discussion of the qualities or weak points of the three considered methodologies, and eventually validation of the pre-decision-in-principle:

(SC1) Compliance with the planned resources,

(SC2) Relevance for the objectives of the research,

(SC3) Enabling treatment of the entire life cycle,

(SC4) Enabling inter-comparison of different technologies,

(SC5) Availability of requested data (including possibility to generate),

(SC6) Adaptability (to include specific requirements, for example modelling the evolution of the technologies and energy market),

(SC7) Suitability to assess performance at regional (European) level,

(SC8) Suitability to the involvement of a large group of stakeholders for certain assessment steps.

Definition of the proposed selection criteria is offered below to support understanding during the stakeholder workshop discussion.

(SC1) Compliance with the planned resources:

(i) The assessment performed by ECOSENS staff should be finalized in September 2024,
(ii) The estimated effort will not exceed 18 person-months.

(SC2) Relevance for the objectives of the research:

The methodology will be able to assess the sustainability of nuclear power for the entire life cycle considering the current development of nuclear technologies. In addition, it should have the capabilities to investigate the evolutions of the energy market in the transition toward climate neutrality and discuss the role of nuclear power in the medium and long term.

(SC3) Enabling treatment of the entire life cycle:

The methodology can take into consideration all the life cycle phases of nuclear power units covering the entire fuel cycle (mining, enrichment, fuel fabrication, reprocessing, radioactive waste disposal) and all stages of development (design, siting and licensing, operation, decommissioning and site remediation).

(SC4) Enabling inter-comparison of different technologies:

The methodology will have enough generality to allow an inter-comparison of different energy alternatives (at least nuclear, gas, hydro, photovoltaic, and wind).

(SC5) Availability of (including possibility to generate) requested data:

A sufficient quantity and/or range of requested data, to a manageable level of complexity, will be available and accessible in literature, official reports, etc., and/or it is possible to acquire needed data or to generate it by using available models.

(SC6) Adaptability (to include specific requirements, for example modelling the evolution of the technologies and energy market):

> The methodology will be adaptable to the assessment of the future generation of nuclear systems, with extra value assigned for ease of adaptation to evolving technologies.

(SC7) Suitability to assess performance at regional (European) level:

> The methodology will have been demonstrated for use at regional level or is judged to have enough potential to be applied for regional-level assessment.

(SC8) Suitability to the involvement of a large group of stakeholders:

> The methodology will be amenable to participation by a broad spectrum of stakeholders, and the criteria and indicators it deploys are amenable to judgment by stakeholders of different roles and disciplinary backgrounds.

Annex IV – Worksheet 1 : Selecting Methodologies

From Working Paper, Section 3.2, pages 18-19

A **scale of 0 to 3 (where 3 represents the complete fulfillment of the selection criterion)** will be used by each participant to score each presented assessment methodology and compare them on the Selection Criteria (SC).

A variety of participants is expected to exercise judgment during the workshop: persons directly familiar with modelling and assessment, or less/not familiar. The source of judgments is not distinguished in the compilation of scores (although debate and discussion of judgments will seek to identify factors influencing any markedly different observations). Individual attribution of "DK" (don't know) will be allowed, and the group will discuss how to treat this judgment. It is proposed that each SC be considered to have equal weight in the final confrontation of summed and averaged scores.

*Table- Appraisal of candidate methodologies using proposed Selection Criteria (SC). Data collected during 30 March workshop. **Average score attributed per candidate methodology by 6 individuals using full list of SC. Individual 7 rated only M3.***

It is not possible to map these individuals on persons who later filled out forms for Task 3.

INDIVIDUALS	Method		
	M1, MCDA-NESA-IAEA	M2, MCDA-KIND-IAEA	M3, LCA/LCIA-JRC
1	0.875	2.375	2.75
2	2.3	2.44	1.6
3	1.75	2	2.75
4	1	1.375	2.75
5	0.875	2	1.875
6	1.625	1.875	1.5
7	-	-	2
Averaged Column Score 6 INDIVIDUAL RATINGS (plus one for M3)			

Annex V – Worksheet 2: Weighting indicators – En-LCA

Table 4.1 Indicators (and sub-indicators) and weights for En-LCA (Environment) -WORKSHOP DATA per six individuals, per line (to be read across based on ordinal position in column).

Red figures: individuals 1&2 rated indicators but did not rate sub-indicators

It is not possible to map these individuals on persons who earlier filled out forms for Task 1.

Indicator	Weight, w_i [%]	Sub-indicators	Weights, w_{ij} [%]
1.1 Carbon emissions	5	-	-
	10		
	10		
	30		
	15		
	20		
1.2 Land occupation and power density	5	-	-
	10		
	10		
	5		
	10		
	12.5		
1.3 Energy returned on investment	10	-	-
	20		
	5		
	5		
	5		
	5		
1.4 Impact on resources	10	1.4.1 Operational water consumption	-
			-
			20
			15
			10
			25
	5	1.4.2 Abiotic resources depletion	-
			-
			10
			20
			20
			20
	15	1.4.3 Depletion of fossil fuels	-
			-
			10
			5
			10
			5
	20	1.4.4 Excessive use of life-sustaining resources	-
			-
			30
			35

			30
			25
	10	1.4.5 Exhausting of rare resources	-
			-
			30
			25
			30
			25
	12.5	*Sum total of sub-indicators* $\mathbf{w_{ij}}$	*100%* ***x4***

1.5 Potential material recyclability	10	-	-
	5		
	10		
	5		
	10		
	10		

1.6 Emissions (other than C - Carbon)	10	1.6.1 NOx and SO2 emissions	-
			-
			40
			30
			25
			30
	5	1.6.2 Ozone depletion potential	-
			-
			20
			20
			25
			15
	10	1.6.3 Photochemical oxidant creation potential	-
			-
			20
			30
			25
			15
	5	1.6.4 Cumulative lifecycle emissions of NMVOC and PM2.5	-
			-
			20
			20
			25
			40
	10	*Sum total of sub-indicators* $\mathbf{w_{ij}}$	*100%* ***x4***
	10		

1.7 Impact on life and ecosystems (under normal operation)	5	1.7.1 Human toxicity potential	-
			-
			20
			15
			10
			10
		1.7.2 Human health/mortality impact	-
	10		-

			20
			30
			10
			15
		1.7.3 Ecotoxicity	-
			-
	10		12
			15
			20
			20
		1.7.4 Acidification and eutrophication potential	-
			-
			12
	10		10
			10
			10
		1.7.5 Freshwater ecotoxicity	-
			-
			12
			10
	15		10
			15
		1.7.6 Marine ecotoxicity	-
			-
			12
			10
			10
			15
	15	1.7.7 Biodiversity of the used land	-
			-
			12
			10
			30
			15
		Sum total of sub-indicators $\mathbf{w}_{ij}$	*100%* ***x4***

1.8 Impact of generated wastes	5	1.8.1 Chemical (generated) waste volumes	-
			-
			25
			20
			30
			50
	10	1.8.2 Radioactive wastes (generated)	-
			-
			25
			30
			10
			10
	20	1.8.3 Maturity of the approach (experience and effectivity in waste management)	-
			-
			25

			30
			30
			40
	10	1.8.4 Long-term effect of deposited wastes	-
			-
			25
			20
			30
			10
	10	*Sum total of sub-indicators* w_{ij}	*100%* ***x4***
	5		

1.9 Impact of accidental situations	20	1.9.1 Impact of the accidents (anticipated, design base)	-
	12.5		-
	5		50
	10		40
	5		30
	5		50
		1.9.2 Impact of severe accidents (considering mitigation/prevention…)	-
			-
			50
			60
			70
			50
		Sum total of sub-indicators w_{ij}	*100%* ***x4***

1.10 Mitigation of accidents	10	1.10.1 Inherent safety	-
			-
			35
			20
			50
	12.5		20
		1.10.2 Passive systems	-
			-
			30
	5		30
			20
			20
	5	1.10.3 Safety by design	-
			-
	10		35
			30
	5		30
			50
		Sum total of sub-indicators w_{ij}	*100%* ***x4***
SUM TOTAL w_i	**100% x6**		

Annex VI – Worksheet 2B&C: Weighting indicators – Ec-LCA & So-LCA

Table 4.2 Indicators (and sub-indicators) and weights for Ec-LCA (Economic)

Workshop data. Individuals 1, 2 & 3 completed all weightings. Individual 4 completed only Indicator weightings. Individual 5 completed only Sub-indicator weightings.

(Individuals per line are the same for Ec- and So-LCA. It is not possible to map these individuals on the persons who filled out other forms for Task 1 or 3.)

Indicator	Weight, w_i [%]	Sub-indicators	Weights, w_{ij} [%]
2.1 Capacity factor	5	-	-
	10		
	0		
	10		
	-		
2.2 Global efficiency	10	-	-
	10		
	0		
	15		
	-		
2.3 Cost	10	2.3.1 Cost of the investment (capital cost)	40
			50
			40
			-
			40
	20	2.3.2 Cost of operation (including fueling and maintenance)	40
			25
			40
	25		-
			20
	15	2.3,3 Cost of decommissioning (including environmental remediation)	20
			25
			20
			-
			40
	-	*Sum total of sub-indicators* w_{ij}	*100%*
2.4 Cost for system integration	15	2.4.1 Maneuverability	20
			15
			25
			-
			20
	20	2.4.2 Load following	20
			25
			25
	25		-
			20
	10	2.4.3 Stability	20

			30
			25
			-
			20
	-	2.4.4 Easy to be integrated in local/regional grids	20
			15
			10
			-
			20
		2.4.5 Realistic solution for large scale storage	20
			15
			15
			-
			20
		Sum total of sub-indicators $\mathbf{w_{ij}}$	*100%*

2.5 External costs	15	-	-
	5		
	10		
	5		
	-		

2.6 LCOE	10	-	-
	15		
	10		
	5		
	-		

2.7 Macro-economic impact	10	-	-
	5		
	25		
	12.5		
	-		

2.8 Applicability for cogeneration	10	-	-
	5		
	0		
	12.5		
	-		

2.9 Level of standards generated, rules and control	5	2.9.1 Maturity of the authorization process	33
			50
			50
			-
			50
	5	2.9.2 Level of industrial codes and standards	33
			25
			40
	5		-
			25
	15	2.9.2 Needs for technical support	33
			25
			10

			-
			25
	-	*Sum total of sub-indicators* w_{ij}	*100%*
SUM TOTAL w_i	**100%** x 4		

Table 4.2 Indicators (and sub-indicators) and weights for So-LCA (Social)

Workshop data. Individuals 1 & 3 completed all weightings. Individual 2 completed no ratings. Individual 4 gave incomplete Indicator weightings. Individual 5 gave incomplete Sub-indicator weightings.

Indicator	**Weight,** w_i **[%]**	**Sub-indicators**	**Weights,** w_{ij} **[%]**
3.1 Jobs created	10	3.1.1 Direct high-education jobs	60
			-
			50
	-		-
			70
	10	3.1.2 Jobs in contributing industries	40
			-
			50
			-
			30
	15	*Sum total of sub-indicators* w_{ij}	*100%* x 3
	--		
3.2 Impact on the local/regional business (partner with other business)	10	-	-
	-		
	25		
	15		
	-		
3.3 Additional goods and services created	5	-	-
	-		
	10		
	4		
	-		
3.4 Value of the knowledge generated and maintained for the future	5	-	-
	-		
	5		
	5		
	-		
3.5 Impact on education	5	-	-
	-		
	10		
	5		
	-		
3.6 Contribute to the reduction of inherited burdens (toxic wastes, military stocks)	5	-	-
	-		
	2		

	5		
	-		
3.7 Impact on health improvement	10	-	-
	15		
	10		
	-		
3.8 Impact on poverty	10	-	-
	-		
	5		
	15		
	-		
3.9 Societal-level adoption of the technology	5	-	-
	--		
	5		
	3		
	-		
3.10 Existing investment in RDI to develop the technology	5	-	-
	-		
	5		
	3		
	-		
3.11 Dependency on government support (funding or incentives, such as tax credits or subsidies)	10		-
	-		
	5		
	(0)		
	-	Individual 4 left the indicator blank-	
3.12 Risks	10	3.13.1 Level of risk reflected in insurance needs	70
			-
			80
			-
	--		40
	1	3.13.2 Proliferation of sensitive materials	30
	15		20
	-		-
			60
		Sum total of sub-indicators $\mathbf{w_{ij}}$	*100%* *x 3*
3.13 Equality of opportunities	10	3.13.1 Women's empowerment	50
			-
			50
			-
		Individual 5 left this blank	(0)
		Sum total of sub-indicators $\mathbf{w_{ij}}$	*100%*
	-		50

			-
			50
	2		-
		Individual 5 left this blank	(0)
	5	*Sum total of sub-indicators* $\mathbf{w_{ij}}$	*100% x 2*
	-		
SUM TOTAL w_i	**100% x 3**		

Annex VII – Workshops Evaluation by the Participants

Numerous kind remarks were sent by email to the workshop organizers by participants. As well, a short evaluation questionnaire was circulated via Google Forms enabling the participants to deliver anonymous feedback regarding both the Wednesday 29 March and the Thursday 30 March 2023 workshops. Of the 19 expected replies, only 9 were received despite a reminder.

The report here of results is thus very brief.

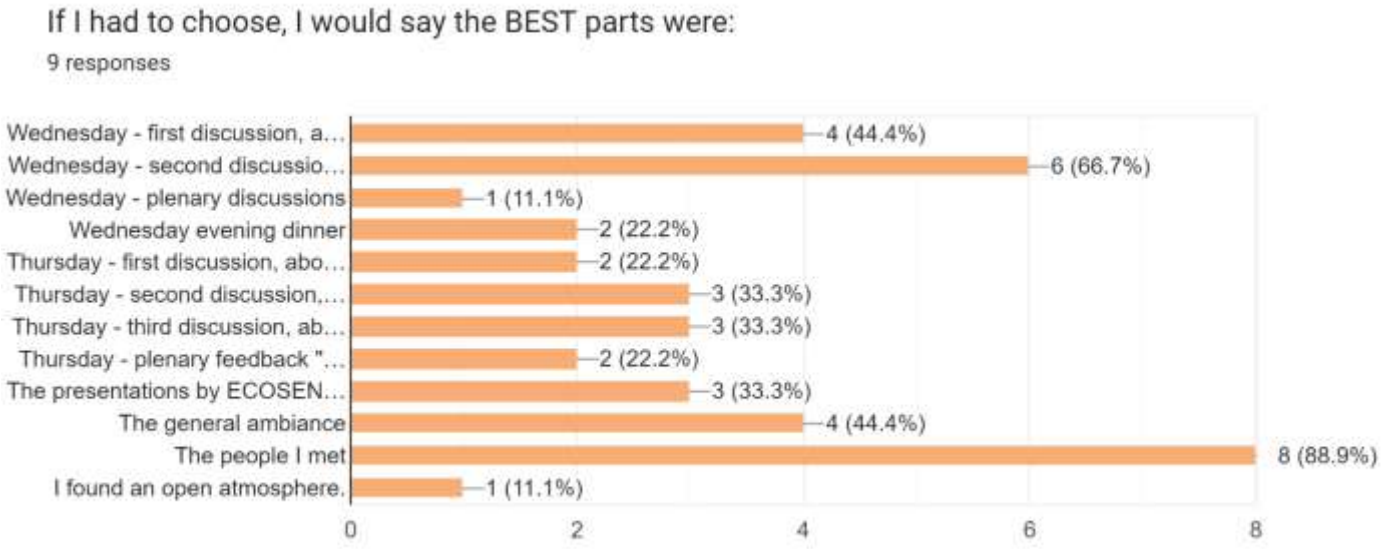
In descending order of positive reply, all respondents agreed, or "absolutely" agreed, that:

- The facilitators made space for differing views and opinions *(7: "Absolutely").*
- Workshop discussions were interesting *(5: "Absolutely").*
- The workshop enabled them to reflect and express their ideas *(5: "Absolutely").*
- Overall, they were happy to participate in the workshops *(5: "Absolutely").*

For the following items, respondents again mostly agreed but a small subset expressed a neutral judgment:

- They heard, or they came up with, something new during these workshops *(5: "Absolutely"; 1: "neither agreed nor disagreed").*
- They would be willing to participate in follow-up seminars or workshops *(5: "Absolutely"; 3: "neither agreed nor disagreed").*

Another question allowed participants to signal multiple features that they most appreciated in the workshops experience (choosing from the listed agenda items, or adding features in a free comments field).



("Open atmosphere" was added in the comments field by one participant.)

Regarding least appreciated features, several wrote into the comments field that they appreciated the entire experience. There was little consensus on negative features, although three persons selected Task 1 of the 30 March workshop as "worst". (Of note, three others had identified this above as a best feature.)

Five detailed comments were received in reply to the organizers' open question "What could we change or improve in our workshops?":

- I would either make them more generic or more specific - being aware that you are working within a certain framework can be both enabling but also very constraining at times.
- In general there was plenty of space/opportunity to leverage the combined strength of the interdisciplenary teams. Only during the first and third discussion on Thursday (methodology scoring and LCA weighing), the discussion format felt somewhat limiting towards the groups' potential. I fully understand the appeal of the quite 'exact' exercises that were asked at those times in terms of processing the results. But in practice we did not succeed in the exact exercises. And the time/expertise could possibly have led to better results with a more open/less stringent work format.
- Add a simulation for further understanding of ideas and outcomes.
- It would be great if the consortium team consulted and agreed upon the content before the workshop among them. It was very interesting seeing the members of the consortium asking (and even questioning) the presenters. Similarly, the chairs seemed to be sometimes quessing what the presenter had in mind with a given task. Besides, coffee was weak ;) 5
- I have no precise ideas nor need to change your workshops. I imagine that sufficient flexibility is possible.

Finally, the following “further ideas” were shared:

- I was very impressed with the way the consortium set up the 2 day workshop and the resulting open atmosphere for the exchange of ideas and discussions. In addition the specific group of workshop members proved very open and constructive during the different discussions. I myself certainly took in a lot of differing insights and opinions, which I value very highly.
- Metrics for socio-economic measures in decision making can be further defined for objectivity.
- I only participated in the second day.
    - Two of the methodologies considered (M1 and M2) were elaborated for the nuclear "sector". I prefer to start with methodologies that have been elaborated for any energy system (nuclear, renewable, fossile).
    - I much preferred methology M3, as it considers the entire life cycle. The study by JRC institute applied this methodology to the various energy systems - I liked that very much.
    - Beyond the technical and scientific arguments (indicators) some other elements are importantto acknowledge. They can determine the position of a country in the debate: public acceptance, politics and lobbies. it is very important to realize this (for instance, nuclear energy was considered as "sustainable" in some countries, and "not sustainable" in other countries.

From the above I conclude the need for solid underlying R&D for the various "key indicators". For instance, the safety of the disposal of nuclear waste led to different opinions towards nuclear energy. A solid position on this issue is therefore needed.

[5] The organizers note that the workshops were indeed prepared in detail by the team spread across three institutes. The open questioning reflected the diversity of discipline and outlook, onboarding some last-minute adaptative program changes, and a high level of interpersonal and interprofessional confidence within the team. While the coffee escaped our notice, some felt that the soup was good. 😊

ECONOMIC AND SOCIAL CONSIDERATIONS FOR THE FUTURE OF NUCLEAR ENERGY

Co-development of recommendations on stakeholder engagement in (nuclear) energy governance

report of the third ECOSENS international workshop

authors

Nadja Zeleznik, Barbara Horvat – EIMV
Catrinel Turcanu – SCK CEN
Susan Molyneux-Hodgson – University of Exeter
Giorgio Locatelli – POLIMI

Funded by the European Union



Economic and Social Considerations for the Future of Nuclear Energy in Society

Project Number: 101060920

Report

Workshop on co-development of recommendations on stakeholder engagement in (nuclear) energy governance

Work Package 1

Nadja Zeleznik, Barbara Horvat (EIMV), Catrinel Turcanu (SCK CEN), Susan Molyneux-Hodgson (U Exeter), Giorgio Locatelli (POLIMI)

Funded by the European Union

Project information

Project full title:	Economic and Social Considerations for the Future of Nuclear Energy in Society
Acronym:	ECOSENS
Funding scheme:	CSA
ECGA number:	101060920
Call/topic	HORIZON-EURATOM-2021-NRT-01-14
Coordinator:	Regia Autonoma Tehnologii pentru Energia Nucleara (RATEN) – Daniela Diaconu
EC Project Officer:	Michal Tratkowski
Start date – End date:	1 October 2022 - 30 September 2025 (36 months)
Coordinator contact:	+40 744 701 476, daniela.diaconu@nuclear.ro
Administrative contact:	+40 744 701 476, daniela.diaconu@nuclear.ro
Online contacts (website):	https://ecosens-project.eu

Document information

Technical report	Workshop on co-development of recommendations on stakeholder engagement in (nuclear) energy governance
Work Package No.	1
Work Package Title	A collaborative assessment of (imagined) energy worlds
Lead Beneficiary	SCK CEN
Contractual Delivery Date	July 2025
Actual Delivery Date	July 2025
Type	R
Dissemination level	Public
Authors	Nadja Zeleznik, Barbara Horvat (EIMV), Catrinel Turcanu (SCK CEN), Susan Molyneux-Hodgson (U Exeter), Giorgio Locatelli (POLIMI)

To be cited as:

Zeleznik et al. (2025): Workshop on co-development of recommendations on stakeholder engagement in (nuclear) energy governance

Disclaimer

This project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are, however those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.



Funded by the European Union

Table of Contents

Executive Summary 2
1. Introduction 3
2. Workshop format and objectives 3
3. Summary of Group Discussions 5
3.1 Group A – Structuring, Simplification, and Terminology 5
3.2 Group B – Funding, Participation, and Regional Specificities 5
3.3 Group C – Power Structures, Language, and Communication Dynamics 6
3.4 Cross-Cutting Themes and Points of Consensus 6
4. Key Suggestions for Improving the Recommendations Document 7
5. Next steps 8
Appendix A: Short transcript from Group A 9
Appendix B: Short transcript Group B 18
Appendix C: Short transcript Group C 26

Executive Summary

The third international deliberative workshop organised under Work Package 1 (WP1) of the ECOSENS project took place online on 11–12 June 2025, gathering 27 participants from across Europe. Representing civil society, research institutions, academia, and industry, the workshop participants focused on the co-development of draft recommendations for enhancing stakeholder engagement in nuclear energy governance. Taking a set of draft recommendations based on the findings from earlier project phases as a starting point, this participatory event sought to strengthen the legitimacy, clarity, and practical value of the proposed recommendations by taking stock of the lived expertise of diverse stakeholder groups.

The workshop was structured over two half-day sessions. The first introduced the ECOSENS recommendations and divided participants into three moderated breakout groups to facilitate in-depth discussion. The second session reconvened participants in plenary for group reporting, open dialogue, and reflection on next steps. The eight recommendations under review were grouped during discussions into three thematic areas: process design, topic-specific issues (e.g. sustainability assessments and Small Modular Reactors), and stakeholder-targeted measures.

Group A called for greater structural clarity and simplification of the recommendations, advocating for visual tools such as stakeholder matrices and timelines. Participants recommended combining overlapping recommendations and emphasised the need for shared definitions of key terms like "stakeholder" and "community." Group B prioritised long-term, independent funding for civil society engagement and stressed the importance of tailoring recommendations to regional contexts—particularly in Central and Eastern Europe. They also proposed categorising the recommendations by intended audience. Group C addressed legal and power asymmetries, urging more precise language, clearer references to legal frameworks prescribing stakeholder involvement, and the integration of moderation and mutual learning into participatory processes. Concerns were raised about polarisation, especially surrounding SMR technologies, and the absence of mechanisms to rebuild trust in politicised contexts.

Despite varying perspectives, all groups converged on several core principles. There was consensus on the need for a clearer structure supported by visual and thematic tools, harmonised terminology, and practical examples of good practice, such as the former citizens' forums in Sweden and the dialogue committee of the ALFRED project in Romania. Participants emphasised the need for sustainable funding, particularly for local communities and civil society organisations, as well as the use of context-sensitive approaches, and the better integration of social sciences and humanities into nuclear research and education. Legal alignment with international conventions (e.g. Aarhus, Maastricht) was also seen as essential to ensure stakeholder rights.

Looking ahead, the revised recommendations will be presented at the ECOSENS Final Conference on 8–9 September 2025, where a panel discussion on the implementation of recommendations will also take place. The workshop demonstrated a shared commitment to improving participatory governance in nuclear energy, laying the groundwork for more transparent, inclusive, and context-responsive nuclear decision-making across Europe.

1. Introduction

ECOSENS Work Package 1 (WP1) *"A Collaborative Assessment of (Imagined) Energy Worlds"* is dedicated to exploring the societal dimensions of nuclear energy within broader energy transitions. The WP1 adopts an integrated, multi-method approach to understand citizen perceptions, assess the influence of interest groups, review energy governance practices, and engage stakeholders to co-develop future energy scenarios. WP1 is structured into four interlinked tasks, each with specific objectives and methodologies designed to inform actionable recommendations for stakeholder engagement, governance innovation, and public policy development related to nuclear energy.

Task 1.4 includes four Deliberative Engagement Workshops with the aim to stimulate discussion and enable inclusive co-construction of energy futures by involving stakeholders across civil society, government, academia, and industry. The third international workshop included a wide range of stakeholders to discuss and co-develop draft recommendations on stakeholder engagement in (nuclear) energy governance, based on findings from Tasks 1.1-1.3. This participatory process enhances the legitimacy and relevance of policy recommendations by grounding them in diverse, deliberated societal perspectives.

2. Workshop format and objectives

The international workshop was organised online on 11 and 12 of June 2025 and was attended by 27 participants. The distribution of participants per country is given in the Figure 1. They represented research organisations, academia, NGOs and CSOs, and industry.

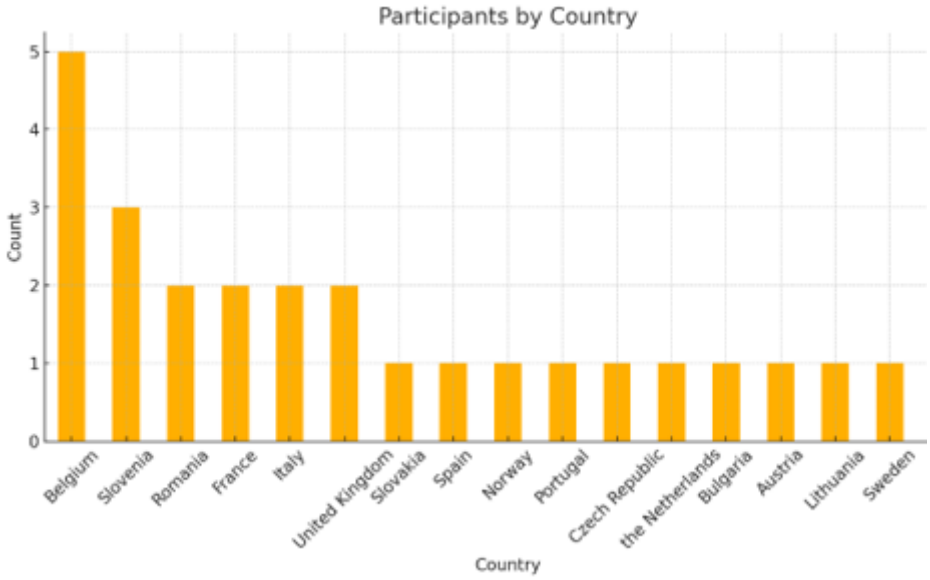


Figure 1: Participants per country in the international ECOSENS workshop on recommendations for stakeholder engagement in nuclear energy governance

The workshop objectives were to present the draft ECOSENS recommendations for stakeholder engagement in nuclear decision-making and energy policy, to conduct detailed reviews through breakout

group discussions, to collect feedback for refining the recommendations and to outline next steps for finalising these.

The workshop was divided in two half days with the following agenda:

11 June 2025, 13.30 -15.30

- Introduction to ECOSENS and WP1
- Presentation of draft recommendations
- Breakout sessions into three groups (A, B, C) lead by moderators

12 June 2025, 13.30-15.00

- Group A, B, C reports in plenary by rapporteurs
- Open floor for additional discussion and comments
- Discussion on implementation and next steps

Each of the groups had equal number of participants, assuring presence of different actors. The eight draft recommendations (Figure 2) were distributed into three areas: two on process, three on specific areas (sustainability assessment and Small Modular Reactors) and three related to specific stakeholders. All registered participants received the draft ECOSENS recommendations in advance as a Word text; additionally, they were presented briefly during the workshop.



Figure 2: ECOSENS draft recommendation on stakeholder engagement

The leading questions for discussion in the groups were the following:

- Are the recommendations clear? Are they 'good'? Is anything repeated? Missing?
- Do you have any good examples of practice and what was good about it?
- Who should implement stakeholder engagement?
- Who would need to pay attention to recommendations? Should we specify this for each recommendation / point in recommendations?

Each of the groups (A, B, C) had a a moderator and a rapporteur from the ECOSENS partners. The feedback reports were given during the second day of the online workshop.

3. Summary of Group Discussions

The group discussions revealed several critical insights and constructive proposals regarding stakeholder engagement and the refinement of the ECOSENS recommendations. The edited versions of transcripts are given in the appendixes (A, B and C).

3.1 Group A – Structuring, Simplification, and Terminology

Group A emphasized the need for greater visual clarity, proposing the use of a matrix format that maps each recommendation to the relevant stakeholder groups and implementation phases. This would provide a clearer understanding of *who* is responsible for *what*, and *when*. Participants also noted redundancies or similarities among recommendations, suggesting that Recommendations 4 and 5 (on Small Modular Reactors) as well as 7 and 8 (on local and civil society engagement) could be consolidated to reduce overlap.

A call for practical support emerged, with a request for more real-world examples, timelines, and actionable content to facilitate application in diverse contexts. Furthermore, participants highlighted the importance of legal provisions, noting, for instance, that mechanisms such as community veto rights must be considered within their national legal frameworks.

Finally, the group urged the clarification of foundational terms, such as *success*, good practice, *community*, and *stakeholder*, advocating for harmonized definitions to minimize ambiguity and improve mutual understanding.

3.2 Group B – Funding, Participation, and Regional Specificities

Group B strongly prioritized Recommendation 8**,** underscoring the need for long-term, independent funding for civil society engagement. Drawing on models from Sweden and elsewhere, they advocated for funding that is not industry-linked, to preserve moral legitimacy and foster authentic participation. Concerns were raised about Recommendation 3**,** particularly the subjectivity of sustainability assessments. Broadening participation in these processes was viewed as essential to address inherent power imbalances and to legitimize outcomes.

The group also suggested thematic clustering of recommendations according to target audiences such as NGOs, policymakers, or academics to improve usability. Notably, regional sensitivities were raised, with an emphasis on tailoring engagement approaches to Central and Eastern European contexts, where traditions of stakeholder involvement may be less entrenched.

3.3 Group C – Power Structures, Language, and Communication Dynamics

Group C directed attention to power asymmetries and legal gatekeeping, calling for a more critical examination of how laws are implemented in practice, often by authorities who may exclude or filter stakeholder input. They flagged the vagueness of terms like *neutral information*, recommending clearer and more precise language. There was also a strong appeal for moderation mechanisms within engagement processes, given their essential role in reducing polarisation and ensuring balanced representation.

Group C advocated for a shift towards mutual learning, especially under Recommendation 2, encouraging a focus on long-term participatory processes rather than one-off engagements.

Lastly, the group warned of the growing polarisation around topics like SMRs, calling for transparent communication strategies that address mistrust and politicisation in public discourse.

3.4 Cross-Cutting Themes and Points of Consensus

Across the discussions held in all groups, several recurring themes and shared understandings emerged, pointing to areas of broad consensus.

A key priority identified was the need for a better structure and enhanced clarity within the recommendations document. Participants advocated for the use of visual tools, such as matrices and timelines, to help organise and communicate the relationships between recommendations, stakeholders, and implementation stages. An executive summary was also proposed to provide a concise overview of the document's aims and content. Equally important was the harmonisation of terminology, with participants urging for consistent definitions of key terms to avoid ambiguity and ensure coherence throughout.

The value of concrete examples of good practice was repeatedly underlined. Models such as Sweden's former civil society funding approach, its citizens' forums and national councils, and the dialogue committee for the ALFRED project in Romania were cited as informative references that could support practical implementation across different national contexts.

Funding and capacity building emerged as another foundational concern. Discussions emphasised the necessity for long-term and independent funding mechanisms for NGOs, experts, and civil society actors. To foster meaningful participation, this funding should be detached from political and industrial influence. Additionally, there was a strong call for investment in education and civic competence, ensuring that all stakeholders are equipped to engage constructively and knowledgeably.

In terms of legal frameworks, participants encouraged for deeper legal integration. Specifically, they called for stronger alignment with international instruments such as the Aarhus Convention, the Maastricht Recommendations, and relevant ACCC (Aarhus Convention Compliance Committee) jurisprudence. Beyond legal recognition, the practical enforcement of rights was considered critical for effective stakeholder engagement.

Another unifying theme was the need for context-sensitive approaches, particularly regarding Central and Eastern Europe. Given the distinct political histories and engagement cultures in these regions, participants recommended strategies tailored to local conditions and sensitivities.

Finally, the importance of research and education was widely acknowledged. Participants stressed the need to embed the Social Sciences and Humanities (SSH) more deeply into nuclear research and development. This also included the proposal to develop long-term educational curricula that address not just technical knowledge, but also core values, participatory methods, and the trade-offs inherent in decision-making processes.

4. Key Suggestions for Improving the Recommendations Document

Building on the thematic insights, participants proposed several concrete ways to enhance the recommendations document's clarity, usability, and impact.

To begin with, the **addition of a glossary of terms** and a **dedicated section** clarifying essential concepts was seen as essential for consistent understanding across diverse audiences. Closely related was the proposal for a **targeted stakeholder matrix**, which would link each recommendation to its respective actors and outline their expected roles and responsibilities.

Participants also recommended the inclusion of **concrete examples of good practice**, even acknowledging that these might be context specific. These examples were seen as vital to translating abstract recommendations into actionable guidance.

The joining of overlapping recommendations was also suggested.

Another key proposal was the development of a framework agreement or **roadmap** aimed at improving stakeholder participation on a European scale. This would provide a shared reference for aligning national practices with broader principles of engagement and inclusion.

To further enhance accessibility and transparency, participants suggested the use of **visual tools**. Among others, this should adopt a less hierarchical looking representation, to lake lcear that all recommendations are equally important. Additionally, a **visual engagement timeline**, mapping out the typical phases of nuclear projects and connecting each phase to relevant recommendations was considered useful.

They also called for the introduction of **concise action cards** or brief, practical guides that explain not only *what* each recommendation is, but also *how* it should be implemented and *why* it matters.

Lastly, there was strong support for developing a **digital, interactive version** of the document. An HTML based format, searchable by stakeholder group or theme, was seen as a highly effective way to tailor information to users' needs and make the recommendations more navigable and impactful.

5. Next steps

Following the valuable input gathered during the international workshop, the next phase will involve revising the recommendations to reflect the feedback received. These updates aim to enhance clarity, relevance, and practical applicability across diverse stakeholder contexts. The revised version of the recommendations will be presented at the ECOSENS Final Conference, scheduled for 8–9 September 2025. The suggestions of the participants will be considered as much as possible.

The workshop affirmed a strong collective commitment to enhancing stakeholder engagement in nuclear decision-making. Across all groups, the discussions were rich, thoughtful, and solution-oriented, reflecting a deep understanding of both the opportunities and the challenges at hand.

The diversity of regional perspectives, professional disciplines, and stakeholder roles brought considerable depth to the dialogue, allowing for a nuanced and context-sensitive approach to be developed. Importantly, the workshop proposed a clear path forward.

Sincere thanks are extended to all participants for their active involvement, insightful contributions, and shared dedication to building more inclusive and effective engagement processes.

Appendix A: Short transcript from Group A

So basically, we have now eight recommendations and the questions we need to raise is the following questions:

- are the recommendations clear? are they 'good'? is anything repeated? missing?
- do you have any good examples of practice and what was good about it?
- who should implement stakeholders' engagement?
- who would need to pay attention to recommendations?
- should we specify this for each recommendation / point in recommendations?



General Remarks:

- I read also the entire document yesterday and I think they were all very comprehensive, quite extensive even. What I want to say is maybe it would be nice if you could have a structure or an overview in like a matrix where you have your seven recommendations and maybe on the other axis the different actors basically that are involved there. That should take the action and that you fill out your actions. That way, just as visualisation, that's where we get together. Matrix maybe of a on the one on the one hand, the recommendations on the other hand, the actors that are involved and then in each cell you can add the specific at the specific how pieces let's say of each recommendation. I think that way it would quickly visualise like who needs to take action.
- I also don't know how to define successful (good practice) to be honest for a stakeholder participation, what does it mean as it might be different for different stakeholders.
- The document is quite good, but some elements are missing. For example, in the introduction I prefer to have some references around the generation of this recommendations, because some of them are collected from literature and other of them are produced by the workshops and different activities in the ECOSENSE work package 1 and for the traceability of these recommendation is preferable to see who generate them or keep an impression.

- General remark is about the good practises. There are only a few good practises presented in the document and I prefer to have more because generally somebody that want recommendation want to look how may be implemented because it is a deficit of implementation in this case.
- It will be nice to have a bit of an overview, the more visually kind of catching the eye of what is the essence of the different recommendations in terms of also well, what is the recommendation? What is the justification for it? The stakeholders that require action?
- Maybe start a document with some or end it with some kind of executive summary which is a visual kind of way of capturing all of the different recommendations and their essential elements on one page.
- In my opinion the different recommendations are exact and really sensible. But what is lacking for me, this is the connection between the separate recommendations. The connection between the questions why and how? Connected with the question who is doing this? For who is this written? For each separate recommendation and for each separate bullet point on the question about the question how.
- I don't have a lot to say on this really other than where we should be trying to arrive at is an agreed framework for how to communicate with stakeholders effectively. Everybody signs up to. I wouldn't like to say what is needed is a framework agreement between stakeholders and civil society. That's where I think we should end up or seek to end up, you know, with transparency.
- It is actually about whether we needed eight recommendations and there were a few that could be combined together. So in terms of structure, I don't see an advantage to creating a long list of recommendations that being concise can be more powerful. Recommendations 4 and 5, which are about SMRs, could be combined, also 7 and 8 can be combined as well, which are about different versions of enabling, kind of appropriate means of participation and I think that way we would lose quite a bit of repetition.
- It's a really long list of recommendations and I thought about some other structural elements that could fit to. To get a better grip on it and what I was looking for was sort of a timeline because there were several points in time when participation really makes sense. And it maybe it would be good to have a graph of such a timeline for nuclear projects and to help sorting recommendations. Also, to this timeline to make it also to start making it more what have you called it substantive and practical. Also to add the information which recommendations you analysed for this first recommendations, as I didn't find this information.

Recommendation #1.
Improve the uptake of existing recommendation for stakeholder engagement, transparency and communication in nuclear decision making.

- It's obviously an obvious one, probably you can already fill libraries with the amount of recommendations which have been made regarding stakeholder involvement in all kinds of fields and especially nuclear maybe might be one of those fields in which a lot of recommendations have already been made. The main challenge is how to make these libraries useful and usable. The difficulty I think is much more the how question, how do you actually make them or taken up in practise so that will be the main challenge. Probably the main how to tackle this is also linked with legal frameworks. In most European countries regarding strategic environmental assessments, that's some form of public consultation and public involvement which is legally obliged to take place.

- What does it mean to need to engage with stakeholders? It's a good thing that you are transparent and that you allow for consultation. Another step that needs to maybe be more clearly defined as well is what do you actually need to do with these inputs. So also, the transparency on what is actually the scope of your engagement about and what are those who are organising engagement binding themselves to do with the inputs that are collected.
- Because sometimes I have the feeling that it remains a bit of an empty box like you can show that you have actually engaged with stakeholders and have improved or have taken up some of the recommendations. But it doesn't show like what are you actually doing with the inputs that you have gathered. I think is something that can be taken up more. And where the update can be improved in terms of what is actually done with the inputs that are gathered through. Any kind of state engagement process doesn't mean that you need to take into account all of the inputs that are being gathered, but that you might need to be at least transparent on why you are not taking up some of the inputs which are provided. It has to do with just a rationale that explains also what is being done actually, a justification on why some inputs are not being considered or why decisions have not been altered based on so. That's for me an important aspect of uptake and improving the uptake, which might be more explicitly focused upon in in the document.
- I think it's indeed the obvious one that it's not always done very well or implemented even though there are guidelines. What I did not really see and that it surprised me maybe in the suggestions is how do you make clear to the people you're supposed to organise. What are the advantages? Because it's all nice to try to enforce it by rules and regulations, but my experience is that usually things happen if people actually want to do it. Because you see an actual benefit in it. I think that's maybe sometimes the problem like having the public participation that is not always clear what benefit is there? At least also not for me, because let's be honest, it's also very difficult to explain these things to stakeholders and then get good feedback and then do something with it. So maybe if there could be something like on the motivational side, let's say at the people who need to take the action, how do you motivate them to actually organise this participation?
- Maybe you could look at recommendations that were developed under the frame of, let's say, the Aarhus Convention and the Expo Convention. There might be some examples or other information.
- I want to speak a little bit about the complexity of the engagement. There are a lot of factors, national cultural experience influencing disengagement, but something that is missing here is about the expectation of the nuclear industry, because nuclear industry wants to have a process of decision in a due time. Don't forget nuclear industry need to survive. They need to work and a very long process for this decision is practically a source of making up the process itself. In my opinion, an important source is in fact the stakeholders are not well prepared for the decision making. They are claiming that the participation they want to participate, but in fact when they engage in the process, they need a lot of time to understand, to inform, to receive information, and this is a very, very long process. I want to introduce a recommendation in this sense for different stakeholders, how to prepare them to be more informed, how we can prepare these stakeholders for straight full decision.
- I support what the colleagues said up to here and especially previous speech. Because what he's thinking about in my view, is education of more stakeholders, not only several experts in NGOs. It seems to me that it is much more general than all the other recommendations.

- Most of the of the citizens are not aware how to be engaged, how to insist for transparency, how to communicate and to be equal partners in communication, communicating and decision making for nuclear projects. Probably it will be useful to make even an educational handbook: Book for action for education, educational book for action, a handbook about stakeholder engagement in nuclear decision making
- I know that you said that there are so many existing recommendations and they are not taken upon. But I still think that the recommendations that are missing in the nuclear field are those on the environmental impacts. And they should be also included here (recommendations based on Aarhus and ESPO conventions). They set the legal perspective for public participation.
- An element about the good practises looking to the full text, the recommendation 1 on the sentence three, I recommend a slightly more diplomatic tone because it's seen this document is written with a position practically (adverse on nuclear industry). Nuclear industry has many scenes, but the intention of this document is to fill some gaps, to create some bridges, not to practically destroy what exist. Therefore, I recommend some more diplomatic tone. (Related to this sentence, the development of new nuclear project proceeds with limited public debate and without comprehensive participatory mechanisms and so on.) Also, in Romania there is a n example of good practice with ALFRED project on public engagement.
- The need to stick to factual language - I think sentence three is stating a fact. But also that the recommendations are neither for stakeholder groups or for industry. They are an analysis of existing work.
- Another point under diversity and inclusion, which is on the second page of this recommendation. The second bullet point is to introduce mechanisms for community veto or consent withdrawal, f.e. in siting processes such as the geological disposing facility. This statement doesn't acknowledge that in some countries such mechanism is and in some countries it is not available. We're writing for a not only a range of different stakeholders, we're writing across very many multiple national contexts where there is quite a lot of variability. In practise, so I think again, the writing needs to take into account differences across contexts. It remains debatable whether that counts as a success because it's a success for some people and not a success to other people. It is the policy working because the policy allows for it.
- But even the kind of the statement of a policy can be an empty box and I might say like tick boxes. You can have a statement of a policy, but that doesn't mean it is conducted in a spirit of how it is meant, rather than a kind of more instrumental reading of it. What is still not completely clear in the UK context, who counts as community. It's like every word has to be defined and agreed.
- Somebody has already mentioned about success. Can you agree in advance? Can stakeholders agree in advance what counts as success?

Recommendation #2

To move from instrumental to substantial engagement.

- Maybe if you could find an example that you as a consultant would classify as good, maybe it would be nice to take it up in the document and for each of your recommendations provide why it fulfils. You have a lot of words that can have a lot of meaning so it is important to have clear definitions.
- I was a bit confused by this recommendation because I really like the title. But what is written under the title I think this doesn't fit together because for me engagement is more the way than

what is targeted here. Engagement would go more in in the direction of dialogue and interaction and so. Maybe the title should be changed, or the content should be broadened.

- I think precisely about the plan, about how exactly and with what instruments and what kind of legislation or changes we can make this happen to move from instrumental to substantive engagement. We should look at what we have currently as legislation or structure, I mean the orchestration, the European directives and the national legislation, and to combine with suggestion of how this could happen in practise by experts.
- I thought I'd come up with an example of good practise, but then realised that actually it was just already in the final bullet point in some respect. The education of scientists, so obviously lots of the time people are talking about educating stakeholders. But of course, the IT is the scientific community that will be a Co-creator of engagement to processes, and therefore there is an educational need in the scientific communities. And so, my thinking was around starting early. So we often think about start stakeholder engagement early, but you actually have to start early with the education of scientists.
- Just a short additional comment about the education. This switch from instrumental to substantive engagement of civil society could work, especially if we implement the science and practise of professional risk communication.
- Maybe another example on another level would be Germany during discussions of RW technological repository. Sort of a technical dialogue was offered for participation concerning the FEPs, features, event and processes and it was very interesting to be able to engage on a detailed level. But what happened after this workshop was that there was no follow up, nothing. And I think this it was a pity. There is no legal right to participate in such technical dialogues, but they are very good if they take place, but if it's only a single event and it's not embedded, if comments or questions are not replied, how they are taken up in the future then it doesn't make as much sense as it could make.

Recommendation #3:
Faster engagement of stakeholders in sustainability assessment for energy policy advice.

- An instrument that is well developed and well working linked to the Strategic environmental assessment is a very suitable instrument for the issue at stake here, meaning for sustainability assessments for energy policy. It is important to use this instrument for your national energy and climate plan that also tackles sustainability impacts of climate and energy policy.
- Text is quite long, in the effective text there are two pages of items. This is too much in comparison with the other part. On the other hand, looking to the title, it seemed to be not enough because the title of the document is recommendation of stakeholder engagement in nuclear decision making and energy policy. I prefer for example to have an approach related to the energy field and because there are a lot of elements that are common for all the technology in terms of the stakeholders, not only for the nuclear and to focus for some examples for nuclear.
- If you talk about the energy policy and that it's usually indeed about a set of technologies, it's like a future energy system. So, it doesn't really make sense to separate nuclear from other technologies, it's all the same. And how it usually goes. You have the first step. You first have to come up with a world view at 2050 or a longer world view where you want to be. For example, if we had a discussion in Belgium, do we still want to have our industry and those jobs in our country or not? That's very important decision and it also defines the limits of where you can

go or can't go. And then you drop down and in the end you fill it up with technologies. It's not the other way around. It. You take a technology and then see if it fits in there.

- There is a big difference between making the strategy, like we do, an energy system analysis like how it could ideally look like in 2050 while fulfilling all the boundary conditions like allowing for industry, mobility of persons and so on. And then you see that the cost optimal technologies but then you have an idealised future situation.
- The thing is getting from now to there and it means you will have winners and losers along the way, and people are instituted or agents that lose something and always gain something. And it's the policy at all. And only then because the policy come in and when you need to nudge society from. The expected trajectory to what you want, where you want them to go, and that's the policy gap. That's what they sometimes call existing policies, are additional measures in the national energy and climate plans. So there is also a difference between strategizing how the energy system should look like and what would need to be fulfilled. First having the vision that's energising how it should look like and only then you have the policy package that needs to address the implementation cap. I don't really see here. But it's like I said, maybe it's also my background that that makes me look a bit different here.
- I think it's maybe just the framing of this recommendation makes it a slightly awkward thing. Question: is this recommendation about the need for stakeholder engagement in sustainability assessments of nuclear, or is it about the place of nuclear in all energy policy? Or is it about all energy policy of which nuclear is just one part?
- From my experience, it is wonderful to involve the stakeholders in the energy policy. Because if this is a major decision at the level of any country or a group of country, region of Europe, Union and maybe larger, but this is very difficult to do. First of all, there are only little examples. We mentioned consultation in the national energy and climate plans development and is obligatory, according with the recommendation of Europe Union, but generally this is only a collecting of input, and these inputs are sometime ignored by the policymakers or cannot be used by the policymakers due to different reasons.
- The process also depends on the capability of the people to discuss and to understand the complexity of the process. At the national level, such process should be built in many years. Probably the experience from nuclear is important, but you cannot expect in four years, for example, to build such a process. Today, people cannot understand, for example, the cause of the blackout in Spain because more of them cannot understand the system itself. Therefore, we need to wait and build this process and let's say introduce enough information in the schools, in the technical part.
- We can probably add as a recommendation to develop the education of European Union member countries with classes in schools about energy and waste in general, and especially about nuclear energy and nuclear waste. This is this additional recommendation.
  How to include the bullets of recommendation through these sections: most important is to introduce new legislation with requirements otherwise it cannot be realised.
- It's more just a general question: Having worked in schools and being a school teacher and also trained teachers, I know that every area of science, technology, engineering, medicine, maths has its priorities of what should be taught in schools.
  School curricula can't be dictated by industrial needs or things like that. I think if we want a recommendation around and looking at the educational system, which I think is a really good idea, but I don't think we can recommend that things should be taught about specific items. I think there's maybe a recommendation around education systems reflecting on the way to

prepare children for the future. But I do wonder whether we can think of making recommendations which are so specific in areas of science, because there are just too many of them to fit into a curriculum.

- I also actually wanted to comment on the education. The content that was made, I also don't think we should indeed focus too much on a specifically and teaching them about energy. I think it's more what you need for this type of deliberation, what youngsters need to realise is the finiteness of resources and that in every decision you make, there is always winner and a loser. But there will always be limits and it's thinking about limits and understanding that there are always trade-offs. I think that's important because too much debate is about should we do nuclear or not, windmills or not.
- Some tools can be developed like Geo safe interface, which is a web-based programme which could allow civil society users to explore the evolution of a geological repository. Such tools could enable better stakeholders' engagement in decision making. I think the argument really will be driven by what technology is available to civil society users to explore the issues.

Recommendation #4 and #5

Basically both recommendations are related to SMR: transparency and public information on SMR technologies and related policies, and the next one is foster public dialogue on SMR by engaging diverse public and stakeholders in conversation to address benefits and risk.

- It's all very specific topic on the cost of SMRs and what stuck with me was when at one event we discussed different parameters when it comes to cost. They don't present any information on cost because they said the information is not conclusive if you ask. If you ask different stakeholders, and while that's all nice, I think what is lacking there and maybe in general in nuclear energy is societal leadership. Like somebody has to take the lead and say these are a probable value for these technical aspects for these costs and we put them out there.
- For nuclear technologies to take leadership and say like, hey, we consulted with different stakeholders and this is what we came up with as probable values. Will it be exactly that? No. Will there be other values possible? For sure? Can you deviate by circumstances: for sure? But still this is good values to work with and to use, for example to engage with stakeholders.
- IAEA, International Agency for Atomic Energy could take this social leadership and publish all other types of parameter information. Why not about cost? And like I said, I understand the idea of it is not sure, but you're better than you're 80%, right and maybe 20% wrong then not seeing anything and being 100% wrong. Sometimes you need to just put it out there with the necessary caveats of that. That is uncertainty here.
- I'm not sure why the information and participation in SMR should differ from the participation in the bigger NPPs? What is the reason? We have some deficits, and we already see them and of course it should be made better here when form of new topics emerge. But I don't really understand why these SMRs do have separate recommendations at all.
- Knowledge on SMRs is insufficient, fragmented and factually incorrect. I think it would be useful to think about why it is so and who makes it to be so. This is connected also with the third bullet information on project benefits and risk is selectively shared. Why is selectively shared? And it should be discussed in public forum, which are these forums. This is question also to you need to be precise.
- I want to say there is a lack of information. This lack of information about SMR is not common only for the stakeholder. It is also at the level of expert, because there are a lot of supposition in

in each design. Today there are 90 types of SMR that are “paper reactors”. Only two SMRs are practically in operation, and this is very few operational experience and not relevant in term of cost because the cost of SMR is depending too much on the hypothesis of fabrication in the factory. This fabrication in factory is not yet available in any country. Therefore, what is to do in this condition? My recommendation is to speak to discuss frankly with the audience, with the stakeholders about the different advantages of SMRs, for example, you discuss a lot about flexibility.

- From my side in in this process is to use the recommendation that are generally produced for the large reactor and to start a good process for SMRs because we are at the beginning and can develop probably better process in terms of the engagement in the decision making process.
- One remark under Recommendation 5. Integration of social sciences and humanities. Invest in targeted research on perceptions. Monitor public opinion. This isn't this is an SSH research, in my view. It's just marketing and public opinion surveys. It's not research.

Recommendation #6:
Open up spaces in nuclear R&D for participatory initiatives, enabling deliberative decision making and integration of social science and humanities.

- No comments

Recommendation #7 and # 8:
Provide national political support and appropriate means for local communities’ engagement and the same for the civil society organisations engagement, in particular environmental NGOs.

- Again, they seem sort of slightly different character to some of the others recommendations. And some of it, I just wonder whether they need to be here, they're actually part of recommendation 2. So, if you want to move to substantive rather than instrumental, then quite a lot of the information under recommendations seven and eight actually seem to be the how for recommendation 2.
- The example of involving of youth and adapting messaging to different age groups has an example of the Netherlands Citizen Assembly that seems more like an example of good practise than something that is in the how part.
- Some of these recommendations are just really specific to particular national contexts, so it's the only recommendations where we've actually got mention of specific countries. Rather than dealing with this as a bigger issue.
- In terms of who our audience for these recommendations are, we would hope they are sure for within Europe but also beyond.
- Foreign funding is important, and it is not out of place. I think it's a reality. When we look at Hungary, they want to implement a law that funding from abroad is forbidden for NGOs, especially environmental NGOs. I think this is a reality in today's life. To engage in participation in nuclear issues takes time. And if this goes without any funding, this is difficult if not even impossible, and I think this is a very important recommendation that funding is needed. It can't be expected that that people engage only in their spare time and do it for free, especially if an engagement should go over the long term.

- What I'm saying is funding is part of the how of the proper engagement and that's why I was questioning whether it should be in recommendation too. So it comes earlier and it's part of the substantive need.
- My question about specifics is literally on the language to do with. So that we mention funding from German foundations. We mentioned something about Slovakia. We mentioned former Soviet blocs that to me is not relevant. The relevant thing to say is we need the funding. The funding is important. That's the recommendation. The other things are just about how we find ourselves in this situation now.
- Point about the funding is really important and it should be such not only for NGOs or local communities, but also for individual experts that are known, which are opinion leaders in the separate countries.
- You need funds to discuss if you want to do nuclear, but it should be the same also for other impacts on environment, like large wind park on shore and because, in my opinion even people get more excited if they will have a bunch of big windmills in their neighbourhood. And so I don't really see the difference from a societal perspective because all different technologies have an impact on the neighbouring. I'm gonna give an example in Belgium context. And I think there has never been as much fuss in Belgium as for the extension of the ring way around Antwerp.

Appendix B: Short transcript Group B

Let me start by briefly acknowledging the visual layout. On page two we see that same very colourful set, which is helpful.
I'd like to quickly remind everyone of the questions:

- How does this document strike you overall?
- Are there things that would make it easier to use and more impactful?
- Are the recommendations clear?
- Can we contribute best practice examples?
- And finally, who needs to pay attention to these recommendations?

The idea is to go through the recommendations one by one and share reflections. The first two are about process, the third about sustainability assessment, and four and five relate to SMRs. If we are having a fluent discussion, a break might make sense after the fifth.
Before going into the document as a whole, I'd like to ask: for those who had time to look at it in more depth, is there any recommendation among the eight that you feel we should prioritise before part of the group leaves in about 45 minutes?



General Remarks:

- Speaking now in my role as one of the co-authors of the document. These recommendations were distilled from all the materials produced throughout the project since 2022. I can assure you there is no particular order of importance in the way they are listed. Each recommendation is relevant in its own focus area, and they often overlap. They should be seen as a networked list, where one links to another. Capacity building, for instance, is indeed central to stakeholder engagement, as was mentioned in the introduction. In case it wasn't clear earlier, recommendations 1–3 are more process-oriented, 4 and 5 focus specifically on SMRs, and 6–8 address particular stakeholder groups or interests. So, while the list could have been reshuffled, the categorisation is intentional.
- A few formal things: we're mixing American and British spelling (with -z- and -s-), and there's inconsistent use of italics, I'm not sure why. It also would be helpful to consistently highlight any term that appears in the glossary.

- I also felt the first page could give a little more information about where all of this comes from, but this will be easy to solve.
- My impression is that the recommendations feel somewhat one-dimensional, meaning they touch on many nuanced issues we experts recognize, but these nuances might be lost on decision-makers or other target groups reading the document. For example, from my experience in the Czech Republic and Central/Eastern Europe, a decision-maker might simply skim the document and conclude, "We need more stakeholder engagement," and leave it at that. This is not unique, as many European approaches already call for increased engagement across various fields. So generally, I would suggest making each recommendation as distinct and straightforward as possible, delivering a clear, focused message. This could be helped by grouping the recommendations into clusters.
- Also, different recommendations might be targeted at different audiences, some more suitable for decision-makers, others for NGOs, and that distinction could be made clearer in the document.
- The title of WP1 refers to collaborative assessment of imagined energy worlds. The idea of imagined points to the future, possible futures that don't yet exist. I find that this future-oriented perspective is largely missing. Stakeholder engagement should also be used to deliberate the future of nuclear energy, not just current practices.
- I find there's a lack of strong reference to social sciences and humanities expertise. Right now, this is only mentioned in Recommendation 6. That may be enough, but if so, it should be clearly highlighted and consistently referenced throughout the rest of the document. As social scientists, we can contribute much more than simply calling for more engagement. We can act as facilitators, provide valuable input, bring data and evidence, and actively support the engagement process itself.
- When it comes to social sciences and humanities (SHS), I'll admit that when I see these references in documents like this or in similar contexts, they can sometimes come across as a bit corporatist, almost like we're just claiming our seat at the table or securing a budget line.
  So, to make the value of SHS expertise clearer and more concrete, what it is and what it contributes, perhaps, one option would be to define it more explicitly in the glossary. It may not be the perfect solution, but it could help.
- For me, this discussion about how to make the different target groups and priorities more visible really highlights that maybe a linear text document isn't the ideal format. In other projects, maybe even in the IPA project, though I wasn't directly involved, there's been the idea of using an HTML-supported presentation, something interactive. For example: "I'm an NGO - show me the recommendations most relevant for me." Or, "I'm a decision-maker - guide me to what I need to focus on." That kind of structure could make the document more accessible and practical for different audiences.
- In general, stakeholder engagement is still much less common in Central and Eastern Europe. From my experience, experts and decision-makers working within government structures may be less familiar or comfortable with participatory approaches. That's why I believe it's crucial to tailor the messaging specifically for them. To make it clear that stakeholder engagement can be combined with scientific expertise and that social sciences and humanities can bring real value. We can contribute with concrete methods, data, and approaches that help design, structure, and support the engagement process, not just ask for more dialogue, but actually move it forward in a meaningful way. This kind of clarification and framing would be especially helpful in the context I know best, but I believe it's also relevant more broadly across the EU.

- We could still mention some of the potential benefits for decision-making that arise from it. In my experience, for instance with the siting process for the deep geological repository in the Czech Republic, there is significant mistrust among government officials toward stakeholder engagement. Past attempts have failed, and as a result, new calls for engagement are often dismissed. So, I think it would help to tailor the message more carefully for this group. That means providing arguments, examples, and showing what engagement can actually achieve.
  Also, it reinforces what I said earlier: we need the individual recommendations to stand out clearly, so that decision-makers don't just skim through and simplify the message as "we're being told, once again, to engage more." In some countries, including the Czech Republic, that oversimplification is a real risk.
- I don't really have anything against the eight recommendations themselves. But I do think that the accompanying text especially the bullet points, could be used to expand the recommendations in more directions. That would help avoid the impression of one-dimensionality in the document as a whole.
- I think there may be a need for a few more lines at the beginning of the document that speak to the added value of stakeholder engagement, not just in an instrumental or functional sense, like *anonymous'* point about "requisite variety" (the idea that without enough perspectives, you might miss something crucial to safety or sustainability).
- But also: is there a moral dimension? A cultural one? The more seriously we take engagement and the more we embed it across months, years, and decades, the more likely it is to become a shared societal practice. Something we understand collectively as necessary and legitimate.
- Public financing of NGOs used to be a good practise. At the same time, I'm personally concerned that there may have been an element of revenge in the decision to cut that funding. My impression is that public officials are generally comfortable with environmental NGOs as long as they stick to "nature" - plants, animals, things that are politically safe. But when an NGO raises a safety issue, as happened in the Swedish copper corrosion case, officials don't like it. It feels like they want to punish that kind of engagement.
- Taking a more general perspective on how the information is presented, and I think Barbara or the physicist in us can relate to this, the use of colours, frequency, and energy feels well designed. Even if there is no formal order to the recommendations, the layout gives a sense of flow, starting with higher-frequency items like #8 and moving toward the more foundational involvement of individuals in recommendation #1. In that sense, it works well as it is.
- I wouldn't worry too much about the form, length, or structure of our recommendations because we simply weren't given enough funding to polish them or make them look visually attractive and centered.
- I don't think we need to make the documents more "understandable" by following trends like TikTok just because young people use it. In the end, ECOSENSE is a coordination and support action activity, and in theory, we are writing documents to be read by well-financed research institutions who are interested in further research. I believe the research gaps are very well identified between the lines of the documents we prepared.
- Unfortunately, there is zero funding for social science research on nuclear issues, as all of us in the SHARE network know. But we have dignity and don't want to be begging the European Commission for money. Still, I agree with someone's remark that the usefulness of social research could be emphasized more.

- On the other hand, as a civil society representative in Europe, I know that those in real power who are often not politicians simply don't want social research because they fear the results. We have to be honest about that.
- I think this will be one of the key outcomes of our project that might reach a wider audience. Maybe it's something we could also present within our networks, not just research networks, but also our national contacts involved in nuclear energy in some way. So, I believe it's worth investing a bit more energy to make it look more compelling and polished.
- I think the question of involving as many stakeholders as possible is crucial. We talked with anonymous before he left about environmental assessments, and I think everything came up there: the importance of doing these assessments fairly and with all stakeholders involved.
- But there's a problem with nuclear decisions, in that unless the process is set up in a way that's basically non-democratic, it's very difficult for nuclear projects to get through the decision-making process. That doesn't mean, though, that the process should be undemocratic. The decision-making should be fair and democratic, and if nuclear doesn't succeed under those conditions, then so be it.
- I mean, how does society make decisions about difficult issues, and how do they do it to reach long-term, sustainable solutions? Honestly, I'm not only tired right now, but actually quite depressed about the situation in the world and how things seem to be going in the completely opposite direction of what I thought we were all trying to achieve with this document. Sorry I can't be more constructive here, but I wonder if it might be possible to discuss these broader societal development issues somewhere in the report or its outcomes, if such observations have been made in the project.
- I'm thinking about presenting a few present-day scenarios where something good is happening where people are having fun, sharing success, and all participants benefit. That really resonates with me.
- I wouldn't want to see a recommendation that just says "share success stories," but something that's sensitive to the fact that we really need to feel that we're succeeding together, that we're making progress as a collective, to encourage us to keep going.
- Regarding the document, if it's meant to have real impact and reach people, then it should be written for the audience it wants to reach. If it's just a checkmark for the Ecosystem project, then fine. But if we want to reach further, there should be another, shorter, more compelling document, maybe a leaflet or something colorful and easy to read. Eighteen pages is a lot nowadays; people don't watch long videos on TikTok, and the same applies to documents. So it should be made very clear, easy, straightforward, and direct. Depending on the audience, you can say, "If you want to know more, read the full document."
- In the life cycle assessment work I did previously, you can set parameters and boundaries so that the numbers suit your purpose. Civil society should always be included because you can't trust the numbers completely otherwise. Life cycle assessments should be done realistically and holistically, not only focusing on environmental or economic parts, but also including the social dimension. Social aspects should be standardized and clearly shown, for example, if children are involved in raw material production, that should be explicitly stated for each energy source. At least for nuclear, this is often missing. I hope solar energy does better, but I'm not sure as I'm not in that field. So this needs to be taken care of from beginning to end, not just commissioning or recycling or circular economy. It should be done openly and in a way that's easy for people to understand, showing the whole picture clearly.

Recommendation #1.
Improve the uptake of existing recommendation for stakeholder engagement, transparency and communication in nuclear decision making.

- I spoke about the importance of integrating this kind of information into education from an early age, as part of preparing individuals for active citizenship. I believe we need to invest in education and promote lifelong learning, so that people have the opportunity to think critically about these issues. At the same time, I recognise that many people simply don't care. In that sense, sometimes it may actually be easier to begin with something like Recommendation #8, rather than starting at this foundational level.
- I agree that presenting this point as a standalone box or a framing element in the document, rather than tying it only to Recommendation #1, could help emphasize that it's a broader societal challenge. It's not just about stakeholder engagement in one sector, but about building a culture of informed, thoughtful, collective reflection.
- That's a brilliant analogy with Schrödinger's cat. Until the box is opened or in this case, until a person is personally confronted with a nuclear issue (e.g., a waste repository proposal nearby, or energy infrastructure affecting their region) the issue remains abstract, out of sight, and out of mind. It also underlines how potential engagement often exists in a suspended state. The public is not inherently apathetic, but rather in a kind of "superposition", where care or concern only fully materializes when the decision becomes local, tangible, or urgent. That's when people "open the box" and start to engage, often under pressure and with little preparation. This is exactly why early education, inclusive dialogue, and a culture of shared responsibility are so important. We shouldn't wait until the box is forced open by conflict or crisis. We need to create channels where people feel it's normal and valuable to be engaged before the stakes are personal.
- Rather than trying to push for "early and universal" involvement, could better highlight the goal of cultivating societal trust through the institutionalization of good deliberative practice.
- Early in the process, not only should civil society be engaged, but they should have the decision-making framework clear in advance, including access to justice, so that they can trust the whole process.
- Early involvement and clarity in decision-making rules are essential. This makes it easier because society is used to decision making on environmental issues generally, and then nuclear issues just become part of that, and nothing special in a sense regarding engagement.
- Decision making in nuclear should follow the same rules as for other things. And just because it's more difficult doesn't mean you can set aside the rules for it.
- If there had been more resourcing for civil society to participate in nuclear decision making, there would have been at least some strong parties that would have had to engage.
- Well, I thought about what someone mentioned regarding imagining future scenarios, and maybe it might help to imagine present scenarios instead. For example, looking at good practices that are already working very well in certain regions where nuclear is present, compared to other regions where it's still not. That might help when developing these kinds of exercises, so you don't even have to imagine the future, you can just look at things that are already happening elsewhere. Maybe it can help to reduce some fear or overcome some traumas.
- And I want to put particular emphasis on the idea that risk perception is probably a very active factor in this, as you said, and maybe even an unspoken one. If we say that the lack of interest

is because it's so technical, so difficult, so clear that there will be little influence, then maybe the risk perception or risk aversion, or experience, or whatever, needs to have its own acknowledged, unthreatening place as well.

- Recommendation #1 is actually the longest, and there's already quite a lot of text to absorb. So, I was thinking that perhaps not all of these valid point-style recommendations need to be included there.
- Maybe an alternative would be to move some portions of the text and make them part of a general introduction. This way, the valid points, which are grouped around key topics like legal aspects, institutional aspects, and oversight could be outlined in more detail upfront. By doing this, the message attached to each recommendation would become clearer, and the recommendations themselves could be cut down in length.
- I'm a fan of using things like coloured boxes or different formats, like in a magazine, where you can read the easier summary in the margin and the more detailed information in the main body of the text.

Recommendation #2
To move from instrumental to substantial engagement.

Recommendation #3:
Faster engagement of stakeholders in sustainability assessment for energy policy advice.

- I want to take a moment to comment on recommendation #3, which may sound technical but is very important. This stems from the ECOSENS project, where WP2 focused on sustainability assessment, and WP1 provided a broader, more critical perspective on this exercise. Sustainability assessments are quite common now. The European Commission, European Parliament, various institutes, and the IPCC all conduct them for nuclear energy and other technologies. The key point is that these assessments are always subjective, based on values and preferences, which is not a problem. When people come together, they bring their own values, concerns, and hopes. To build trust and address concerns about subjectivity, it's essential that these assessments are transparent and participatory. They should be as inclusive as possible without losing formal rigor, using different methods and models, as we did in WP2 of ECOSENS. Although it's challenging to fully engage the general public, especially those without technical background, I believe it is worthwhile to include them in these sustainability assessments.
- In my work in nuclear issues, about 25 years ago at university, I was involved in a lot of this kind of analysis. However, it was often quite academic. The environmental movement generally does not use these analysis tools much; sometimes they commission reports like LCAs, but that was a long time ago and not in my personal work. I think there is some scepticism about these analyses because sometimes the person commissioning the work has a pre-set result in mind, so the analysis can be designed to show a specific outcome. I'm not sure what value this type of analysis has for the public. Of course, the scientific community values it highly, but I wonder how much it really benefits the general public.
- I could give you an important example. The European Union has issued a taxonomy of sustainable energy options and actually declared nuclear as being one of them. There has been very heavy critic from the opposition's in the parliament, but also from environmental groups about this decision, calling it a political analysis rather than scientific.

- There is a hard line between a scientific and a political decision, as we say, all of these inputs are not value free and should not be value free. It's impossible.
- The question is who has the power to decide an outcome of such an analysis and where is it placed? This analysis (taxonomy) was actually placed within the nuclear part of the of the EU Commission.
- It actually undermines the whole idea of the process itself. It's not only a question of who participates, but actually if the process is set up badly, then then then it loses value.
- In short, if sustainability assessment is to be done, it should be done together, collaboratively.
- When I interviewed military personnel about risk perception, I noticed their strong need, like all of us, to recycle certain exercises and information. This seems key here as well: going through sustainability assessments is not always about discovering something entirely new, but about revisiting and relearning what we already know, because we never know enough.
  I believe this point could even be added to the recommendation itself, as one of the bullet points. It's always worthwhile to look at previous assessments and reflect on what we can learn from them.
- There's been a great deal of difficulty defining and finding satisfactory indicators for the social pillar. The general idea here of involving stakeholders in identifying indicators, but I would say that particularly for the social pillar, there's a need to understand what is measurable and meaningful.
- This is really the core challenge of sustainability assessments: how to quantify what is fundamentally not quantifiable. Even something seemingly simple like visual pollution, often dismissed as irrelevant, can actually be quite important, yet nearly impossible to measure meaningfully.
- What I've been missing, though, is the ability to engage with other parts of the Commission beyond the nuclear-focused units. I understand why this is difficult, the internal structure of the Commission is very complex, but if environmental assessments are to be meaningful at EU level, they can't remain siloed within DGs focused only on nuclear. There needs to be better coordination across different DGs, for instance, those working on renewables, energy efficiency, and others, so that broader stakeholder perspectives are included in the evaluation process, not just those organised by the nuclear side for nuclear topics.

Recommendation #4 and #5:
Basically, both recommendations are related to SMR: transparency and public information on SMR technologies and related policies, and the next one is foster public dialogue on SMR by engaging diverse public and stakeholders in conversation to address benefits and risk.

Recommendation #6:
Open up spaces in nuclear R&D for participatory initiatives, enabling deliberative decision making and integration of social science and humanities.

Recommendation #7:
Provide national political support and appropriate means for local communities' engagement in nuclear decision making.

Recommendation #8:
Facilitate and support the engagement of civil society organizations, incl. environmental NGOs in nuclear decision making.

- This should be developed further in connection with recommendations #1 to #7. Long-term and sustainable resourcing is essential, as many of these processes, including waste issues, will continue for decades.
  Without focused support, advisory councils to government or strong NGOs won't be in a position to contribute meaningfully. At present, many environmental NGOs avoid engaging with this topic entirely, they simply hope it disappears. My input comes also from experience in Sweden, where the environmental sector was well-resourced and able to contribute constructively to nuclear waste discussions, ultimately improving decision-making.
- I just want to note that if the very first comment we receive is that recommendation #8 feels lost at the end, that already tells us something important. It might be a matter of the ergonomics or visual presentation, perhaps the networked structure we spoke about should be made more visible in the way the recommendations are displayed.
- That aligns well with the broader vision of sustainability. The idea that we're embedded within complex systems. If we define the boundaries too narrowly, we're not really engaging in true sustainability work.
- The issue of *stakeholder fatigue* is significant, and we've seen that continued support is essential, not only financial, but also moral and motivational. That, I think, is a key point we should emphasize.
- The key point is how fragile this kind of capacity building can be. It's very easy to dismantle. That's why sustainable, long-term resourcing is crucial from the outset, and all parties need to understand its value to society. Even though major decisions on waste have already been made in Sweden, these are long-term issues, and things will continue to evolve. Civil society must remain involved in that evolution. I believe it's vital to have diverse voices in decision-making, including those you might not agree with. Not to silence them, but to ensure a resilient and inclusive process over time.
- I'd like to raise a quick point about vocabulary. The term *capacity building* is often understood in many fields simply as *training*. So we should be careful to communicate that what we mean here is broader, it's more of a systems concept, involving long-term support and enabling structures.
- Yes, capacity building can mean much more than just training. For example, in the context of UN climate change negotiations, it includes resources, time, and broader structural support. If we choose to use this term in the recommendation, we need to clearly explain what we mean by it.
- The community around Östersund, and similarly in Oskarshamn, took ownership when they realized the repository would be located there. They strengthened their efforts and conducted their own analyses because they had the necessary funding and resources. Likewise, NGOs were able to do independent work thanks to adequate resourcing.
- What this suggests to me, and what I would recommend stating clearly at the beginning, is that we need to rethink the roles of the different actors involved. This is not a charity issue where one strong actor asks a wealthy actor to fund some local involvement. For the system to be sustainable in the long term, it requires highly competent and well-supported actors.

Appendix C: Short transcript Group C

Let us begin with a brief roundtable to share your general impressions of the document. This is a safe space, so please feel free to be as critical as you believe is necessary. We will go around and hear from those who wish to contribute. Would anyone like to share their overall thoughts on the structure, the tone, or the way in which the recommendations have been formulated?
Is there anyone who feels there is room for improvement in these areas?



General Remarks:

- I would like to respond to one of the points raised in the final slide, specifically the idea of including examples. It might be worthwhile to go beyond examples and also include references to legal instruments and requirements. For instance, documents such as the Nuclear Safety Directive contain provisions related to access to information and the possibility of enabling public participation.
- While this may not be directly within the terms of reference of the ECOSENS project, grounding the recommendations within the broader legal landscape could enhance their relevance and impact. There are approximately five or six key legal texts that are particularly pertinent and worth referencing. It may even be useful to include this suggestion as a standalone recommendation, to clarify the regulatory framework that underpins these kinds of requirements.
- One point mentioned in the document, which I believe deserves greater prominence is the need to analyse and understand the power dynamics at play. This is crucial. When designing a public participation process, it is essential to be aware of the power imbalances involved. Otherwise, legal frameworks can easily be used not as enablers, but as tools to restrict participation. Public hearings, for example, are disappearing. Most input now is written, and it gets filtered by civil servants rather than independent bodies. As a result, even detailed, well-argued feedback often gets ignored or erased from final reports, which demotivates people from participation.
- For me, the crucial point is the relationship between legal prescription, the implementing authority, and the public. Authorities often act as gatekeepers, using legal provisions as

justification to filter or minimise public input, which severely compromises the effectiveness of the participation process.

- Another point maybe, as an example for the recommendations regarding public participation principles: insisting on the major roles of environmental impact assessment and SEAs also.
- What I felt was missing are clear definitions of key terms. The glossary is a good start, but I think there's more potential to clarify terminology. Let me give a concrete example: the phrase *"neutral information"* appears several times, but it's quite ambiguous. What exactly does *neutral* mean in this context? Does it mean balanced? Objective? Is there even such a thing as truly neutral information, especially in this field? So for me, it's essential that we clarify: participation for what purpose? Is it to contribute to an actual decision, or just to provide input for a report? Without that clarity, the process risks feeling generic and unproductive. To summarise, I believe the core terminology needs to be better defined, not just with a few references, but with meaningful context. Otherwise, we risk everyone interpreting key terms in completely different ways and that undermines the whole process.
- Looking at the entire document, one thing I really missed is a clear indication of which recommendations are relevant for which stakeholders. When you're involved in a particular process or procedure, you want to be able to look at the document and say, What can I actually implement here? But at the moment, that link is hard to make, because there are so many recommendations that apply to different actors and contexts. Structuring the recommendations more clearly by stakeholder group or by procedural context could really help.
- On the issue of definitions, especially around terms like neutral information or neutral communication, I think it's too limiting to try and capture all of that in a single word. We might need to take a bit of time as a group to explore: What kind of information do we actually need for meaningful public participation? In my view, this should include verified information, but also information from different viewpoints. The same goes for communication it's not just about balance or neutrality; it's about clearly describing the nature and sources of the information being shared. So I'd suggest expanding on these concepts rather than trying to compress them into one term. A richer description of what information and communication should look like especially from multiple angles would be much more useful in practice.
- My first impression when reading the draft was that there is a lack of concrete examples. I understand that this is already on the agenda for our group, and I know there may not be perfect cases, we don't live in a perfect world, but examples are crucial. Each recommendation should explain more clearly what is meant and ideally include best practices to illustrate the intent. Even if we cannot show ideal situations, we can highlight where something works better for example, compare how one country has handled a particular challenge more effectively than another. That helps us move toward improvement, even if perfection isn't possible. Also, we shouldn't limit ourselves to examples from the nuclear field. There may be relevant cases from other sectors, or from civil society engagement more broadly, which could help us communicate more clearly what we expect from decision-makers. In short, more concrete examples even imperfect ones would make these recommendations much more actionable and compelling.
- I do think we still need to make the content more concrete. The document is quite long, and at times feels unbalanced. Some recommendations come with lengthy justifications, while others are quite brief. I'm not sure whether it would be better to provide a general justification at the beginning, rather than a separate one for each recommendation, just something I've been thinking about, although I don't yet have a clear answer.

- Wouldn't it be possible to relate recommendations with stakeholders using colour codes? Or emoticons? In order to avoid repetitiveness.
- The document should have been shared earlier.

Recommendation #1.
Improve the uptake of existing recommendation for stakeholder engagement, transparency and communication in nuclear decision making.

- My first point is that we need to look more closely at the legal aspects of public participation. Many legal obligations stem from the Aarhus Convention, but as mentioned in the recommendations, these are often not properly implemented.
- Civil servants often interpret the law differently than civil society does. While legal tools like the *Maastricht Recommendations* and ACCC jurisprudence give clear guidance on how broad and meaningful public participation should be, many officials still fall back on narrow readings of national law or claim that such guidance isn't binding. What I'm missing in the current recommendations is a stronger, clearer point that references existing legal obligations and guidance. There's already a wealth of content in the Aarhus Convention, Maastricht Recommendations, ACCC findings that outlines what proper participation should look like, including the possibility of informal participation before formal procedures begin. So, the legal framework exists, but how authorities engage with it is critical. Implementing these obligations is not just about compliance, it requires skill, willingness, and a learning process. Authorities are still learning how to do this well, and I think our recommendations should reflect both the legal obligations and the need to build capacity and awareness in how to apply them meaningfully.
- We need to be mindful of national and local specificities when discussing participation methods.
- The document mentions polarisation only once, and even then, it's linked only to the first recommendation. I believe it's important that the document more clearly acknowledges the potential pitfalls of stakeholder engagement and addresses how they can be mitigated. Engagement is, of course, essential, but the risk of it leading to extremes or polarisation is always present. Just mentioning it once isn't enough. From academic research, we know that rules of procedure are critical as others have already pointed out but so too is the role of moderation.
- If I'm not mistaken, the entire document does not mention moderators or moderation at all. That seems like an important omission. Effective moderation plays a crucial role in managing diverse viewpoints and preventing discussions from escalating or becoming polarised. I would suggest including this aspect in the document moving forward.
- I want to add that if we're aiming to create a meaningful map of different actors or publics, it really depends on the objective and level of participation we're talking about. For instance, representativeness is often linked to tools like opinion polls, or designed to engage very large publics. Even in some public debates, aiming for representativeness is considered important but in reality, we know there are always biases in who actually participates. From my point of view, representativeness can be a misleading objective, especially when it doesn't align with the actual goals of the participation process. Not all engagement needs to be large-scale to be meaningful. Some stakeholder engagement efforts are small, focused on specific publics or panels, or limited to a few actors but they still contribute value, influence decisions, and change outcomes.

- I think we need to be much more specific when we talk about the spectrum of public participation: What is the objective? Which publics are we engaging? How do we reach them? Sometimes it's not about analysis at all sometimes it's about contributing to public and political life more broadly.
- We've already mentioned the idea of power mapping. For me, power mapping must be linked to power balancing. There are concrete instruments that can support this, like veto rights, referenda (although I find them problematic, too unpredictable and easily manipulated), and others. These tools aren't just theoretical; they can genuinely shift how power operates in participatory processes.

Recommendation #2
To move from instrumental to substantial engagement.

- I'm not sure whether this fits best under the current recommendation or somewhere else, but based on my experience with engaging the public, particularly small or medium-sized communities, I believe one essential element is creating opportunities for learning. Participation shouldn't just be about asking people to take a stance or make a decision. It should be about fostering a process of mutual learning. That means both the public and the organisers gain something meaningful from the engagement. Otherwise, participation risks becoming purely formal or symbolic. When the process involves genuine exchange of useful information, communities can better understand what's at stake, and at the same time, project promoters can learn from the concerns, perspectives, and knowledge of the public. This kind of two-way engagement makes it much more likely that the project or investment becomes something that all parties feel connected to. That emotional connection matters. So, for me, this recommendation should really be read or even expanded to include the idea of co-learning and co-ownership. Participation must be seen as a common project, not just a procedural requirement.
- There are good practices for this. See the Douth radioactive way process. E.g. check historical processes, books about international practices, local inputs and youth-only sessions. Good practice. Look into it. Negative side: not all the interested parties were included.
- I want to highlight something that isn't really mentioned explicitly in the document, but which I believe is crucial: the need to move from ad hoc decision-making moments to sustained participatory processes. What's really important is to shift towards long-term, process-oriented participation where engagement continues throughout the decision-making cycle, across different phases, and over time. This marks the transition from instrumental to substantive engagement from ticking a box to genuinely integrating public input into policy and planning. Embedding participation as part of an ongoing process, rather than a one-off event, is essential if we want to build trust, accountability, and lasting legitimacy.
- Perhaps the term "salami slicing" should be considered here – many different procedures for many different things.

Recommendation #3:
Faster engagement of stakeholders in sustainability assessment for energy policy advice.

- I have one very practical concern, and that's how to embed participatory processes in the context of a four-year political cycle, which is common across most EU countries. The kinds of long-

term engagement processes we're talking about often take longer to define, launch, and implement than a single political term allows. And I still struggle with the question of how we can prevent these processes from being interrupted or abandoned when a new government takes over. I don't have a clear answer. I do believe that continuity must come from civil society to some extent, and I know we're doing our best to ensure that, but it's not easy, especially in the current political climate, where populism is increasingly influential and can shift priorities very abruptly.

- First, it's really important to ensure that civil society actors are given the opportunity to provide historical and critical feedback on past experiences with assessment processes particularly sustainability assessments. I'm thinking of several cases where civil society was invited to participate in such procedures, which often involved complex and demanding methodologies. So, before we move forward with new recommendations or actions, we need to ensure that we've learned from past experiences and that includes honest, critical feedback, not just formal evaluations.
- Good practices are in France, structured processes. Such structures have legal bases. Also, a good one in Sweden. Facilitate the participation of civil society in decision-making. Feeling of responsibility for people.

Recommendation #4 and #5:

Basically both recommendations are related to SMR: transparency and public information on SMR technologies and related policies, and the next one is foster public dialogue on SMR by engaging diverse public and stakeholders in conversation to address benefits and risk.

- In debates such as those around SMRs or other emerging technologies, it might be helpful to synthesise the communication not just in terms of factual content, but also in terms of dominant frames. From my perspective, this can be even more informative than focusing exclusively on granular details because it helps people navigate complex, value-laden discussions more effectively.
- I have a real problem here, and I think it's a fundamental one. You rightly pointed out the issue of information quality, but what I want to stress is how deeply compromised the current communication environment is particularly within conflicting frames. There's a perception war going on. On one side, we have the SMR industrial alliances, whose messaging is heavily framed, often featuring over-optimistic timelines and exaggerated progress claims. On the other side, we have government communication, which suffers from internal bias. Many within the ministry want SMRs to succeed, so their information is often not balanced either. So where can we turn for independent, reliable information? So my question is: do our current recommendations offer any tools to deal with this kind of culture war environment? Because I don't see them. Perhaps this is something we need to explore further. Whether there are good practices from other fields or countries that have managed to restore trust and re-open real, meaningful dialogue in such polarised settings.
- Add the pillar of giving resources for civil society to participate.

Recommendation #6:

Open up spaces in nuclear R&D for participatory initiatives, enabling deliberative decision making and integration of social science and humanities.

- I would recommend that national projects related to SMRs and nuclear installations should be required or encouraged to include dedicated space for social scientists and civil society actors. Early and meaningful involvement can build local trust, increase understanding, and lead to genuine public support.
- I was just writing about this as part of a review of good practices specifically the Swedish National Council for Nuclear Waste. It has long been recognised as a positive example of how to structure meaningful engagement. Maybe providing these forums for discussion between the experts, the civil society, and also thinking of R&D.

Recommendation #7:
Provide national political support and appropriate means for local communities' engagement in nuclear decision making.

- You've missed an important one: citizens' forums. If we're talking about good practices, these should absolutely be included. Citizens' forums have been used in a growing number of cases as deliberative tools, particularly at the local level. In these forums, a group of around 100 citizens is selected by lottery, meaning they are randomly chosen, not self-selected or representing a specific interest group. This is a key feature they're not there to speak on behalf of any stakeholder organisation, but as members of the public. These forums have shown that random selection combined with informed deliberation can produce credible, well-reasoned input that goes beyond polarised or interest-based positions. I would recommend working this into the recommendations more explicitly.

Recommendation #8:
Facilitate and support the engagement of civil society organizations, incl. environmental NGOs in nuclear decision making.

- I'd like to address a major practical barrier that hasn't received enough attention: the lack of funding for environmental NGOs working on nuclear issues. This problem goes far beyond Central and Eastern Europe. So I would suggest:
- A recommendation to support NGO participation through dedicated, independent funding structures, especially in areas like radioactive waste governance.
- A call to private foundations and public funders to include nuclear issues within the scope of climate and energy debates. Right now, too many are simply afraid to engage, due to the polarised environment and the risk of being labelled politically.
- If the European Commission or any other body wants to engage broadly with civil society, they must avoid setting ideological or prescriptive conditions. Civil society participation must be open to critical voices and scientific uncertainty, not tied to pre-determined technological commitments.
- If we want environmental NGOs to be meaningfully involved, nationally and at the EU level, we must ensure that funding, inclusion, and independence are guaranteed, not constrained by political expectations or fixed visions.
- Local participation is also important during decommissioning.

ECONOMIC AND SOCIAL CONSIDERATIONS FOR THE FUTURE OF NUCLEAR ENERGY

2050 Here & Now Scenario Workshop

report from the ECOSENS panel discussion at the RICOMET conference in Tabloo, Belgium

authors

Marc Poumadere, Aylin Erden, Claire Mays – Institut SYMLOG de France

Funded by the European Union

2050 Here & Now Scenario Workshop

Report and Verbatim of the 29 August 2023 ECOSENS Stakeholder Workshop (Dessel, Belgium)

Marc POUMADERE
Aylin ERDEN
Claire MAYS
Institut SYMLOG de France

ECOSENS is a 3-year project (2022-2025) funded by the Euratom Research and Training Programme. It aims to create a neutral space where specialists in social sciences (including economics, sociology, social psychology, Science and Technology Studies, among others) and humanities and in nuclear energy research and policy will meet, exchange views and collaborate with civil society and other relevant stakeholders in order to:

- Provide a societal perspective on the development and use of existing and new nuclear technologies,
- Provide an assessment of nuclear energy sustainability considering the entire life cycle of the current nuclear technologies,
- Provide a radically new economic model, based on the System of Provision (SoP), for the assessment of nuclear energy.

As part of the first objective, a face-to-face stakeholder workshop was conducted on 29 August 2023 under **ECOSENS Task 1.4 - International workshop 2 (SYMLOG): Future scenario methodology to gauge the influence of disruptive climate change events on potential evolution in citizen energy choices.** The following report analyses outcomes in terms of narrative and ethical arguments, trade-offs and the place given to nuclear energy.

Table of contents

I. EXECUTIVE SUMMARY 2
1. CONCEPTUAL BACKGROUND AND REFERENCES 3
2. FORMAT OF THE SCENARIO WORKSHOP 4
3. WORKSHOP PARTICIPATION GUIDELINES 4
4. PARTICIPANTS 6
5. THE 2050 NEWSPAPER ARTICLES 6
6. OUTCOMES: « RADICAL IDEAS AND RECOMMENDATIONS » 10
7. DISCUSSION AND CONCLUSION 13
A. THEMATIC ANALYSIS 13
B. DISCUSSION OF ASSUMPTIONS 14
ANNEX I: Transcript of the Group Discussion 16
ANNEX 2: Participants' Evaluation and Feedback 40

I. EXECUTIVE SUMMARY

Most if not all decisions regarding climate and energy policy are taken in a group setting, be it at international, regional or national levels. Even individual behavioural habits regarding climate and energy are influenced by groups and networks such as family, friends, co-workers, education, activism, etc.

To integrate this social dimension into the ECOSENS project, the "2050 Here & Now" Workshop (Dessel, Belgium, 29 August 2023) organized a group discussion of stakeholders, structured with stimulus material (newspaper articles dated 2050) presenting a scenario of the climate and energy situation in 2050. The interactions between these three poles (stakeholders, stimulus material, climate impact scenario) generated insights about the influence of disruptive climate change events upon citizens' reasoning regarding the climate and energy choices.

This ECOSENS report presents the background and format of the workshop, the stimulus articles, and the general profile of the (anonymized) stakeholder participants. It details the "radical ideas and recommendations" they produced (without seeking consensus) as policy measures to meet the 2050 climate situation. After discussion and conclusions by the authors, Annex I contains the anonymized verbatim transcript of the 3-hour workshop, and Annex II presents the anonymous post-workshop evaluations.

1. CONCEPTUAL BACKGROUND AND REFERENCES

Most if not all decisions regarding climate and energy policy are taken in a group setting, be it at international, regional or national levels. Even individual behavioural habits regarding climate and energy are influenced by groups and networks such as family, friends, co-workers, education, activism, etc. Trying to integrate this social dimension into the ECOSENS project, the 2050 Here & Now Workshop organizes a) a group discussion of stakeholders, b) structured with stimulus material c) presenting a scenario of the climate and energy situation in 2050. The interactions between these three poles have the potential to generate insights about the influence of disruptive climate change events upon citizen's reasoning regarding the climate and energy choices.

Made familiar by the IPCC, the scenario methodology encompasses many varied options (Elsawah et al., 2020). The option chosen for the Here & Now scenario workshop for stakeholder involvement, rests in part upon previously developed scenario methodology, e.g. for sea level rise impacting a river delta (Poumadère et al., 2008) and for the management of coastal vulnerability (Poumadère et al., 2015).

For this workshop, we retained a single near-future (2050) scenario. In addition to its climate policy significance, this relatively close time distance is chosen to facilitate proximity of stakeholders to the recreated situation. Further realism is then sought by establishing, through the preparation of serious/quality newspaper articles, a vision of climate impacts in Europe and of global energy consumption in 2050. This vision presents a degraded but plausible situation as compared to today's already extreme weather events, and the trend projection of global energy consumption is based upon current expert analysis. Participants are asked to share and discuss their thoughts about the 2050 situation as depicted in the material, and to provide recommendations.

Providing these two newspaper articles dated 2050, presenting a likely and overall degraded future, targets a practical goal: group members have access to common and rich information content to fuel individual reasoning and group discussion, allowing them to explore ideas beyond generalities and not limited to pre-existing stances. The central underlying hypothesis is that the 2050 degraded situation will provide a stimulus to trigger radical ideas and recommendations.

This approach does not provide several future scenarios to choose among. It is different as well from citizen conventions for which participants receive extensive training by experts[1].

Group moderation for this workshop is based on principles of small group research (Levine et al., 2008). In contrast to the familiar focus-group approach, attention is given to both content and process, to open up a creative encounter between the worldviews of the participants or, as Montaigne (1533-1592) put it, "to rub and polish our brains against the

[1] An unexpected outcome of France's eight-month 2020 Citizens' Convention on Climate was the request by members of Parliament to receive as well a training by experts about climate change.

brains of others". Thus, moderating interventions are limited in order to let the participants manage their interactions and the task as much as possible, while nonetheless aiming for equality of expression within the group.

Elsawah, S., Hamilton, S. H., Jakeman, A. J., Rothman, D., Schweizer, V., Trutnevyte, E., ... & van Delden, H. (2020). Scenario processes for socio-environmental systems analysis of futures: a review of recent efforts and a salient research agenda for supporting decision making. *Science of the Total Environment*, *729*, 138393.

Levine, J. M., & Moreland, R. L. (2008). Small groups: An overview. *Small groups*, 17-26.

Poumadère, M., Mays, C., Pfeifle, G., & Vafeidis, A. T. (2008). Worst case scenario as stakeholder decision support: a 5-to 6-m sea level rise in the Rhone delta, France. *Climatic Change*, *91*(1-2), 123-143.

Poumadère, M., Bertoldo, R., Idier, D., Mallet, C., Oliveros, C., & Robin, M. (2015). Coastal vulnerabilities under the deliberation of stakeholders: The case of two French sandy beaches. *Ocean & Coastal Management, 105*, 166-176.

2. FORMAT OF THE SCENARIO WORKSHOP

The 2050 Here & Now Scenario Workshop was held on 29 August 2023, from 9:30 to 12:30, in Dessel, Belgium (at the Tabloo installation, as part of ECOSENS project events prior to the 2023 RICOMET conference).

After a welcome and introduction by ECOSENS project coordinator, the workshop was introduced by the two group moderators. Participants presented themselves in roundtable fashion. The two newspapers articles from the year 2050 (A3 format, see below) were then distributed to the participants. Following was group discussion of articles and fulfilment of the group task (described below) to generate recommendations.

The ECOSENS coordinator and two other researchers were present to observe the group activities. Their role was to act as resource persons and answer up to three questions the participants might have. At the close of the workshop the participants, group moderators, and resource persons debriefed together.

3. WORKSHOP PARTICIPATION GUIDELINES

The following setting was provided to the participants:

> You are a group of EU citizens invited to place yourselves in the year 2050 with the help of two serious newspaper articles from that year. One reports disruptive weather events and the other reports about the energy consumption and policy

making to combat climate change, along with controversies. Although it is difficult to predict the future, these articles aim at presenting a plausible 2050 scenario. [2]

Group task

As a 2050 group of citizens mandated by the European Commission, considering the climate situation in 2050 as documented in the newspaper articles, and taking into account your own thinking, which recommendations can you formulate to the attention of the European Commission?

For this task, the group can proceed as it wishes. After a first reading of the articles, you may wish to share the content each participant finds relevant for discussion to generate recommendations. There is time to go back and forth between discussion of the articles and progression on the task.

We suggest that participants pay attention as well to the group dynamic and to facilitating input by each person. The group can also discuss if they aim at reaching consensus or a simple majority, if minority points of views are mentioned in the recommendations, etc.

Resource persons

Three ECOSENS researchers are present in the room. They do not participate directly in the group discussions but will answer up to 3 questions asked by the group about content they need to know, e.g. what happened in terms of climate policy between 2023 and 2050. Each question is given in a written form to allow the three experts to provide an answer. They will participate in the debriefing and will share their insights.

Moderators

Two ECOSENS researchers have prepared this workshop design and materials and are moderators of the group work. They present the workshop program and can answer questions. However, once the group task has started, interactions are principally between participants. Moderators can comment on the content or process of the group work, but it is the participants' analysis and final output that counts.

As agreed at the registration step with participants, the groups session is recorded. As explained in the consent form, content may be quoted in the final ECOSENS report but who said it will remain anonymous. The same rule applies to comments shared after the meeting.

Debriefing and other steps after the group work

- Debriefing session, with priority given to participants: What are your feelings at the end of this group work? Which moments from the group interactions do you recall particularly? What do you think about this 2050 workshop methodology? etc.

[2] The participants were also informed in writing that *all rights have been paid to Canva Pro Licensing for the photos included in the 2050 articles.*

Participants, experts, moderators leave behind their formal roles and can exchange together freely. This step is required because the workshop voluntarily immerses participants into the bad news of the 2050 scenario. As Seneca explained, “A mind preoccupied with the future is unhappy” (*Calamitosus est animus futuri anxius*); the debriefing gives the possibility to share experienced emotions.

- Follow-up one week after the meeting: participants back home who wish to share additional thinking can send it by email to the moderators (content from this step will be integrated, the rule of anonymity applies as well).
- Workshop outcome: The moderators’ report will be sent to participants for validation and comments will be integrated as well and anonymously.

4. PARTICIPANTS

The workshop welcomed 13 stakeholder participants from 8 countries (6 EU Member States, 1 non-EU European country, and 1 South Asian country). Gender balance was achieved (5 women:8 men; ECOSENS researchers were balanced at 3:2). Ages were smoothly ranged from masters’ student level through early and mid-career to retirement. Organizations included municipalities, civil society organizations, a consultancy, universities, and research centers. Professional expertise included physical and environmental sciences, policy and modeling, political science, psychology, management and economics.

5. THE 2050 NEWSPAPER ARTICLES

Two newspapers articles dated 29 August 2050 were created specifically for the workshop:

- Article A, from the journal *Europe Today*, is entitled: “2050: Annus Calamitatum; Relentless extreme weather events drive unprecedented multi-crisis in Europe”.
- Article B, from the journal *Eco-Politics Digest Europe,* is entitled: “The never-ending transition?”.

Both articles mimic serious journalistic style, with interviews and pictures. For distribution to group participants during the workshop, the articles were printed in A3 format (29,7 x 42 cm) which provides a print surface accommodating a fair amount of content in easily legible font.

The two articles were carefully elaborated by the researchers in July-August 2023 using numerous publications freely available at that time.

Article A “**2050: Annus Calamitatum; Relentless extreme weather events drive unprecedented multi-crisis in Europe”** provides a thorough overview of extreme weather

events that have taken place in the year 2050[3], with specific descriptions of the consequences, such as of low-lying areas impacted by sea level rise, mega-fires generating destruction as well as respiratory health crisis, heat waves causing the death of 142,000 persons in Europe (the double compared to 2003 fatalities), floods drowning people and putting other victims in search of housing, etc. The gravity and coincidence of these events undermines the capacity of international cooperation and solidarity, e.g. for firefighters, and overwhelmed insurers refuse coverage. At the end of the article, the journalist asks: "Will we finally take the warning: unite to redouble our efforts to combat climate change, or simply suffer the consequences?" This message, hardly subliminal, provides a logical link with article B.

Article B "The never-ending transition?" focuses upon the status of the worldwide Green Transition. A clear and striking figure occupies the center of the page: world primary energy consumption by source, from 2020 to 2050. This figure is in fact based on one generated in 2021 by the U.S. Energy Information Administration, reproduced in the IEA *International Energy Outlook 2021*. It is based upon a trend analysis to forecast future consumption worldwide. While there exist several energy scenarios for the future, and many figures, applied to various regions (e.g. Europe, OECD vs. non-OECD countries, etc.), we chose this figure for its simplicity and plausibility, and also to highlight the global dimension of CO_2. This figure shows roughly that in the thirty years between 2020 and 2050, global consumption clearly increases, the use of fossil fuels and nuclear remains stable, and the share of renewables doubles (and covers most of the consumption increase). Throughout the article, IPCC mitigation options and impediments to their achievement are recalled: behavioural habits against sobriety, an ongoing pro-and anti-nuclear debate, slow development of carbon capture and storage (CCS), limits of and opposition to renewables, etc. The lack of worldwide energy coordination is contrasted with the remarkable scientific cooperation achieved by IPCC.

[The two articles, distributed in A3 format, are reproduced below as illustrations; contact mpoumadere@orange.fr to request PDF files for use in future events.]

[3] Of note: the article, intended to present a degraded climate characterized by an unprecedented volume of extreme weather events, was developed at the start of Summer 2023. In fact, this contemporary season itself proved to be severely marked by such extreme events (as several participants remarked during the group discussion).

A

Europe Today

29 August 2050

2050: ANNUS CALAMITATUM

Relentless extreme weather events drive unprecedented multi-crisis in Europe

By our reporter in Lisbon, Maria Laura Fernandes

2050 was to be a milestone in the Net Zero carbon emissions journey. But in 30 years of Europe's Green Transition, global temperatures have kept rising. Instead of celebrating achievements, the continent staggered under natural disasters – after decades of "never before" calamity. In these past ten years, the territory of low-lying countries has risked dramatic shrinkage under sea level rise, and all coastal areas experienced submersion and erosion. Hurricanes devastated communities across the continent. Mega-fires produced a public respiratory health crisis that still has not been recovered, and the Seven-Year Drought severely distressed the agricultural, energy, and industrial sectors. "These are anthropogenic events – human-made, not natural. All doubt on that subject is gone. These crises are due to human-made climate change," said Susana Fresa, chair of the Intergovernmental Panel on Climate Change (IPCC).

The worst-ever back-to-back extreme weather events fueled by chaotic climate systems have generated a multi-crisis in Europe. The Belgian Minister of the Interior called 2050 "Annus Calamitatum," the year of complete calamity: "The combined events to date form the greatest disaster Europe has ever known."

The European Environmental Agency estimates unprecedented economic loss due to climate impacts totaling EUR 105.3 billion in 2050 alone, doubling the baseline 2021 costs. Across the continent, 142,000 people have died this summer in heatwaves under record-breaking urban temperatures, with millions unable to access cooling from overburdened power grids. Wildfires blanketing Southern Europe and the Balkans drove 100,000 to flee. Extreme rainfall in seven EU states forced over two million to evacuate; major floods together killed 827, the highest toll since 2041. Wind bursts, tornados, heat domes, sea level rise: exhaustingly familiar phenomena that keep the attention constantly on our environment.

"Each weather event alone would be disruptive but manageable – Europe can deal with calamity, especially heatwaves since the first modern shock in 2003. But the sheer magnitude and number of disasters overwhelm us. Under severe climate change Europe is in a total storm; everything comes at once," explains Helena Kovaříková, European Commissioner for the Environment. The disasters cascading across the continent this year expose a harsh reality: *Europe is unable to protect populations from extreme weather in our +1.7°C world*. Despite emergency plans, governments know they cannot prevent deaths.



Destructive mega-fires across Europe are charging the atmosphere with carbon. ©KenRinger via Getty Images

2050 wildfire season worst on EU record

The EU experienced its worst wildfire season since 2042 according to Copernicus European Forest Fire Information System (EFFIS). Extreme temperatures sparked over 100 fires extending across Portugal, Spain, Greece, Romania, Bosnia and Herzegovina, and France. The total burnt area reached over 20,000 sq km, almost exceeding the size of Slovenia.

Kim Shian of France's National Center for Meteorological Research states: "The combination of the 7-Year Drought followed by an abnormally wet season and equally abnormal heatwave – all attributable to climate change –reinforced the vulnerability of the Mediterranean basin and part of the Balkans. They are simply a tinder box. We've made monumental mitigation efforts since the 2020s, but the number of wildfires occurring simultaneously makes it impossible to cope as we used to. The resources to fight fires, to reforest and to rebuild after them have long worn thin."

Wildfire-fighting troops and water-carrying aircraft were ready in April, in a trend to early preparation fitting the increasingly precocious annual wave of fire. In Greece, after the death or medical departure of much of the professional corps, the bitter experience culminated this year in forced conscription of youth to battle flames. "This is not what I wanted for my daughter," mourns Athina Bombalis as the helmeted young masters' student sprints with heavy breathing equipment into the training line-up with her university cohort.



Firefighters are on constant duty. ©Cristian Martin via Getty Images

International aid is in short supply as North American countries struggle with their own mega-fires once again burning millions of acres of land and sending toxic smoke across the Atlantic.

Carbon emissions from wildfires reached their highest levels since 2043, which scientists say will make keeping temperatures under 4 degrees by 2100 unlikely. "We are seeing these extreme events at +1.7°C today. There will only be worse to come if we don't eliminate greenhouse gasses – human-made or otherwise – entering the atmosphere," says Shian.

Halfway to boiling: Paris experiences 50-degree days during heatwave across Europe

Not long ago, a temperature of 50°C was considered an anomaly, confined to the Gulf states and occasionally Southern Italy or Andalusia. However, the relentless march of global warming has brought this once-extreme heat to the heart of Europe. While the continent experiences warming at a faster rate than the global average, the dreaded 50-degree mark had remained unbreached in most major northern cities until this summer.

The city of Paris endured once again, as it does each year, the "hottest July ever recorded" as temperatures soared to an infernal 50.2°C. Hospitals valiantly struggled despite frequent load-shedding electrical blackouts to care for thousands of emergency patients suffering from heat-related illnesses.

Significant mitigation work has transformed the urban setting. In Paris, trees and native plants replace asphalt. Vertical greenery climbs to the once-iconic zinc rooftops now painted white or replaced by solar panels. Only bicycles, trams, and electric taxis and ambulances circulate during heat emergencies. All day long, cooled and dark collective siesta rooms in the basement of every office building offer respite to company and outdoor workers alike. Yet, across the continent many such measures have not been fully implemented due to political and social turmoil. When regulations appear constraining, controversy breaks out over concerns for individual freedoms and drags on economic growth.

Not only humans are affected, of course. In Lisbon, Ines Sofia Pinto dos Santos, co-founder of the Lusitanian Raw Vegetarians Guild, whose city-wide shared meals were suspended when July temperatures forced members to stay inside, looks sadly at the quiet dog at her feet. "Her paws were blistered by the heat still radiating from black cobblestones after sunset." The World Wildlife Fund reports that intensified temperatures and volatile weather this year strained endangered species, leading to a domino effect of ecosystem extinctions, making the general biodiversity decline almost inevitable. Already 13% of Earth's animal and plant populations are gone. This rate is expected to surge to 27% by 2100 if land use policies and fossil fuel uses continue to push the same global temperature trend.



Heat domes smother the cities. ©coffeekai via Getty Images



Despairing flood victims feel they have no rebuild options. ©modovisible via Canva.com

Hundreds dead and millions evacuated after raging floods strike Western Europe

"This was where I grew up," says 67-year-old Nikola, sitting on a muddy mound littered with broken trees and building debris. Incredibly heavy rains have caused the most devastating floods in Czech history, killing 265 people and causing EUR 35 billion in losses - including tourism losses since Czechia, like Scandinavia and the Baltic states, became a primary holiday destination after Southern Europe became too hot in the 2030s.

The "wild water" of the Vltava surged over its banks inundating much of Prague, which was without electricity. 70,000 people were evacuated. Smaller villages like Nikola's were essentially wiped off the map as flood gates failed to stop torrential waters.

As the oldest citizen in his village, born in 1983, Nikola has a long memory. "Extreme storms are nothing new, so why are these floods still destroying our lives? The politicians must act and at last take responsibility for the root causes!"

Nikola's anger resonated beyond the Czech borders as massive floods swept through southern Bohemia and into Germany. Over 50,000 people were evacuated, compounding the dire situation in The Netherlands, Belgium, Luxembourg, Italy, Austria, and France. There, severe flooding earlier this year killed 572 people and displaced 200,000. The damage to infrastructure included soil erosion severely impacting the agricultural sector.

In Clermont-Ferrand in central France, aid workers were overwhelmed with treating people like Emma Lambert and her 7-year-old son who both contracted cholera after drinking contaminated water. "We've got infectious and waterborne diseases unusual for Europe - and a massive demand for bottled water and medicines to be managed. It's totally disruptive," observes Isabel Causanel, Oxfam's Water, Sanitation and Hygiene coordinator, adding that "Hotter weather this year extended the tiger mosquito habitat, bringing north the chikungunya virus."

Proactive flood protections are old news but scientists say the difference is climate change: "At current global temperatures, the amount of water that can be stored in the atmosphere, and the probability of it being released in almost a single violent event, have increased precipitously with every tenth of a degree since 2021" explains Charlotte Kaufmann of the Potsdam Institute for Climate Impact Research.

The amount of rain that fell between 13 and 15 July would be expected only once in 200 years. Under climate change downpours occur frequently, overstressing even retrofitted flood controls. The Netherlands has a strong dam protection culture, but inhabitants like Jan van Doorn say "Enough, no more higher dams, we prefer to move away and settle somewhere else in Europe – if anywhere is safe!"

As floods and flames strike more frequently, insurers increase their premiums or refuse coverage, causing many like Nikola and Jan to question whether they can afford to rebuild or to resettle. European solidarity plans are almost emptied of cash.

"What will we do? My son here doesn't know if he can or even wants to build another home. Our family can't go through this again, but where do we go now? Everywhere is flooded," says Nikola, breaking down.

As global temperatures continue to rise, citizens around Europe will go on facing increasingly extreme weather events. The devastating tolls of the record-breaking wildfires, heatwaves and floods sweeping across the continent in this "Annus Calamitatum" will undoubtedly be etched into the history books. Will we finally take the warning: unite to redouble our efforts to combat climate change, or simply suffer the consequences?

ECOSENS

B

Eco-Politics Digest Europe

The never-ending transition?

By our editorialist Aryn Leiden – Antwerp, 29 August 2050

The worldwide Green Transition has reshaped energy supply, the economic landscape, and the behavior of business and consumers alike. However, the 30-year transition faces mounting challenges: surging energy demand, energy market pressures, climate shocks damaging global energy infrastructure, and prolonged societal unrest. Despite the calls by the International Panel on Climate Change (IPCC) for a radical sufficiency outlook, overconsumption remains strong. Will our collective efforts be enough? At this point we can ask: Will the transition ever end?

Renewables still haven't triumphed over fossil fuels

The global energy portfolio has evolved the most. Renewables consumption doubled between 2020 and 2050, nearly matching the level of liquid fossil fuels use. In Europe, wind and solar now supply over 60% while nuclear energy slightly progressed at 9%. Nonetheless this year's weather shocks have affected clean energy investments worldwide. These are no longer scaling at the pace needed to avoid price volatility, which has directed investment to oil and gas, and reinforced coal use in developing countries. Producer nations, led by the USA, claim that fossil fuel revenues are essential to finance the Green Transition.

Humanity has not yet abandoned fossil fuels, despite summit agreements since the 2030s. Fossil consumption remains stubbornly present, even if it dropped from 80% in 2022 to approximately 60% today (see our graph). Energy demand continues to rise. Under climate change and global population growth 7 billion people now need cooling, with 90% of the increase found in emerging markets and developing economies.

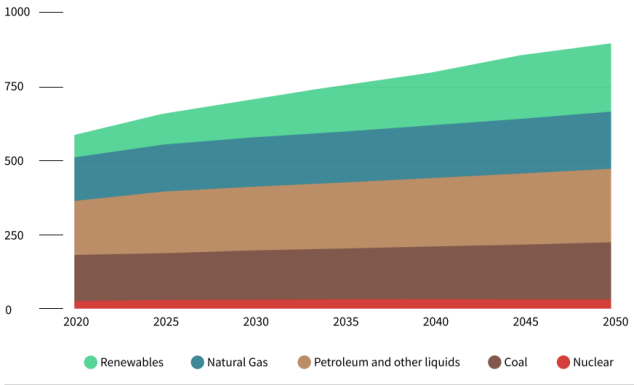
Keeping it in the ground?

The news is not all bad. In Europe's buildings, improved energy efficiency and passive cooling have cut residential energy demand in half. Faster deployment of renewables technology in developing countries, as well as 20 years of technoscientific innovation delivering solutions like carbon capture and storage (CCS), have contributed 11% of cumulative emissions reduction.

Going forward, about 7 gigatons of carbon dioxide will need to be captured annually – the equivalent of the 2020 power sector emissions from Europe, China and India combined. For over 30 years the IPCC has recommended CCS to reduce atmospheric CO2 by capturing it at the industrial source or directly from the air and storing it underground. Yet although geological storage has been widely used for natural gas since the 20th century, development of CCS has been illogically slow. Along with cost issues, there is continued suspicion that CCS is a Trojan horse for oil companies to encourage fossils production and consumption.

Our current trajectory would limit global average temperature rise to +2.6°C by 2100, an improvement to previous projections but still a precarious path. France's Ministry of Ecological Transition maintains its climate change adaption plan for a +4°C average future, as Europe continues to heat up faster than the rest of the world and many nations fail to deliver on Green Transition targets.

Climate activist Daria Djordjevic said, "There is no room for the current reliance on fossil fuels. We've long passed the carbon budget for +1.5°C, and yet we still add nearly 43 gigatons of carbon to the atmosphere annually, up 80% from 2020 levels. It's reckless to bet solely on CCS to save us, or to envision adapting to a +4°C world. In that scenario, crops will die, ecosystems will collapse, and extinction cascades will occur – not to mention continued catastrophes affecting the human habitat. Fossil fuel dependency will all but ensure the end of Europe as we know it."



This graph produced in 2021 proved widely correct in its prediction of world energy consumption by source. Fossil fuels consumption has remained unchanged at a high level and nuclear has remained low while renewable energy has risen to meet the overall increase in global energy needs. If relevant decisions are not taken now, this trend will continue along the same lines until 2100.

Sufficiency faces contradictions and pushback

The May 2050 Eurobarometer poll shows 96% of European citizens are deeply concerned about climate impacts, while 79% overall are angry at perceived government inaction. The EU-wide "Climate Anguish March" is now held monthly, rather than yearly, in 700 localities. Courtroom litigation too grows year-by-year since the 2038 landmark case when the European Court of Human Rights said more ambitious climate action is an ethical obligation for all 46 states of the Council of Europe.

Some European Parlementarians call for radical sufficiency measures. This year's most significant proposal was the Carbon Pass Law, a cap-and-trade system that would require all EU citizens to track individual carbon-intensive activities in diet, transportation, energy use, and non-essential consumption. Some economists in favor of the law, like Bernd Heinemann, claim direct behavioral mandates are needed. "The Green Transition is more than just maximizing renewables, incentives and nudges. It's true behavioral change involving all of us. If governments finally say, 'no more gas heating or shopping sprees', change will happen."

The initiative, however, failed to pass in Strasbourg earlier this year. Lobbyists and civil society backed away from the proposal, arguing that a carbon quota should apply only to the wealthiest 1%, or that the Carbon Pass would invade people's privacy and cripple freedom of choice. Some argue that fossil fuels aren't the main source of greenhouse gasses: EU wildfires in 2050 have released more than half a billion tons of CO2, methane and nitrous oxide, equivalent to the annual CO2 emissions of Germany, Europe's number one emitter.

MEP Carmen Ruiz Beltran, a co-author of the Carbon Pass bill, comes from Spain where the pilot app "MiCarboBajo" is already widely used. She said "The failure of our bill shows Member states are still controlled by the rich and by the fossil fuel industry. Here we are in unprecedented ecological crisis and society has never been more polarized. Every side is accusing one another of radicality, and lobbyists are pouring oil on the fire. It's hard to see how [Europeans] can reconcile our differences long enough to push forward the sufficiency measures necessary to fight climate change."

Social unrest and strikes, with episodes of violence, have affected countries such as France. All over Europe, local councilors and mayors are resigning, unable to carry out an impossible mission: on the one hand, they are prosecuted for climate inaction, on the other, they are accused of violating individual consumer rights. European democracy has reached its limits before creating true consensus on the Green Transition.

Mind the gap

The gap between climate awareness and accepting behavioral policies remains large. Over half of Europeans (57%) are unwilling to further reduce their level of comfort, entirely give up meat or certain luxuries like air travel; 31% also stated to Eurobarometer that any needed change should target industry or major consumers rather than regular citizens. Lewis Kurt, professor of social psychology at Berlin's Humboldt University, explained: "People may sincerely wish to do good for the climate, but some of their individual values and behavioral habits, along with cultural norms, may work against that wish. Additionally, eco-anxiety can lead to feelings of powerlessness. We must support people to take part in a collective form of action without being overwhelmed."

Kurt points to the historical success of the old EU directive to Member states to roll out electricity smart meters to 80% of consumers by 2020. Although several states requested delay, and some citizens rejected new connected technology in their home, the goals were achieved: households have quick, direct access to monitor their electricity consumption. Whenever electricity prices have risen during the Green Transition, households are consciously able to reduce their consumption, keeping down their energy bill and contributing to global sufficiency.

Cooperation and controversy

Beyond behavior, conceptual divisions slow the Green Transition. Europe's hundred-year-old pro- and anti-nuclear debate remains lively, holding back the scaling of large nuclear reactors as well as the broad deployment of Small Modular Reactors (SMRs). An alternative to the old coal-fired plants, SMRs can flexibly provide district heating, desalination, process heat for energy-intensive industries, and production of hydrogen fuel. Analyst Pip Bloch of the Energy Now thinktank states that a vast rapid newbuild program is needed for nuclear to be a genuine climate mitigation option, per the IPCC's recommendation. "It'd have to be similar to the French government's 1974 'all-nuclear' decision after the first oil shock. France built up nuclear supply to 75% within a decade. Today we'd need a joint determination by nations and operators to install standardized nuclear power plants all over the planet – something even Europe alone couldn't achieve in the past half century."

The lack of worldwide energy coordination contrasts with the remarkable transnational scientific cooperation achieved by the IPCC. Direct criticism of IPCC reports and recommendations is scarce. Nonetheless, opposition to nuclear or to CCS remains present in several EU states, and communities continue to struggle against proposed installations such as wind turbines even placed far offshore. Europeans behave as if they could pick and choose among the most convenient IPCC options to tackle climate change. In fact, every one of these mitigation measures must be implemented – yet there is still no unified agreement on that simple truth. Without national and regional political cohesion, we are missing a virtuous example that could also inspire EU citizens in their own individual engagement.

The lifetime of every European under 33 has been spent in transition, yet success remains uncertain. The Green Transition is testimony to human resilience and determination. We have seen the value of cooperation and positive feedback loops, as well as the setbacks of denial, individualism, and conflicting strategies. Going forward on our increasingly narrow ledge we may ask: Will the Green Transition bring us to destination, or will it remain an eternal journey?

6. OUTCOMES: « RADICAL IDEAS AND RECOMMENDATIONS »

These radical ideas and recommendations were generated during the last part of the group discussion. They are recorded below in the chronological order of their presentation by group members, with a short explanation of the discussion context. While certain ideas were discussed in some detail (i.e. regarding smart water meters or the child policy), there was no formally established unanimity or consensus on any of the ideas generated during this phase of group work.

1. **Smart water meters (on the industry level) — working with a cap-and-trade system with the caveat that it combats inequalities.**

The first recommendation about smart water meters on the industrial level has to do with creating a cap-and-trade system for water because water is quite a scarce resource in 2050. It was added on later that the cap-and-trade system for water and keeping track of water through the use of smart water meters would only be acceptable if the cap and trade was enacted only on the industrial level and also addressed at the minimum didn't exacerbate inequalities.

2. **Have the EU take the lead in making fossil fuel production illegal.**

This recommendation followed a discussion about oil consumption analyzed as an addiction. This analogy led to this second recommendation.

3. **Degrowth policy and well-being.**

This recommendation has to do with rethinking the European Union's and national ambitions of economic growth centered around GDP and ensuring that there was a replacement of a GDP-lead economy with an economy that was more focused on well-being and degrowth and less consumption. This was intentionally left very broad.

4. **Two child policy.**

The fourth recommendation one is very much like the China one child policy. This would be a population ceiling for couples wanting to have children. There was no explanation on how it would be enforced, besides resulting from education, and it was rather unpopular.

5. **Improve lobbying transparency at the European Union level.**

This recommendation was to ensure that big oil and mining and industry interests we're not getting in the way of creating robust green transition policies.

6. **Sortition body or citizens' assembly at the supernational level.**

The goal is essentially to pick citizens at random and create an independent body that would be completely dedicated to environmental policy and which would advise the European Commission in creating pathways or expediting policy concerning the environment.

7. **Broad deployment of SMRs.**

This deployment goes along the creation of a regulatory framework for small modular reactors at the international level. Nuclear will replace fossil fuel production of electricity.

8. **Reduction of food waste, clothing waste and waste in general.**

This recommendation was the acknowledgement that behavioral changes were needed to reduce consumption and overconsumption culture. Change the consumption culture through campaigns (analogy with non-smoking campaigns) and create subsidiaries to support positive choices

9. **Eco-dictatorship.**

The participants discussed the idea of having a climate Tzar or an Eco dictator where one person from a group of what they called industry Titans or captains of industry would rule for four years without democratic systems restraining them so they could execute climate policy more efficiently.

10. **Creation of taxonomy parameters for defining sustainability.**

The recommendation is to put more resources into defining sustainability through life cycle assessments and ensuring that materials and energy systems like nuclear are indeed considered “sustainable/durable”

11. **Immediately net zero and replacing any fossil fuels in the energy portfolio with nuclear energy production.**

This recommendation complements the previous idea about making fossil fuel production illegal.

12. **Prohibit the use of fossil fuels for common sense items.**

This recommendation uses as an example flights that are less than 200 kilometers.

13. **Production of electricity by renewables.**

Any and all electricity should be produced by renewables. Any system built before 2030 should be linked up to renewable energy sources if it is not already.

14. **Create climate maps of Europe.**

This recommendation is about creating maps of Europe using climate forecasts that would inform which places were particularly vulnerable to climate shocks and identifying less climate affected places, e.g. for climate refugees to settle to.

15. **Build a time machine.**

This recommendation might reflect concerns of participants considering that actions in 2050 were too little too late.

16. Further develop all technologies.

From discussions about the positive role of technology to combat climate change, this recommendation is about developing all such technologies (such as carbon capture, SMRs) and nuclear was targeted at completely getting rid of fossil fuel use from the energy portfolio.

17. Radical conceptual map of Europe 2100.

This recommendation is about creating a map based on climate forecasting, not much unlike the 2050 Here and Now workshop, that would provoke decision makers to consider policies based on climate realities in the year 2100.

18. Create independent/decentralized energy initiatives.

This recommendation was targeted at local city regional and national level energy initiatives so that it would complement EU wide and global energy actions to ensure the energy transition initiatives were better supported.

7. DISCUSSION AND CONCLUSION

Participants were given, through two credible “newspaper articles” created for the occasion, a 2050 scenario presenting a degraded climate situation in the EU, and a vision of the global energy consumption with a still high and dangerous share of fossil fuels. In short, according to these scenario elements, things look bad in 2050 both for weather events and for low-carbon energy. This scenario aimed at being plausible and realistic. The 13 participants were engaged to imagine themselves in this 2050 situation and, through group discussions, to generate radical ideas and recommendations. This approach opens a window onto reasoning about climate and energy in the context of group interactions.

A. THEMATIC ANALYSIS

Presented in the chronological order of their presentation by group members, each radical idea and recommendation (RAR) comes from points raised during the group discussion, as participants tried to move away from the slow pace of previous climate and energy policy that led to the 2050 situation. These RAR and their related framings can be subsumed under several themes which sometimes overlap: Governance, Energy, Technology, Consumption, Adaptation and anticipation, Care and ethics.

Governance was discussed about the relationship between science and policy, and appears in RAR 5 about the need to control lobbying of oil, mining, industry at the EU level; in RAR6 with randomly picked citizens to create an independent advisory body; in RAR9 from the discussion that democratic decision making is slow, the ECO-dictatorship option is formulated; in RAR18 to create local energy initiatives to complement global energy actions and to ensure better support of energy transition initiatives; and possible in RAR 15 about building a time machine. Empowerment of citizens appeared at different moments of the discussion.

Energy was an object of group discussion under many facets, which appears in RAR2 about making fossil fuel illegal, from a reasoning by analogy about addiction; RAR12 suggests a prohibition of the use of fossil fuels only for specific use; RAR13 is about producing all electricity by renewables while RAR7 and RAR 11 suggest that nuclear will replace fossil fuel production of electricity.

Technology overlaps often with energy, but is specifically mentioned to be developed in RAR16 for its role to combat climate change, with examples such as CCS and SMRs; it is as well understood in RAR10 about creating taxonomy parameters to ensure that materials and energy systems are sustainable.

Consumption control or limitation is present in RAR1 with a cap and trade system for water – for industry and with care about social inequalities; in RAR3 reflecting discussion of how to the Good Life so as to orient decisions about climate change; in the two-child policy of RAR4 which raised many reserves; in RAR8 calling for a reduction of waste, and the need to prompt behavioural change towards a different consumption culture (through campaigns like those against smoking).

Adaptation and forecast are brought with RAR14 about creating maps of Europe for climate refugees to settle to when their living area becomes improper; similarly, RAR17 is about a radical conceptual map of Europe 2100, like the 2050 Here & Now Workshop, to provoke decision makers.

Care and ethics concerns appeared at various moments of the discussion and are transversal to many recommendations. Concern for inequalities in RAR1; RAR3 puts well-being at the starting point of analysis; the two-child policy of RAR4 was controversial for the human and ethical problems it raised; RAR8 reduction of waste should involve a change of consumption culture; discussion of RAR9 pointed that dictator-like politicians are not very engaged in climate action, on the contrary; the analogy of our dependency to overconsumption through tobacco (RAR8) or to illegal drugs (RAR2) insists on our addiction, suggesting that our individual decisions are not completely under control or autonomous. The need for solidarity with the whole world was mentioned, as was the fact that having children changes the way we look to the future. The attention paid by participants to the human dimension in climate-related decisions was underlined by a resource person at the debriefing and commented as well by a participant in the post workshop feedback.

Participants accomplished a lot of work given the complexity of the scenario situation and the short amount of time. A single session is probably insufficient to consider all thoughts and (radical) ideas, and a reconvened session would have been appropriate. This would allow a) to fully integrate post workshop thoughts and comments and b) the list of radical ideas and recommendations, presented in a chronological order, could be ranked by level of agreement, which would require search for consensus through compromise, and maybe reach unanimity in some cases (although not all).

B. DISCUSSION OF ASSUMPTIONS

Concerning the role played by the future context created for this workshop, results are mixed. We held as a central hypothesis that the 2050 degraded situation, as depicted by the newspaper articles given to participants, would increase awareness of the emergency posed by the climate crisis and stimulate radical ideas and recommendations. Although participants had varied reception of this future bad news, a shared attitude indicated a lack of surprise as compared to today's situation. In terms of global energy consumption, the stability of fossil fuels (at today's relatively high level) and nuclear power (at today's relatively low level) did not really create a surprise, although this means a dangerous continuity in terms of CO_2 emissions. In other words, the 2050 climate situation presented in the scenario did not really come as a shock. Besides the goal to present a plausible future, one of the explanations that would need to be further explored, is that the calamities described (in Europe) are occurring at regional level, or even globally (in the case of maintenance of high fossil fuel consumption), which might make it difficult to relate to such a large scale. In fact, during previous workshops presenting sea-level rise scenarios to stakeholders from vulnerable coastal or delta local communities, portrayed future impacts were felt all the more keenly as the places affected were familiar and the object of an attachment. Hence the motivated commitment of participants to drawing up recommendations applying to the place where they live.

The other level of hypothesis, a corollary of the previous one, concerns the functioning of the group and its ability to consider and discuss radical ideas as required in 2050 given the worsening climate situation. By definition, such ideas are divisive and have the potential to generate polarizations in a group. This did not happen as the group was essentially cooperative and sensitive to a wide area of expression (e.g. technology, inequalities, emotions). We can see here an indirect awareness of the gravity of the climate situation depicted in the 2050 scenario, encouraging the participants to unite despite their numerous differences. Rather than insisting on being right, participants were open to other points of view. While this unity operated during the workshop, some participants did request clarification and differentiation afterwards during individual evaluations (of which some are clearly negative) and other feedback (e.g. emphasizing that the recommendations are radical ideas for which there was no formal unanimity; suspicion of manipulation of the workshop by industry). A possible conclusion can be that the scenario workshop had the capacity to temporarily unite stakeholders who avoided division as they tackled climate change within a structured task framework.

ANNEX I: Transcript of the Group Discussion

This annex is devoted to the verbatim transcript of the group discussion. Contributions by group participants are anonymized as agreed. A carriage return indicates that a different person is talking.

Participating researchers from ECOSENS acting as resource persons are identified by their first name (and additionally by GM for group moderators; in blue). Numbers in green indicate elapsed time (hours:minutes).

After the introductive steps below, group discussion unfolds. It is followed by a debriefing period and by exchanges with the resource persons.

Introductive steps:

00:00

Welcoming of participants and presentation of ECOSENS by Daniela, the research project coordinator

Introduction of the workshop by the group moderators (GM) and reminder of the process and guidelines (already communicated by documents)

Participants introduce themselves.

Exchanges between participants about their affiliations and activities.

GM distribute the agenda with guidelines for the group work.

Discussions about speaking loudly enough for all group members and resource persons to hear and for recording purposes.

GM distribute the two 2050 newspaper articles and recall the group task. Reading time: 10-15 min.

Group discussion:

00:20

When I read the articles, they are clearly different. So, article A is more about the need for adaptation while article B is more about climate mitigation. I did have a lot of questions when reading it. Like what is the power level of the EU? Did more competence develop on the EU level? Also, what is the population level? Are we assuming there will be the same amount of people in Europe in 2050?

GM Aylin. You can have that as a question to our resource people. You have only three questions. [To all:] If you think that this issue is important, you can agree with [participant's] idea and write the question in a form that we will give to the resource person and they will give you an answer.

Then we'll keep it maybe for later. But I have to be honest on the adaptation level. Personally, I don't have much idea or I can't say that much because dive in for the B part. Yeah, I think it's almost very easy but maybe I'll keep any suggestions for later. Maybe someone else wants to tell us what they think?

I have a bit different opinion: if you read all these things, they are written often in the media nowadays but a lot of dramas will happen in the future. That's the conclusion. But what can we do as scientists? If you see the discussion on climate change, you see the need for new techniques and whatever, new construction methodology and whatever. But the basis to me, I think as scientists we need to think about the basis and the basis is what is durable? So, people are thinking about durable energy sources, but what is durable? You see fossil, nuclear, renewable and so on but there are different reports that have been prepared by the European Commission. So the JRC report did a very good report, but still the discussion is existing. Now take the example of transport, the batteries for electric cars.

Is what's happening durable? So, I think it's not known whether it's durable or not. People can say it's not durable because you devastate natural environment and so on. So, I think the science needs to come up with an accepted system or methodology for discussing on durability taxonomy, taxonomy for energy systems. To me that's the basis on which science can contribute. On the other hand, you have politics, you have the media, whatever, they do their own job. We as scientists can influence, of course, but we need to provide an 17cepted methodology. That would be my view.

But how to convince the politicians, yeah...

That's the other thing, but we can't.

Do ourselves you know, you have a lot of scientists in agreement but the politics is not following.

Yeah, but even about maybe it's a how scientists define, let's say, sustainability of electric vehicle transport? Is there consensus? I don't know. I would say no, but I'm not sure. But it's very questionable. I think it's an illusion to separate politics from science.

I agree.

So, I think if scientists accept a sustainability assessment method, they are making value choices. So yeah, this is like an image, the separation of science and politics that's a discussion that has been going on for I don't know, for 70 plus years. It's not going to happen. So, it's intermeshed.

You shouldn't wait for scientists to come up with one single definition of sustainability because it will always be contested.

[*two participants being addressed*], You give advices to companies, you give also advices to the government.

If I can add, you can see that with the small modular reactors. The European Commission is investing a lot for scientific research to be done in that realm and the fact that now nuclear energy is part of the renewables category. So, I think we can see progress.

But I would say if our job as scientists is precisely to find consensus, that's the basis of science in my opinion.

Basis of science, scientific discussion, I agree. But in my career, I've seen lot of projects which were being commissioned and there was scientific problem. So then what people do, they try to come up with consensus. That's what you have to try to do. If it doesn't work, then bad luck. At least you have to try. I think as a scientist you have to be open where the discussion is and then the politicians should take their responsibility. But what politicians like is shifting the responsibility to the scientists to come up with the answer.

I think there's enough science in these articles to convince everyone that something has to be done. I don't know. We need a lot of more science now discussion on sustainability and energy because it will always change. 100 years ago, coal was sustainable because it was thought of as an everlasting source of energy. So, this will always change. I think the only thing we can do if we really want to do something is focus on the mentality of the people and how they are functioning. And that's something you do by communicating a lot more and communicating things that are really a problem that people should respond to. We should do this without scaring everyone. But if we don't do anything it will be scary.

From that point of view, I think it would be a good idea if you could kind of encourage more and more grassroots initiatives where people actually think about what they want out of life. Because you mentioned basic assumptions that should be made from a scientific point of view. So, from a philosophical point of view you should ask yourself yourselves what is the good life that we're striving for?

What is the good life in 2050 and what can you do to achieve that? But that that is a basic more or less agreed upon or in small groups to start with in order to go forward.

Yeah, I think it connects to what you said because when I read the 'Europe Today' article, I was thinking of course it is supposed to be a news negative reported and I think today it is negative. But I was thinking is this the new normal then? And if this is the new normal, what do people think? Do they actually read or is it too much the future? And how do people react to this if this is the new normal? On the one hand, it could mean that people deny that there are those changes and we must do something, and that means that maybe they accept them. But on the other hand, it could be also too much and there are groups that do not want to it think about it, it is too much. So, they kind of shift their focus and interest to something completely different. So, I was thinking about that and what it means. And yeah, that was just a reflection.

00:30

Something that stood out to me in contrast between today's reality and this future projection, particularly in reading Article A, is that one reason that we haven't had substantial behavioral shifts, both individually and collectively to combat the climate crisis is because these are issues that are externalities to our lives 50 years from now. But everybody's dealing with the consequences in Europe at this time, whether it be wildfire, whether it be displacement, whether it be floods. So, at some juncture, the actual hard, concrete science of it, which is inevitably very important, isn't needed to convince people that there's an issue. The issues are present in their everyday life. So also, being a social scientist, something that strikes me is that these complications have led in many situations to political fragmentation as well. And there's a need to have some sort of cohesive vision, as you've mentioned, about what is a good life, for example, but also how do we live now in this new reality where our territory is under increasing threat from multiple fronts. So how

do we prioritize shifting that? How do we prioritize coming together as a collective? The point being that the science is no longer even necessary to explain that something bad is going to happen. The bad is happening in 2050.

I think if you read it, when it comes to behavioral change, it's the same discussion. I mean, you can write this article now purely on behavior. We need behavioral change, but we are not doing it. All the reasons mentioned in it are the same as now. It's polarization. It's a political unwillingness or courage, let's say extremely pessimistic that in 2050 we are still having this same discussion. We need to change. And apparently, we are still not able to change. So, I think if we make recommendations, how can we make sure that this discussion is not going to happen in 2050? Still? Yeah. How do we move forward? Even without consensus, even without an idea of where are we going to move? We have to decide now within all of these uncertainties. We have to change our behavior. Is science needed? I think it's a good question. Should we scare people? I think we are not a good idea. But then what do we do?

It's the eternal problem. I think of where lies agency? Is it on the individual level or is it on the structural level? And people that you talk to nowadays who say, well, what can I do about myself? It's the big industries that would need to change. It's China that would need to work differently in order to get that change happening. So, it's that eternal problem, I think that philosophical and anthropological problem. Is agency in the structure or is it in the individual? And how do you bring those two together to such an extent that individuals will want to go with that different structure?

But you have to agree that citizens, they do change. Maybe not the way you want, but we are changing, all of us. Question in which direction.

Can I pose a question here? So, the exercises that we talk in 2050 and this is already happened or happening. So, for me, we're far beyond point where behavioral change can solve this problem. Way beyond that point. And I think the question of how do you advise the European Commission? So, let's assume that they want to do something if we ask them. So, I was thinking completely different than you. I was thinking a lot of top down things, but maybe that's also my background from the technology. But when I read this, I think like, okay, you're going to need maybe like direct air capture using gas, using nuclear energy, because you can do without behavioral change. You can immediately start implementing. I think I would open international negotiations to discuss and there are scientific ideas of blocking parts of the sunlight coming into the earth. To reduce climate heating, I think you need maybe energy rationing and carbon budgeting forced behavioral change.

I think all these things have already been made and calculated for two months. An exposition by Energy Bill, they calculated what is needed to do. Their problem is politicians are not following, are not able to don't know how to push these things through to realize it. That's the problem.

But you're in a completely different situation. I think someone in the Text was like basically mayors, like stepping down, having I think the political urgency and the pressure from the elected is also completely different in this point. I mean, yeah, I don't really believe anymore that when you're here that you can do much with be able to later.

Although to some extent behavioral change is needed. Because when I'm reading Article B, one thing that I notice is that renewables grew, but only in proportion with our energy consumption. So not only do we need to limit our own consumption, we needed to change the grid radically as well. But to focus on behavioral change, I suppose one question is are we exceeding our actual capacity? Not energy capacity, but our carbon budget and the fact that we're continuing to consume more and more, sometimes that's going to be inevitable. Heating, for example, and cooling. Although the article did mention geothermal and heat pumps. Things like this can be used to mitigate that. However, if our objective as a society is to continue to grow our economy, which is of course a debate, right? Energy consumption in theory could continue to grow unless we focus very heavily on energy efficiency measures or just reduction of final energy consumption too.

I don't think it's an "either or" question.

True

I mean, nothing is stopping us from using new technology and changing our behavior.

This is what I want to get to consider both of the domain technological perspective and try to formulate some recommendations based on this. I also wanted to say that if we need that, we have the three questions. So maybe we can also

First of all, I said that we can consider both the domains, so the technological and also the behavioral perspective and do consideration, some consideration on the technological perspective, some consideration on the behavioral perspective, and try to provide some recommendations based on that. And also, to ask maybe if we need some questions to these two domains to spread media, we can formulate some questions to take advantage of this for you.

Yeah, I'm having a little bit of difficulty wrapping my head around that. Some of the other premises in this article that's envisioning a world just, what, 30 something years from now? Because in terms of facts, in terms of science, it seems to be way off. This seems to be more like a few years from now in terms of some of the data that we're seeing. An example is the paragraph in the first article about the seeing 50 degrees Celsius in some cities in Europe. This is already pretty much happening. And 100 wildfires in the southern Europe. This is happening in Canada as we speak. And it's the size of, I think, Greece, the amount of forest fires that have destroyed land. So that's happening right now. It's not in the future. Another thing in the second article, there's something about I find it hard to believe that there's still a current reliance on fossil fuels. Personally, that's hard for me to swallow a bit. The other thing is renewables have doubled again. It's completely in conflict with what we see in the news today, which is that there was something in the news just, I think, two weeks ago that I think solar has increased by 40% in Europe, and it's supposed to be 50% by the end of this year. That's just solar. So, for me, there's a bit of dissonance and it's hard for me to it seems very optimistic, and a lot of these things seem overly optimistic to me, especially with 1.7 degrees Celsius.

00:40

GM Marc. It is interesting to hear that you find this documentation optimistic, maybe there are some reasons to be concerned nonetheless. And maybe if we wrap up the things we have heard in this group so far, I think a thread appears around the idea that something has

to be done. So, we are in 2050. 2050 compared to now is roughly same distance as the year 2000. So, between the year 2000 and today there have been some changes, not for the better maybe, but some changes nonetheless. So, 2050 again might not be very different than from today, but maybe a little worse or something. And so there are still issues about policy and energy and so on. So, something has to be done. “What is a good life” provides a perspective? There is a question about individual level or structural for the level of change and also do we want to do something and what should it be? So, you are empowered to decide what needs to be done today. Today meaning 2050, considering the situation, and you can bring up more ideas. So, you can change of course of things after 2050.

GM Aylin. And you are welcome to use our resource people just to remind you if you want to question the science behind this, you can ask a question on what you think the temperature projections are for 2050 as well as the population. And if anyone has responses to whether you think it’s going to be worse or that science is on point in 2050, please go ahead. We still have quite some time to discuss these articles too. Whether you find this realistic in 2050, where we are right now.

I don’t know if there is an expert on social behavior among the resource persons.

GM Marc. Yes, there is.

Scientific things are clear. So, for me it’s more the question from social point of view. How do you empower decision making people? How can you empower these people?

GM Aylin. So, if you want to ask a resource person, perhaps I could suggest we can write a couple on the paper there and you guys vote for the top three you want answered and then send it over to the resource people. Does that sound agreeable to you? Yeah.

When I was reading about the wildfire, I was looking to the date of the year. I think it’s about today and not about 2050, but about 23. And it is not after eight years of drought, but after three years of drought only. And I wonder how people in this region, Spain, Greece, Italy and so how they will react on what has happened today, this year. Their mindset, I hope they will change and they will push politicians to do something about it. That is high time, I think they will have that’s one of the better things that’s coming out of this wildfire this year, that people will be aware of what’s the danger and how awful it will be and there should be something done and we don’t have to wait. We don’t have to wait. And if the people are convinced they will push the politicians to do something. In a quicker manner.

But isn’t it? I think people are convinced already today that something needs to happen. But the thing is, once you ask or you give them a choice if you want that change but then you have to hand in something else because it might cost more. You might lose some luxury or you might lose some other things, then they’re not always convinced that there should be work for the climate. It’s not like people want this to happen, that the priority is not always in the direction favorable for the climate. Because you give the example of Italy but I’m not so sure. Maybe you also have regions there where there are other problems that impact our lives a lot more even than this. And then we might choose for that. We have to be careful not to see that this is not the only thing that happens, not now.

Well, I think also you have to start by your own. I think you cannot convince politicians, I think they cannot convince the people but you have to start by your own and that’s very difficult. People say okay, you have to do that, but you have to do it so that’s it. Take a little

example I start with my guard for a wild guard, so I start by myself but you cannot change the world and I don't want to drop a bomb but it's all the carbonizations, the fault, all the industry is not the climate as normal? I think it helped a little bit, but I think it's not all the industry and if I see in 2050 on this temperature the industry will be down so they cannot pollute it. Can you work at 50 degrees a day? Come on.

To be honest and that's from my line of work the only area where there's actually a lot going on towards this decarbonization is industry momentarily so they will be decarbonized far before the regular citizen is decarbonized.

For example, they said the cars, all the cars have to reduce yes, but you got the company cars, take the company cars away and they come with the own car. So you don't solve something, you've just made a problem another way but you have to say okay, we leave the car at home. For example, I did one suggestion to politician, I said okay, everybody had one car. If you want two cars, okay, but you pay more tax. If you want three cars, okay, you pay more taxes oh yes, you're going to think about it but I think.

What you were just alluding to was inequality in the world. Some people cannot put their energies now into decarbonizing. And that's exactly what I think this morning on the news in London. The mayor has extended the area in London where you cannot go with polluting cars. And of course, immediately people say, yeah, but what does that mean for the small guy who only has this old diesel car and they cannot drive into the city anymore and go to hospital? Whatever that problem of inequalities and global inequalities and inequalities within Europe would need to be addressed.

GM Marc. Do you have an idea? Because one of the problems I think you are facing is where to get started doing something, what to start with, so maybe can start with something. Mario, the idea which was discussed here was to limit the carbon capacity to consume at the individual level. I guess it's mentioned in one of the papers. The idea is we would have each of us have a carbon credit, whatever the source and when we reach it finished, we cannot go beyond. So they put a lot of limits on individual rights and right to consume and things like that. So that's something you think in 2050 you can push forward. Or there were ideas about direct air capture of CO2, of more nuclear. I think you have to jump in the water and say okay, we want to discuss important moves to be done in 2050. You are free, don't worry. You can say breaking ideas put forward.

00:50

I think certainly given what our charge here is to provide recommendations to the Commission. There's social elements and political recommendations that can be made and I think we've been circling around a lot of them. But there's also technological recommendations. One thing that strikes me immediately is the need to change the grid. So is that a recommendation that we would want to pursue? The fact that nuclear had stayed pretty much level between present and 2050, is that something to reconsider? I know that there's different political narratives in the European Union versus the United States, north America in general about acceptability of nuclear energy. That is changing, that is shifting. But is that something that a recommendation should be to push even further in Europe in 2050.

From a Swedish perspective, nuclear is changing and also because they are taking decisions about waste and where to store the waste. And that decision is taken away in some of the criticism. So, I think there are possibilities, but that will change. And I think there's possibility not to change that line, not to be the same as it is today. That is just a reflection

What I found interesting in the concluding paragraph in article B was the pro nuclear propaganda which is represented as something that's a simple truth, something like that, without mentioning the waste. That's the decide that I would like to make.

Maybe ultimate note, I think, at least I assume so that with the graph that we're looking at, it's the complete energy consumption of society. Which means that the part that electricity plays because you're discussing the bit is only like 15% or 20% of the emissions by solving that, but certainly everything and the majority is somewhere else. So it's also very important. Same for climate emissions. The majority of climate emissions is not only from burning of fossil fuels. A lot comes from other states, like for example, cattle, like cattle, for example.

Every living being basically so you have to be careful, not focus I think too heavily on just electricity and in that regard you're certainly right like only talking about the nuclear is a bit certainly not the main problem but I think it can help. I totally agree. I don't think you have to stop possible solutions from helping, you need more of them.

To that end though, I think it's important to make the distinction between electricity and energy as a sector, right? Because in many different sectors that are highly emitted, for example industry and transportation the idea from the IEA and others is to electrify these industries, right? It just depends upon where that energy source is coming from. If it's renewable, if it's low carbon, if it's nuclear, things like that. I agree, though. I mean, you do have to consider other sectors, I suppose. The scope of this exercise are we going to tackle every single one of those sectors in our recommendations to the Commission or not? That's an open question'but insofar as elec'ricity I would say I'm considering means changing the energy grid so that we have greener and more sustainable electricity that can then also go to decarbonized transportation and industry as well and the building sector too.

Could you just make it illegal? You said I'm surprised that we are still using these in 2050 as much and we have even this morning brown coal made out that green at all recommendation just also stop using it. We have enough alternatives.

GM Marc. Yeah, fossil fuel is still here in 2050, the enemy for climate is still around so can we do something simple?

Of course, if you banish it in Europe it will simply become cheaper and it will be consumed more in other countries. The geopolitical reality, of course. So just prohibiting it in Europe, that will also not even you can't just abolish it. Because what will happen then is then you will suddenly need a lot of energy storage. And then we will use up critical materials, the batteries which there aren't enough also. And secondly, we will start importing like green fuels and they will deforest in other regions. Because they will be happy to receive our money to take them here. So, you always have to think from a system perspective. Stop using it.

So, then what is the recommendation? Do nothing because whatever you decide somewhere else something bad is going to happen.

No, I mean then you have to have to give a suggestion or a plan that encompasses these things

you come up with discussions between people who disagree some will continue to say that fossil fuel is not durable I agree. Then you come up with again the type of uncritical theories and if you continuously argue and you never agree so my opinion is to continue to try to reach some understanding of the taxonomy and what is durable or not still thinking but maybe you never succeed. It's a lazy discussion anyway, if you see the materials which are mined for these batteries Indonesia has nickel, copper, whatever, but the rainforest will maybe diminish seriously. So, this is not durable, sustainable. So how do we consider that the lithium mines in South America, what about the fauna there?

I was wondering if there will be wildfires in south of Europe when solar farms are replacing the forests in a significant part of the territory. I would like to do a parallel outside this topic of energy to food. I was thinking metaphorically in terms of the organic food movement where we produce locally to the processed food industry, both. And *[participant]* was mentioning that change has to start at the individual level. I was thinking besides the individual, there's the cities where most population live nowadays, in Europe at least, and that diversity is key. And how can we promote smarter cities? Cities that can capitalize its natural resources, adapt to its geography around and cope with the natural and anthropogenic hazards. And so, there's not one solution to fit all different cities.

GM Aylin. Do you have any recommendations for cities? Like an EU wide directive for cities to implement maybe locally sourced foods, ban on imported goods for foods?

I would avoid bans, but I mean…

GM Aylin. Again, do you have any recommendations for that?

01:00

You could make a covenant binding for certain sizes of citizen. You all know the covenant of Mayors can freely enter that they take up.

Yeah. That cities can voluntarily enter the covenant of Mayors. They have to sign the mayor himself and they aim to reduce their climate emissions in all areas, energy, but also livestock and all those things. So, you could conceive a possibility that you make it binding above certain level, that it becomes more of an obligation to do.

GM Aylin. Now you're in 2050, we remind you you're already in 2050…

Yes, I think that's going to happen because people don't believe anymore in the politics. So, they see now almost cities do more and more for their own without.

Politics, the national politics actually, can I see *[participant]*? Yeah. She was asking how to empower people. I don't think it's by turning their back to politics because we know that.

It is democratic and that's the fault of the politicians. But it's different in the cities. They know the politicians, they see what has happened. But the national politics people don't believe.

I would say that varies.

That's very sad. I know that's very sad, but it is so. And there's a fault of the politicians, not the fault of the people. Today they say it is black, tomorrow it's white and then it's gray. For

example, the nuclear power plants have to close tomorrow, they stay open after tomorrow they're going to close again. So, they said we have to decarbonize carbonizers. We're going to close the nuclear plants, but we're going to subsidize the gas plants and we have to use less gas. Can you follow it?

Yes. It's hard to trust any institution being it politics or science when there's no consensus. But it reminds me a controversy that was during the Pandemic if we should wear masks or not. And the scientists replied to the journalists that science is a living thing, it's not a definitive solution, so it evolves. So that's why opinions sometimes change and we have to embrace uncertainty as well.

And it's not only the fault of the politicians, also the fault of the media. Yes, everyone plays a very bad role. They bump up the people.

I read somewhere in the article about digital electricity meters and I think it's a good idea. And as a proposal, I would also propose to do the same thing concerning water consumption. And as a politician I would propose the idea to also work with quota, so the difference in the population can be diminished by trading. People who are using less, like older people, can sell their water to other people. Everyone has the same budget, but if they don't use it, they can sell it. So, you can equalize a bit the difference in the population. It's easy done. It's just putting a measure and a quote on it. It will be open for a lot of discussion. That's what we do on national levels. We buy carbon in Ukraine. No longer in Ukraine, but in the eastern countries.

GM Marc. Yeah, that's a concrete recommendation. Maybe we can start with that. Congratulations for jumping in and suggesting. So, can someone maybe write it down on the board.

That's the carbon cap.

It's like a water cap.

That's the amount you are allowed to use. And if you use less, you could sell it. If you need more, you can buy.

GM Aylin. Water cap and trade

Problem with having a cap and a trade on such a low level is again the inequality. Because the gap for affluent people it is nonexistent people.

There is no gap.

It's completely if I can also react to that, it will create a massive Matthews effect. So if I'm a rich person, I drive an electric car, I have a passive house, my carbon budget is extremely good and then I can even sell the surplus that I have to other people that have to live in a less well insulated house.

But when we take the plane every day, he doesn't have to pay a lot.

But it doesn't matter. You can't charge that much that it hurts that person the same, like speed, fines maybe there's a different way to.

Do it than with buying and selling income wise.

GM Marc. But let's be supportive of the idea of [*participant*]. She made a recommendation, that's what you are supposed to do...

The underlying assumptions are not made clear there because that's coming from a financial framework that you put on the world and maybe how you want to conceptualize a good life.

GM Marc. Maybe we'll comment it afterwards. But first, let's write it down like as it was suggested by [*participant*]. And it was an analog with smart meter, the electrical digital smart meter, to do the same thing with water. Am I correct? Yeah, so that's the suggestion and then there were an idea of quota and trading because any suggestion can be commented and criticized and here it's only a small group of 13 persons, imagine when you have an assembly of people much larger attacking such problems, it's very difficult to reach decisions, it cannot be perfect right away. So, let's try to have some ideas put forward which then can be commented. We don't need to all agree, your comments will be kept on record.

To limit the comment, we can say, okay, we recommend caps, but we will only do it if there is a way to combat the inequalities that we know can happen and then it still leaves open. Yes, if you put it into practicality, then you can take that.

GM Marc. But also, remember, we're in 2050 and the situation is pretty bad and we need some changes. Yes, please continue. And also, the resource persons here, they have listened to your discussion, the difficulties you have come across and they might say a few words to help you proceed.

01:10

Resource person Marian. Ok. When I read the text the first time before this meeting, I was in the same position as you are now. And the clear idea we have here presented in this scenario, extreme scenario, practically it shows a failure of all European measures, all society measures. But we have to think to this part, it's very important because probably this extreme scenario will not happen in practice. Very clearly, we have some hopes but beyond of this we have to think and to recommend something to change drastically our style of living in order to reduce our consumption and our production of electricity, in order to avoid this kind of catastrophe. And we have some elements, the elements which have you have discussed about consumption, changing our behavior. Changes in our daily life are an important part, of course, but the fundamental thing is if we are replacing, for example, a type of car with other cars, we are replacing a consumption with another consumption. Let's think more radically: what do we have to do to reach an objective that is very high and very difficult? Because we are, all of us, not the politicians. The politicians are our representative and they will say what is convenient for their life and for the society, apparently. In fact, we will be forced to work together and try to do something. What is your perspective about the consumption? We have to keep the consumption as today in the future, or we want to change more differently and to impose another philosophy to the society. This is one question. The second one is related to the energy resources. We have some resources. Each country has some resources, local resources and some possibilities, some technological possibilities, some money to go farther. How can we progress? This is the question that I say to you in order to stimulate a little bit the discussion, to go to some recommendation. Don't be so shy. Try to think, let's say more directly even. There are some very idealistic proposition, but let's think and try to extract some elements that may be valuable.

That's a good recommendation. Let the EU take the lead in making fossil fuel illegal.

Out of what was said, there is that the main idea is degrowth, less consumption is less production and so on. And the degrowth is essential, is essential to manage this climate change.

Doesn't mean the production has to lower down because the world population will continue to grow. So, the industry won't have a direct effect of having to produce less. If we would divide it over the world because check on the world, the consumption will be further. It's just our consumption we should limit here. But for the rest so the impact on the industry, what's claimed by the Economist is relative. If it's all about population growth, why not make it illegal to have more than two children? Yeah.

That's something that's happening in China.

Maybe for production.

That is merit to it. If you if the choices between we're around certain 25th any choices? Having lots of children and knowing very well that they will live in very poor conditions, having less children and knowing that they will have a more healthy and wealthy life, what do we choose as a parent? Okay.

If you implement Social Security in a country, the population, the children that are producing it's just a question of you have a lot of children because you want to make sure someone will take care of in history, you see in every country where there's Social Security, the number of children.

Basically, in Africa, there's no Social Security. I would say in Africa, but still they have a lot of children.

They have no Social Security. To implement Social Security.

Wanted to comment on [*participant*] recommendation. I would support it if it was more on the industry level to have some water considerations of water caps. Because the individual level, it's nothing compared to industry. When I was growing up in Canada in the 70s, there was an ad that everybody saw that was a Native American Indian who cried because someone was throwing garbage out into the on the side of the road. Everyone knew this ad, and it turned out years later that that was produced by the plastics industry and the purpose, the strategy was to make individuals feel like they're responsible for pollution. And it's a so that's one thing. I also have two idealistic suggestions. one is lobbying transparency at the European Union level, which hasn't still been implemented yet. Lobbying controls is really key, I think in having ban lobbying or transparency. Well, lobbying transparency, at least for the economy. I could go further. But the other thing is to have along with the European Parliament, a body of citizens, like a sortition body. So that helps to make decisions along with the European Parliament.

GM Marc. Something like this group here?

Yeah, well, like citizens assemblies, but at a supranational level.

PM Marc. But for what reason would the group which you described should be more efficient than this group here? You are encountering difficulties to make recommendation, I mean, that's reality. If you encounter those difficulties, probably those difficulties are

encountered everywhere. And that's why we are in this situation of not being very efficient in tackling the climate crisis.

It might provide justification for politicians. If the citizen council has the same recommendation, it might make political difficult decisions easier because you can say okay, the citizen council agrees. So, the benefit might be but you.

Yeah, we have a recommendation that the politicians can use us as a justification. This comes from the citizens. So, it might be easier. But I can answer that question actually, because in citizen assemblies it's not just a group of individuals discussing, it's facilitated, it's highly organized and it's randomly selected and it's also representative of the population. Completely representative.

This is exactly what our group is doing.

GM Marc. I mean, you are a citizen group here. I cannot imagine how another citizen group could do better work than you. You are ready to go.

I suppose if you scope the citizens assembly to focus on specific issues, it's easier to tackle things as opposed to the entire climate catastrophe, for example. That's one thing.

GM Marc. Maybe, but before 2050 there have been many citizen assembly groups and the situation has not improved much as we see it here.

I'm going to do it again to change scenario. So now it's regarding the second suggestion has happened with the laws for the drug problem that we have. So some drugs consumption are legal, but the production is illegal. And I think regarding the fossil fuel production should be illegal, not the consumption.

GM Marc. That's pretty interesting. Another analogy, it might be a good approach to think in terms of analogy with drugs, smart meters, water.

I have also a couple of ideas that may be some suggestions I like this idea of the broad deployment of small water reactors could be also at international level is my idea because it's kind of point of view, moderate actor, makes sense only if deployed at some point. This would also need a specific regulatory framework for small modular reactors at international level. So, this could be an idea.

The broad deployment of those born moderate reactors is the idea. And then also a specific regulatory framework for more moderate reactors. Specific regulatory framework for small moderators. I have a question to the moderator. How is this going to be reported? Recommendations the group agrees to?

01:20

GM Marc. You don't have to all agree. But as it is difficult to reach a consensus and again we see the difficulties which any group would have to reach a consensus about the climate. We keep the recommendation and we integrate the comments. You don't have to agree with everything. You can say this recommendation has such and such fault. For that reason, I don't support it and so on. But if we say that we put a ban to make fossil fuel illegal, I guess yes, SMRs[4] might come in. The point about drugs was interesting also because if we look at

[4] SMR = Small modular (nuclear) reactor

the consumption, we can say also there is an addiction to fossil fuels. We are addicted. So if it is an addiction, we might need to be treated also as addicted people. In addition to make the production illegal.

We see it with cell phones as an addictive behavior. And we are dependent upon energy for that as well.

Sure, how to about consumption we know that in what's called the well developed countries of what is produced, a lot of things a lot of things are thrown away are thrown away. About a quarter of what is produced is thrown away. If we can reduce that, it would be a high step in the right direction.

The reduction of food waste as a proposition.

Waste in general because it also goes for things for fuel.

And the same about clothes and solar thrown away after one year.

I agree with that. I think that we should find a way to change the culture, the consumption culture and do some campaigns similar to, for instance, smoking campaigns that actually work to change the consumption culture. Maybe some specific campaign to change the consumption culture could be done.

I think what we're still missing a bit is and it was said here and there is this overall questioning of where are we going? Because we are talking about degrowth, about consuming diminishing. Yeah. So, this recommendation would be you have to keep questioning okay, what is our end goal here? Where do we want to go so that we can steer all of these decisions and recommendation towards that? What is our better life that we are aiming for? What is the safe place as it is being questioned?

GM Marc. You are also kind of optimistic, like we said before, that in 2050 with this situation you still speak in terms of having a good life, how?

We can economically degrowth but rise in welfare, in wellbeing, developing and grow together with the degrowth of economics.

GM Marc. Yes, but if the situation gets really bad, I'm not sure people will speak in terms of having a happy life. We have talked about democratic process, like citizen groups, politicians. But democracy is a very slow in decision making approach. Very slow. There is debate, discussion, deliberation, new commission again, and it's not in the papers, but we can imagine a future where there could be conflict over water, over basic resources. And the decision making there will not be done in a democratic style. It might be done in a much more authoritarian approach, e.g. with military action.

Recommendation is to find a "good dictator". I think we should come up with a new word.

Something in that direction. Maybe stop for four years politicians and do, for example, captains of industry, the government, they do some rules for doing four years. They are not elected and they don't have to elect it anymore. So, for captains of industry and let's see.

Go captains! Members of industry.

Energy market in Europe.

GM Marc. Okay, that's another recommendation

Because what you see now happening is you don't get the investments for baseload capacity and you have to do this very expensive tendering for the baseload capacity and it costs hands full of money. They once moved to a liberal market because there was an idea that would be more efficient and cheaper. But if you consider all the costs, I'm not sure if you're still there. So that could be an option. It's also quite far reaching, but not so far as having a dictator.

GM Marc. Yes, but if we look at the trend of politics, we have seen in many European countries extreme Right-Wing movements gaining power. In a crisis, when there is a crisis, the political decision making might change radically. So as Marian the resource person said, if we don't make drastic suggestions and recommendations, they will be made in a different form. Here it's democratic, so it's slow. We encounter difficulties. Yes, maybe a dictator will show up and say this is how we do it…

But the authoritarian people that are in power now tend to take decisions that are not in favor of the climate. The people want authoritarian things who do not go into that direction. So, it may be any more eco than that. An eco-dictator. Also, different models from different countries, how decisions were taken haven't we learned that too much dictatorship is not good in the long run?

But what do you call dictatorship, Singapore, is that a dictatorship?

Yes, but everything, kind of, works. Everything works.

Community will remain still an important issue.

01:30

GM Marc. Okay, maybe we can do a roundtable so you can all comment on the recommendations that were made so far and bring up your own ideas for radical change. Yes, maybe we should have prepared more dramatic 2050 articles for you to consider more radical changes, but we didn't want to traumatize you. So, we start with a roundtable, then we have the break and the debriefing.

I would like to share the three questions that I think most grabbed my attention in the whole discussion: how to empower people, how to change industry mindset, and how to promote smarter cities. And in terms of key concepts: the durability taxonomy, population number, science and policy, what is the good life and technology, literacy and the need to change the grid.

GM Marc. Good, and the recommendations you heard from the group participants, it's okay with you?

In general, yes.

I think one issue here is regulation or adjustment on energy production and different emitting industries. One comment that was made is about making fossil fuel consumption versus production illegal. That's a fair point, and I can sympathize conceptually. However, the European Commission governs the European Union with varying degrees of efficacy. And if you make fossil fuel production illegal in Europe, that's fine. But other parts of the world will continue to produce. And if we're not going to simultaneously insist on changing the energy grid, for example, going like France did in the nuclear to have low carbon or no carbon baseload capacity generation, then they're still going to continue these trends with

the coal and petroleum and other liquids will continue to ’Ise. So that's a glaring emission, in my opinion. And another thing that we did not really discuss also is addressing climate adaptation. The first article speaks about cascading negative feedback loops of varying climate catastrophes in the European Union. And I think these ideas are all very important. The idea of changing the consumption culture, the idea of reducing our consumption, degrowth, things like this. But when people's houses are being destroyed and they can't afford and there is no territory for them to rebuild, there's other concerns that they're going to happen.

So, I think I cannot endorse the majority of these personally, because I think that there are more pressing practical matters at hand.

GM Marc. More pressing? Can you give one shot recommendation as a radical change?

I would say that the energy mix should be completely inverted. I agree that if w’'re going to be net zero by 2050, obviously w’'re not so immediately becoming net zero in terms of our energy production. I would say completely getting rid of fossil fuels and supplanting base capacity production with nuclear.

GM Marc. Okay, so no fossil and more nuclear.

I believe that all the suggestions are more or less reasonable.

I believe as well that all the suggestions are reasonable, except I do not agree on the population cap. I’'s something that I do’'t think is a good idea.

GM Marc. And you have one?

What I think is really important is always to think about the two domains, technological and behavior. And then I think that we embraced both of them. Which I think is really important is to change the consumption culture through specific campaigns.

GM Marc**.** Okay. Change consumption culture

Clearly, we have to think about how to do that.

Yeah, i’'s not easy

I think all the ideas have a lot of potential. What would be the motivation? So, it needs further discussion.

GM Marc. A lot of further discussion. You want to meet again…? [*smiles*]

But I found it a good suggestion from her. I do’'t know your name. We agreed in Europe on a COVID political approach in response to the pandemic crisis, at least we could have also EU eco politics. It could be a separate group, not a politician. But the way the politicians, the suggestions that will come from that group, we will accept it without a lot of discussion. When they start to rediscuss, everything falls apart.

And also, the suggestion that the United Nations would be good, that they had also eco department and not only a safety department to have a global level vision.

There's a lot of discussion necessary on these proposals. For instance, stock fossil fuels. Of course, you cannot be against it, I would suggest maybe that you start with the ones where i’'s really absurd to continue doing it. Like flights less than 200 km. Tha’'s not prohibited yet. So maybe start from this general principle. Look at different uses of fossil fuels and the ones

that can be prohibited most. I would not say easily because there's a lobby behind it, of course, but where it makes most sense to do it.

Yeah. And then maybe continuing on the fossil fuel, but then making a positive requirement. For instance, every new electricity production capacity by 2030 should be as a rule. And by renewable, I mean renewable. Yeah. Population gap. ’'m also not so much in favor of things like that.

I have two children.

I have three, so I cannot subscribe to that one.

GM Marc. Thank you. Another idea?

Yes. For me, I can understand most of the concepts suggested and I think they will all contribute. I don't think they are coherent yet. And I also think a lot of them are stated in the goal that they should reach, but not how to reach it. So, i’'s not really an advice yet to a politician, you can't put this in a ministerial degree and sign it because it will not do anything. And that is a lot of the problems that come up when you have to do that. Yeah, and then my last remark is talking about what I found interesting, the statement of a happy life. I just want to give my opinion that for me a happy life is mostly defined by freedom and not so much by the wealth or the state where you live in. I think a cage is always negative. Even this is a gilded one. So, I also in general would prefer not to have too many rules saying that you can't do something.

01:40

GM Marc**.** Okay, not too many rules. Let's hope we won't have to.

Well, also obviously a gap. Everything else, of course, all of them need to be I think the main problem with all of them remain they have to be quick and radical. None of these are going to work if Europe is literally on fire. Nobody is going to care about buying that water because my house is physically on fire. That will be the last priority I have. Of course, safety will be the first. Maybe the best recommendation would be where are we going to move if the world is actually on fire? Luckily, we have a Swedish person here, so I guess we go there. Maybe that is the recommendation really missing, we might need to move somewhere safe. Everything else we should do now, build a time machine, go back and do these things now would be a better idea.

GM Marc**.** There are many scenario approaches, like going back to the present after exploring the future. But here we do something simple, one shot only: we are in 2050, the group discusses what should be done …

Of course, there have been a lot of interesting ideas. I would like to point on the deployment of SMR. And I think we understand that we need to have technological development on all areas, either fossil, renewable, nuclear, whatever, carbon capture and so on. So, I think tha’'s very much needed to continue more and more technological progress. Development. For instance, SMR now is one of the key ideas in the nuclear energy. I think it has not been yet demonstrated that the nuclear waste generated will be that less. So again, it has to be demonstrated, model calculations and so on and so on. So still a lot of development is needed, but I can only recommend all areas.

Yeah, there are a lot of things that you said I do not agree with. Like number four. And I would like to comment on campaign aid on consumption culture. I think one should also think not only to tell people what to do, but to give them choice and support them to make the right choice.

So, I think that is an active way of thinking how to support people to make better choices and to also find ways to subsidiaries for people to make choices, so we can kind of go into the right direction. So maybe complement campaign with something more.

We need, before and also, to promote different lifestyles. ’'m thinking about when we talk about consumption and over consumption. Over consumption and tourism to promote different ways of traveling, different experiences and not put everyone in one place.

That can make a difference and is important. I think about tourism.

I think I will keep harping on the good life. That’s something that people need to have discussions about. And you could also say what kind of society do we want to live in? And I was really taken by the idea of a citizen assembly, which is really well facilitated, to advise the European Commission where you would have a chance to try and determine where you stand in life, what the worldview you want to have. Because i’'s of course very different. If you take ecomodernism as a starting point, technology will save us whether you take an authoritarian view or whether you take degrowth as a departure point. But apart from that, I wanted just to mention that I was really taken by a project that was done a couple of years ago at the University, where they drew up a map of the Netherlands in 2120 with quite radical ideas behind it. And that map of the Netherlands is now leading to real discussions: do we have to move away from the coast, for example, and all kinds of ideas on how cities will be, where they will be located and how they will be organized.

So, I would want to promote a map for Europe. Well, we are in 2050, let’s say in 2100.

GM Marc. Okay. A map for Europe. Tell us two more words about what this map would look like.

Yes. So that map would present a radical view on what Europe would look like in terms of where people live and where human and non-human activities are located on that map and how the landscapes will have changed by then and whether we can engineer landscapes to change into certain directions, more conceptual.

GM Aylin. Or is it like a law that people build towards invite 2100 people up.

To a bias by that one? No, it was meant conceptual. It was meant to stir up discussions now with rudder.

Yeah, there are some very interesting things here. I think I particularly support the taxonomy idea for sustainability with the caveat that there are guarantees that the decision making is based on science and that there is no political influence. Because I do believe that politicians and science they can be separated. And in history we see that there are many examples that show this and this always benefits society, I think. And the other thing yeah, I think i’'s important to, if humanity is in a crisis, we have to refrain from speaking in the abstract about technology and consider solutions that we know work and that aren’t just, I don’t know, good intentions or good ideas, but that technologies that we know will reduce emissions. That’s my main overall impression. And the other thing is nationalized energy. Well, we’ve

already seen what this looks like and I don't know that would necessarily ameliorate things for the better in terms of climate change. And in fact, I would want to go a little bit more in the opposite direction with supporting independent energy initiatives.

We were speaking about making the right choice. Making that's on different levels. The politicians have to make the right choice, the industry have to make the right choices, but the consumers have to make the right choices too. And how can we best stimulate making the right choice? That's by giving them money if they make the good choice, and penalizing them when they are making the bad choice. People get not more intelligent, but they use the intelligence more if they are stimulated by some money, in which form a possibility for citizens to act and to stimulate. In the Netherlands, there was what they call the "climate case" and they won it. And so, the government is obliged to take higher measures than they did before. Quicker and higher measures in Belgium, the same process is going on and it seems that i''s all based on decisions made by the European Court. Then what about politicians and how to govern the whole problem? Captains…?

01:50

Not captains of NSC, but the CEOs of CEOs. You can't do that. They are not elected and they depend on their shareholders. They depend totally on the shareholders. If at the end of the year they didn't earn enough, he has to go. We have to keep our democratic system of chosen and elected politicians.

And then about the technical part, we didn't speak about it. I think I didn't understand everything. But we have to stress on stacking and storing electricity, that's still a problem.

I am the last one, so it is very difficult to find something else but I almost agree with all the things discussed. About water, not selling it, just everybody can exchange and tha''s it. You cannot sell, we cannot buy. That's my opinion. Then again, the population gap also again, and as I said, when you have a group of citizens who decide, or group of experts who decide, it must not be an advice, because an advice is okay, I know it, but I do what I want. You need a consensus and that's it. You have to take it. To make a consensus is not so easy. Trying to make a consensus here is not easy. Once you have a consensus, okay, that's it, it's not any more a simple advice.

GM Marc. Well, thank you all for this step, which you successfully accomplished. We all deserve a little break and a coffee. And then we will have a debriefing session. We will be all together at the same table, the resource persons, the moderators, and you can tell us how you felt through this exercise, the pros and cons, the advantage and criticism you want to address for this approach and so on. People can vent out stress, emotions they could have had. I don't think it was your case, you were rather at ease. Someone said that the newspaper articles described a not bad enough situation. Nonetheless, how did you feel in that situation? And then we will have resource persons give us some feedback also about what they have observed in the discussions. So how was your experience?

Very comfortable. I felt very comfortable.

GM Marc. Comfortable. So, you think the scenario should have been more… dramatic?

No, I mean, that's a conversation among us. It was good from this perspective.

Well, I have to admit, when reading it, I was wondering in my head again why I put two children on this earth if this is where they are going to end up in 25 years. That did come up. And some people even said this is not the whole truth, it's a mild version of where we are heading. I have to admit that question came up.

GM Marc. So, you think it's a mild version?

Yeah, in some cases mild. Some of these things are already natural disasters, wildfires. Still no idea of what we here in Belgium, I think I still have no idea of what is coming to us.

Politics now maybe I also want to add so the discussion itself was certainly good.

I felt completely comfortable in the discussion. I did have one thought, however, because we were discussing all these suggestions for our EU. Then what I actually missed at the table was an elected official to participate, maybe a judge for the second power, and then maybe someone from the administration or the capital, one of the two. I think if you would have had them joined or somebody needs to take up the draws. He knows it very well. I think it will be very helpful to see if you make suggestions how it influences them and how they react. I think it could have been worthwhile if you had them all to it.

A very overwhelming exercise, I'd say a very positive one. But as I mentioned in conversation, when the scope is such that we are to address all of these different variables of the climate catastrophe, i''s really difficult to have a thorough conversation on any one point, which I think we saw. We talked about a variety of things but also there is plenty that we've not even come close to addressing. Perhaps scoping the exercise could be a useful way to focus on critical issues at hand or target issues.

GM Marc**.** Yes, right, this is the problem with climate change, impacts are everywhere, at all levels.

I was also thinking about this complexity. So, I think that is something that I will bring and that I am still feeling. I was not overwhelmed but if you have children, I think that is something that changed your way of thinking also about the future and yeah, maybe that is also something to address more. We didn't do that in our discussion, what a feeling means and how can we use or take advantage of feelings also when we talk. I''s not just something individual, I think that is something parents have, concerns about the reality your children will face. Okay personal things are also important.

02:00

In general, the discussion was very nice, kind of interesting, we always need to think and discuss. But we are all representatives from Western countries, America, Europe. How does the other continents think about this? So, at the end of the day you need to have discussions with the entire world because they also have a very strong impact. It seems to be obvious, but hard to do.

I wanted to make a remark, we all agree here that something needs to happen. We agree that there are right decisions to be made but I think we have to think about other perspectives and perhaps also about other kind of life issues. I think one of the problems is

that we tend to think that we are a collectivity that includes everyone. So, I want to mention those inequalities once more, and which I think we didn't discuss.

It was very good. But maybe one suggestion. If we get these papers, the newspapers before we could read it at home. And then I couldn't think about it because I am not a scientist. And I became older, so my mind is a little bit slower.

GM Marc. That's a point we discussed within the team about sending the articles before or not. As you said, participants would have more time to read them if sent before the meeting. Finally, we decided not to do it, because we wanted you to share the group experience of discovering the content all together. But as we said before, when you are back home, you can read again the articles and you are welcome to send more ideas.

GM Marc. Furthermore, following the comment about children, maybe find a way to get the family involved in a discussion?

I am not with children anymore. This recommendation on the population, we should add something about control of the growth of the population caused by education? Yes, caused by education. Very important.

Will you ever do this group exercise with another public? We are all rather well-informed people, I suppose, with a certain education level. Would it be good to do the same exercise with just people out of the field? Really to see how they react?

GM Marc. Yeah, I would be useful to do this exercise was various groups.

How much they are informed about the problem and if they would say then ''ll just leave it over to the experts to make the decision. That would be a good evolution within society. I think when people get aware of too much complexity, they will listen to the experts, and then I think we can get forward. I don't know if that would be the reaction. I''s a question: how would they react?

GM Marc. One difficulty with those group discussion settings is to find volunteers. We are researchers, we say let's involve stakeholders, let's do empowerment. But it's really difficult to meet and to involve stakeholders. So, thank you once again for coming and doing this work.

I felt comfortable in this group and I think everyone comes out alive so we didn't need some kind of moderators here [*smiles*]. But I'm also thinking, and you have probably thought about it, if it is easier to start with after reading the articles with just small groups, smaller groups first, and then go into a bigger group because sometimes that makes it easier.

GM Marc. You describe a format that could have been used. The point of having you all together, 13 participants, still a small group, is to allow a wider relationship between you, more interpersonal interactions, which exposes each person to more opinions, ideas, values. And so, if you split into smaller groups like 4 persons, you might get more efficiency on the output, quicker recommendations and so on, but you lose on the process, on the more complex interaction between people from which more insight can come up. So, it's a balance, with pros and cons, you have to make a choice.

I've been wondering from the beginning why we are doing this because nobody has said what we are going to do with the recommendation. So, I had a feeling that you are more looking at how we are doing this than at what we are talking about.

GM Marc. Certainly, it is the issue of the link between group process and content. Two specialists from IPCC would have reached consensus in 15 minutes (maybe…), but we would not have had the underlying discussions and ideas of 13 citizens being confronted with complexity about climate, bringing personal experience and points of view from different backgrounds (nationality, age, gender, occupation...). The difficulties you encountered here to make decisions about recommendations practically exist as well “out there”. This why it is important to have the process and output from this group work and it will be integrated in the ECOSENS project as presented by project coordinator Daniela at the beginning of this workshop. And so maybe that's a way to hand the floor to the resource persons and so that they tell us about their experience about the group’s work.

02:10

Resource person Daniela. It was very interesting to listen to your comments, to your ideas, to your recommendations. It was a very interesting, I would say like a radiography of a group of people coming from many sides, different communities, different sectors. Thank you very much for doing this effort to be here and doing that work. One of our targets is to increase the awareness of the stakeholders. And I think every of us is a stakeholder in the complexity of this problem and on the need to be engaged in different ways which are suitable for each of us in the decision-making process. And the question, which maybe is a tough one: what recommendation would you make to the European Commission? Somehow, in my view, this put you in the position of people being able to change something, especially in a very critical situation. So at least from this point of view, I think that we succeeded to increase a little bit the awareness and the complexity of this problem. I was honestly expecting to see questions about, I don't know, what are the contribution of each activities to the emission levels. But I noticed an approach which is much more human, I would say, than technical. I think that at least from the point of view of knowing better your interest in this problem, we did succeed, so thank you very much. We can keep this in mind for other activities and we really hope to hear from you and to stay in contact. And Nadja will tell you how we can stay in contact with you and you in contact with us.

Resource person Nadja. I don't have much to add as I agree to what was said, I will mention some of the possibilities you will have to be further involved in ECOSENS. We are going to establish the Stakeholder Network Group so you will be all invited to join. So, you will be then informed regularly about the activities we do, about the events we will have, how to collaborate, participate and how to be engaged. Also, it is possible that you provide comments to our outcomes like Deliverables or any other things we are doing. So, you would be most welcome to join a kind of end user group. I hope you have also the ECOSENS website. We can email the link to you. So, you can just go there and have a look at what is going on and what we are planning still. And one only small comment regarding the scenario as described in the newspaper articles: I would see in 2050 much more material like we saw in the movie Mad Max *[Australian dystopian film directed by George Miller, 1979*], I mean fighting for the resources, fighting between people. This is what I think the future will look like. I'm very pessimistic.... Thank you very much.

Resource person Marian. In ECOSENS we tried to involve as much as possible the stakeholders and we performed some activities in Work Package 2 where I am the leader, and also in Work Package 1. We try to produce an assessment of energy technology from the perspective of energy transition, to develop a methodology to be technologically neutral. To involve the stakeholders in the assessment itself is a very difficult process, but your contribution provided some practical suggestions and some important elements. Now we try to discuss about the future energy scenario and the possible role of nuclear in this scenario. And what is encouraging for me was the questioning you had. For example, you want to look at the demographic context. In Europe, according to the United Nations model, there was a small increase of the population of 10 million from 2015 to reach less than half a billion in 2020.It is practically nothing. But at the global level, we will have an increase of the population by 1 billion in 2050. We are looking on longer term at what is happening with the population and there are different scenarios here. There are catastrophic scenarios like the empty planet because the western trend to have less than two children in a couple is very clear, we go to the extinction and it is possible to have this extinction in some hundred years. But we hope, of course, this catastrophic scenario will not happen because we are rational beyond all of this. You discussed very interestingly about the empowerment of the stakeholders in the decision process related to the energy and I want to remark on the fact that we are challenged by some very disruptive technology: today you are practically relying on something that is outside your mind. For example, you are relying on your smartphone, taking decisions by using different applications. And in 20 years or 30 years, this will be practically a common thing for the new generation. Our individual decision will not be as powerful as it is today because the power of the algorithms will predominate. In practice, such strategies of calculation will replace your decision. It is very important that society conceives this as a problem. Are we able to think in the future and not to be people that are simply using some practical technologies? And it is very interesting that you try to follow this idea. I am sure that staying together for more time and practically thinking, we can discover some solution not to evolve to the catastrophic scenario that was proposed today.

02:20

GM Aylin. Very few comments to add to your wonderful feedback. Just want to say thank you very much for participating and reading the material and interacting with it and really trying to get at the heart of the situation that we're at in this time. And just all of the research and all of the things that I've read while preparing for this workshop have put me in quite of an interesting situation this summer. I spent most of my summer looking at what catastrophes could happen and what scenarios there could be. And I tried to create a scenario that wouldn't put you in a depression like it put me in the summer, but also bad enough to really try to drive the issue that we're going to be stretched thin. And like many of you said, not all of our priorities will be on what we can do in the future, but what we can do now. My family and I were affected by natural disaster fueled by climate change. We lost our home in wildfires in California and I went through three wildfire seasons which was the catalyst of me moving to Turkey. So where do we move? I moved where I had family and then I moved to Paris where I could study environmental policy. So, this is exactly the kind of discussion and participation that I really hoped for and hope that continues on beyond this workshop because my life and my mother's life, our trajectories were changed by a fire that we didn't see coming into a community that had never experienced wildfires, but now experience it almost on a yearly basis. And I think more and more people will be

experiencing this. And I think that's what brought you all here, because you know that your lives personally and your children's and your grandchildren's lives are going to be experiencing this. And you want to find out ways that you can communicate with others about this, but learn from each other, teach each other. And I have really benefited from all of your words here today.

GM Marc. Thank you all. It looks like you are a nice group, working well together, you are friendly with each other, so you are good citizens. We put you through this exercise in the middle of complexity and bad news in 2050 and we all agree that it was difficult. You tackled the difficulties all group and decision makers must probably encounter. And besides your being nice to each other, which is of course important, I want to point also some learning in the process of the group work, from the beginning throughout the progression. I could notice some changes in the way you related to each other, paying more attention to what was said and building upon it. And as you are a performing group, ECOSENS might ask you for more involvement [*smiles*].

02:23

End of group discussion

ANNEX 2: Participants' Evaluation and Feedback

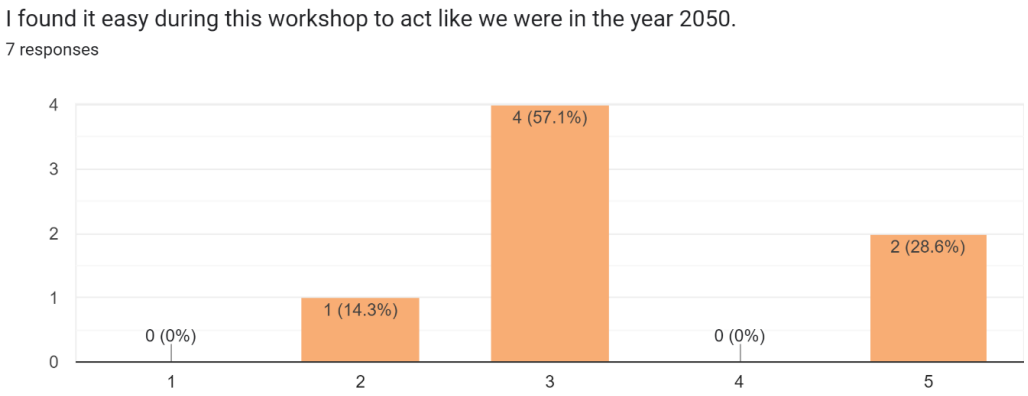
A survey for post workshop evaluation was done with participants. Results present the responses to the questionnaire and the individual comments to open questions. 7 out of 13 participants responded to the online, anonymous questionnaire opened after the workshop.

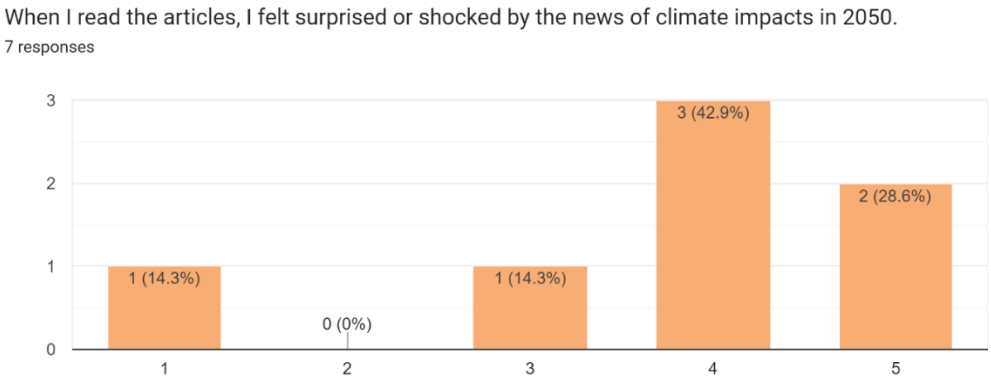
Separately, a draft version of the *Group discussion* and *Recommendations* was sent to participants for review and comments. 3 participants responded (see their comments and ECOSENS moderators' replies at the end of this annex II).

Overall, evaluations are contrasted and comments provide as well distinct points of view, reflecting various modes and levels of engagement in climate issues.

Responses to the online evaluation questionnaire

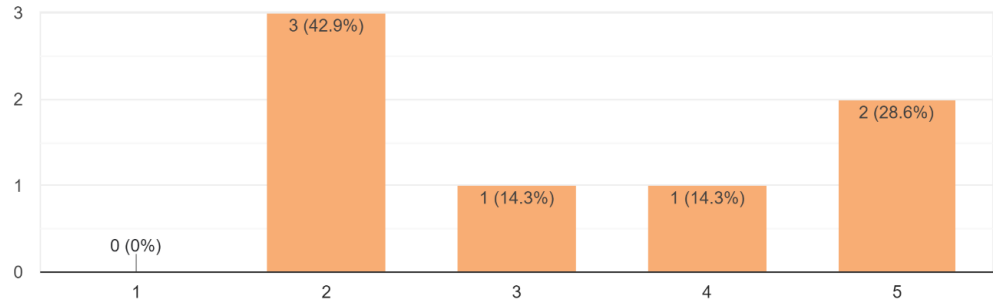
Scale: 1= Absolutely 5= Not at all





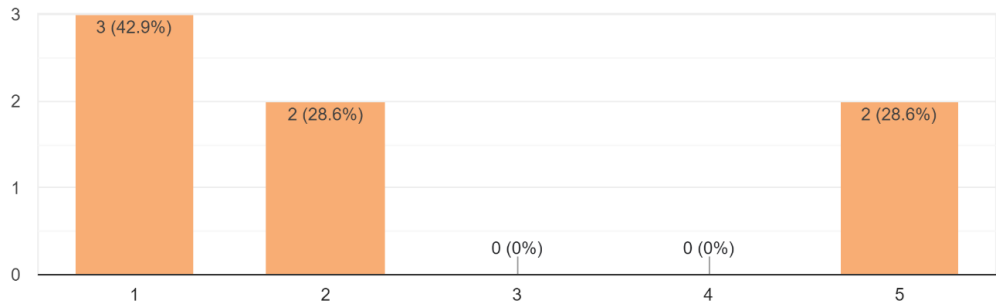
When I read the articles, I felt like the 2050 energy landscape was surprising.

7 responses



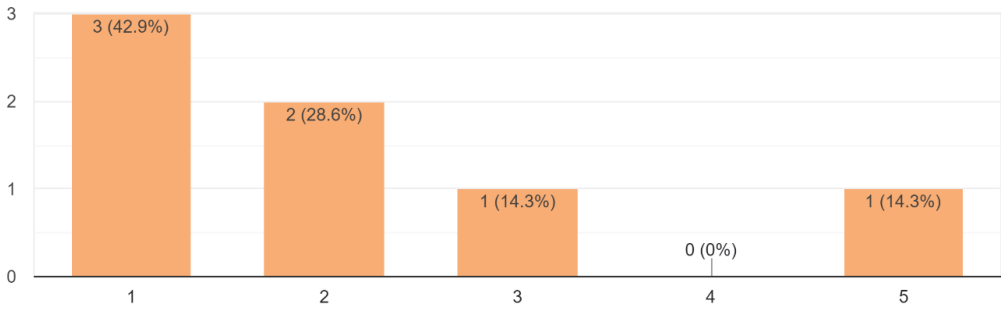
I found the discussions interesting.

7 responses



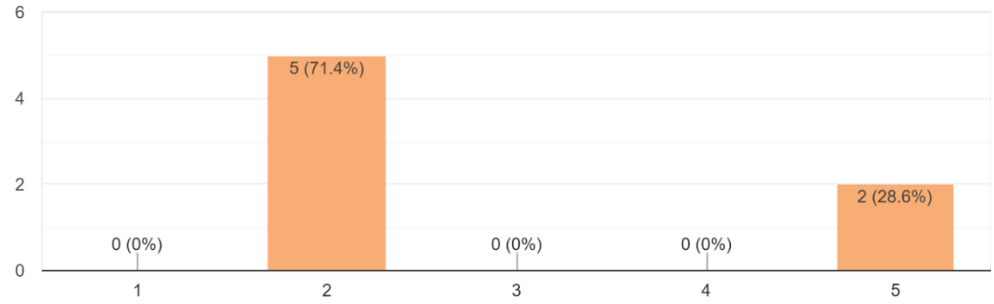
The workshop enabled me to reflect and express my ideas.

7 responses



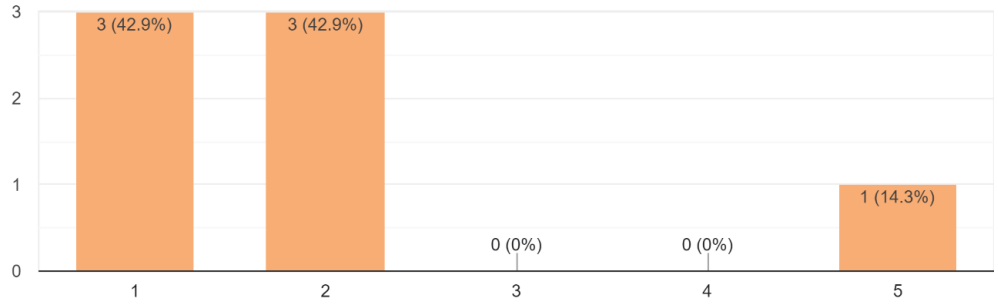
I heard, or I came up with, something new during this workshop.

7 responses



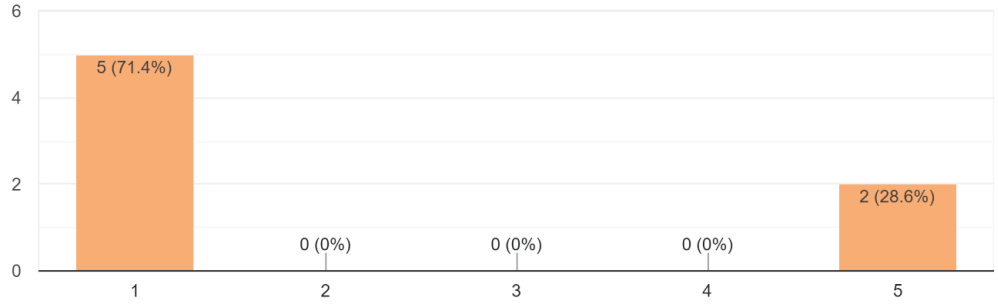
The facilitators made space for differing views and opinions.

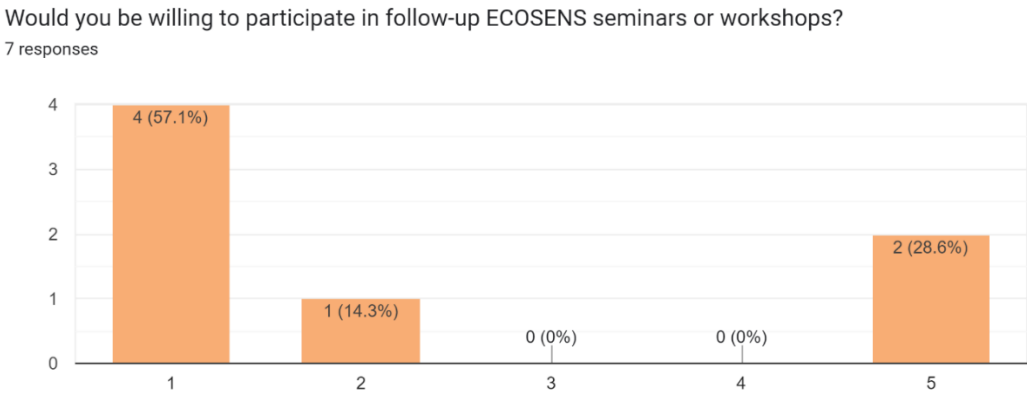
7 responses



Overall, were you happy to participate in the workshop?

7 responses





Individual responses and comments to open questions

Is there a special moment (good or bad) that you remember? (4 responses)

- The discussion in the afternoon with people from the community
- Reflecting upon how the participants, who come from a very broad range of academic and professional sub-disciplines in the social sciences, ingest and grapple with climate issues. I was particularly surprised to see livelihood and way of life considerations (to include ethical components) top the list of the recommendations for policymakers, rather than concrete steps to reduce emissions, decarbonize the economy, advance climate adaptation measures, etc.
- Bad moment was hearing the afternoon nonsensical methodology presentation, waiting for chance to point out flaws and outrageous loopholes in design, but instead having to hear a panel present not on methodology but preferred climate-friendly energy solutions; also, unfortunate to hear one of the organizers twice cite the "stakeholder" group "major conclusion" when there had been no such conclusion
- There were many good moments

Do you have any feedback to give us on the two newspaper articles dated 2050? 4 responses

- Eliminate parts from the articles that smack of promoting nuclear energy
- The article on the disasters/calamities seemed plausible. But the energy mix for 2050 is much too conservative. I strongly believe we will have mostly carbon free energy sources in 2050.
- Narratives unrealistic, clearly copy pasted from fossil fuel industry PR/ecomodernist literature
- Not directly. Except that action is urgent with respect to the climate change.

What could we change or improve in this workshop? 3 responses

- There was a lot of focus on 'stakeholder engagement'—this gave the impression that, in the end, ECOSENS was meant to promote the nuclear, make it palatable; it would be good to

clarify where ECOSENS stands from the very outset of a workshop. And: it would be good to discuss worldviews/assumptions underlying scenarios.

- Possibly, providing the documents before the workshop could have helped to make better use of the time available. Perhaps some additional guidance could be helpful. Now you had the experts you could consult. But some examples of policy advise could have made it more tangible for the group.
- The workshop was well organized. The morning session led to a list of suggestions by all participants that was collected by the moderators. The panel session in the afternoon was meaningful[5].

Review and comments on the Group discussion transcript and Recommendations (which were circulated to all participants). 4 responses.

- Framing/presentation of the 'group recommendations'. While recommendations were indeed discussed, it would be good to make it quite clear in presenting these (in any kind of forum) that these were 'radical ideas' rather than recommendations AND that there was no formal unanimity on any of the ideas presented. Not being in favor of nuclear energy solutions myself (take far too long to be realized; and nuclear waste remains as problematic as ever), I would not want the impression to be conveyed that participants agreed on the (rather numerous) 'recommendations' involving the nuclear (SMRs in particular).

[Following this comment, the title of this chapter was changed to "Radical ideas and recommendations" and a note was added in introduction.]

- Positive feedback on the completeness of these documents.
- Positive feedback on the discussion document. Regarding the Recommendations: first n° 14 needs rewording to be understood correctly. Secondly, questions about the role these recommendations play in the ECOSENS project a) how do they contribute to the ECOSENS objectives? b) how will they be reported? c) to which target audiences will these recommendations be addressed? d) will the names of the group of people behind the recommendations be revealed publicly?
- Request to receive the full transcript of the group discussion.

[The wording of Recommendation n°14 was changed and other questions answered: The fit of the Here & Now 2050 Workshop within ECOSENS and the conceptual background are introduced in the present report. The full transcript (provided in Annex I) identified speaker names; only the anonymized document can be circulated as agreed with respect to data protection; the presentation of the participants doesn't reveal the names nor the institutions.]

[5] This refers to the ECOSENS Scientific Event held in the same venue, which included remarks by the workshop participants.

ECONOMIC AND SOCIAL CONSIDERATIONS FOR THE FUTURE OF NUCLEAR ENERGY

Transdisciplinary sensibilities in investigating nuclear research and innovation

report from the EASST workshop

authors

Robbe Geysmans, Gaston Meskens, Catrinel Turcanu – SCK CEN
Susan Molyneux-Hodgson – University of Exeter

Funded by the European Union

Transdisciplinary sensibilities in investigating nuclear research and innovation

Report of the ECOSENS panel at the EASST/4S conference 2024
Amsterdam 16-19 July

Authors: Robbe Geysmans, Gaston Meskens, Susan Molyneux-Hodgson, Catrinel Turcanu

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

Introduction

Every 4 years, the European Association for the Study of Science and Technology (EASST) and the Society for Social Studies of Science (4S) co-organize a joined conference to bring together a large amount of researchers working in the field of Science and Technology Studies (STS). From July 16th until July 20th 2024, the EASST/4S conference took place in Amsterdam, bringing together over 3000 STS-scholars. The focus of the conference was 'making and doing transformations', hence providing a strong potential connection to the ECOSENS project, which inter alia focuses on the potential deployment of nuclear technologies in a context of vast societal challenges. It was therefor decided to submit an ECOSENS panel to the EASST conference, in order to facilitate discussions and exchanges relating to topics relevant for the project with a wider range of (academic) stakeholders.

The panel was titled 'Transdisciplinary sensibilities in investigating nuclear research and innovation', and was co-chaired by Susan Molyneux-Hodgson (University of Exeter) and Robbe Geysmans (SCK CEN). It aimed to invite contributions on the challenges and opportunities for trans- and interdisciplinary collaborations in research, development, innovation, and decision-making in the nuclear realm. Attention was also directed at participants' experiences with, and conceptual and methodological approaches to inter- and transdisciplinary research in the nuclear field. A full abstract of the panel can be found in Appendix A.

This report provides a summary of the various contributions made to the ECOSENS panel, with a particular focus on the ensuing discussions held during the panel sessions.

Panel template

The panel was accepted by the conference organizing committee in November 2023, after which it was opened for contributions from potentially interested scholars. By the abstract deadline in February 2024, 5 contributions were received, which were all positively evaluated by the panel convenors. Of the five received contributions, 4 were more classical conference presentations, while one proposed to host a group discussion on experiences related to inter- and transdisciplinary projects in nuclear research and policy advice. In consultation with the conference organizers, it was decided to provide two sessions in the panel: one 1,5 hour session in which 4 presentations would be provided, and a second 1,5 hour session for a group discussion. Both sessions were organized on Wednesday July 17th 2024, from 9h00 until 10h30 and from 11h00 until 12h30 respectively. The detailed program can be found in Annex B. A total of approximately 25 conference participants attended the panel, both during the 1st and the 2nd session.

Panel report

Session 1 (Wednesday 17/07/2024 – 09h00-10h30 CET)

During the first session, 4 conference presentations were provided.

The first presentation, by Linda Marie Richards from Oregon State University, provided an account of the inequalities which tend to dominate the nuclear landscape, with a particular focus on nuclear weapons and the legacies of their development. Driven by a desire to better comprehend how such inequalities exist and came into being -with e.g. historic contaminations as perpetuating witnesses to the real-world effects of such inequalities-, an account was provided that argued how international institutions such as the United Nations and later on the IAEA have dominated the nuclear landscape and narrative, while sidelining other organizational actors (e.g. the WHO or the ILO). During the Q&A after the presentation, this view was

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

backed by some participants, who shared a view that currently, the IAEA is working both as 'protector of safety' and 'promotor of nuclear', which might entail conflicts of interest.

The second presentation was provided by Jan Haverkamp from Nuclear Transparency Watch, WISE and Greenpeace, who reported on the civil society interactions which took place in light of the European Joint Programme on Radioactive Waste Management (EURAD). Particular attention was directed at experiences gained in the UMAN and ROUTES workpackages of the EURAD program. Interactions were based on a 'double-wing' model, in which a distinction was made between civil society 'experts' (with e.g. strong technical knowledge) and a broader civil society group. Besides reporting on some concrete activities undertaken in the UMAN and ROUTES WPs (e.g. the PEP serious game in UMAN), the presentation highlighted the positive assessment of the civil society interactions by the EURAD program, with the prolongment of the CS interaction model in EURAD2 as a testimony to this. Some of the challenges mentioned entail the differences between societal and technical understandings of certain issues, differing views regarding the 'consensus' around geological disposal (which was 'loosened' a bit due to CS interactions) and the challenge of continuity.

In presentation 3, Robbe Geysmans from SCK CEN presented some insights regarding socio-technical integration gained through experiences in an ongoing project on the development of heavy liquid metal nuclear systems (ANSELMUS). The presentation discussed attempts to facilitate reflections of techno-scientific researchers regarding the interactions between their research and broader society during the R&D phase. The various activities reported on entailed individual questionnaires, socio-technical integration research (STIR) and workshops, which were justified with an intention of enabling responsible research and innovation (RRI). The experiences revealed that techno-scientific researchers reflected (already or more strongly) on the socio-technical interactions shaping their work, but mostly considered these interactions in the immediate context of their work (e.g. organizational impacts, project communication, researcher agency), while in a lesser extent also drawing connections to broader societal impacts. Overall, the facilitation of socio-technical reflections entailed also some challenges, not in the least regarding the sometimes fuzzy role of the researcher her/himself.

Finally, presentation 4 entailed a joined presentation by Brandon Costelloe-Kuehn and James Olsen from Rensselaer Polytechnic Institute. In their contribution, they discussed experiences with an ongoing consortium on developing a community-centred toolkit for community engagement in the context of "Consent-Based Siting" (CBS) of nuclear waste facilities in the US. This consortium is one of 12 consortia which are currently active in this US effort towards CBS. Drawing on their different backgrounds and perspectives on the topic, they provided a wide range of questions and challenges that come with trying to set up a 'consent-based siting' process in the development of a nuclear project (e.g. how to avoid 'deficit-model', but also critically reflect on knowledge needed to have meaningful discussions, what could 'transdisciplinarity' mean in practice in contexts of consent-based siting?). Focus of the presentation is specifically on the process of inter/transdisciplinary work, rather than solely the outcome, arguing that this process is an essential feature in order to establish a new subject (instead of applying interdisciplinarity 'to' a subject).

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

Session 2 (Wednesday 17/07/2024 – 11h00-12h30 CET)

The second session consisted of a group discussion, in which participants were invited to share their experiences with and reflections on transdisciplinarity. The session started with a presentation by Gaston Meskens on the subject of transdisciplinarity.

In this introductory presentation, it was highlighted how science has evolved, due to societal challenges being of such a nature that 'traditional' science is not equipped to tackle societal challenges. Many of the grand challenges society faces are characterized by a wide variety of actors that are part of the complexity, with a responsibility shared among everyone concerned. This offers a key step towards transdisciplinarity, in which the involvement of various actors, with a problem-oriented focus, is a key aspect.

After a short introduction to the ECONSENS project, with a particular emphasis on the concept of sustainability and the diverse meanings and activities sustainability could entail, the floor is opened to a wider discussion on transdisciplinarity in the nuclear field.

The discussion started with some participants sharing experiences with transdiscipinarity which they considered as rather shallow or unsatisfactory, because they were short-lived, or because they excluded certain voices (e.g. some local community members in environmental remediation). While short-lived initiatives of collaboration might be a step towards more profound and durable collaborations, the issue of exclusion was recognized by some of the participants as a clear issue of power inequality, which risks to be at play in many transdisciplinary initiatives. The fact that in many collaborations or exchanges between researchers and other stakeholders, there is a power imbalance (e.g. in terms of financial resources, perceived 'expertise', access, …) means that in practice many collaborative initiatives are rather limited in what they can achieve.

Furthermore, and partly connected to the issue of power inequalities, transdisciplinary collaborations in (and beyond) the nuclear field are also characterized by a potential lack of trust. Those working in the nuclear field as technical experts (engineers etc.) sometimes feel that if broader publics are involved (SSH researchers, but also citizens) everything they say 'might be used against them', while to 'outsiders', the nuclear industry is often considered as a 'black box', in which a lot of decisions are taken without transparency or clear justifications. Some participants raised that a way to overcome such issues of trust/mistrust, could lie in emphasizing that different actors are working on a shared issue, which is by default characterized by uncertainties, which you need to accept, while also consolidating knowledge and moving forward.

The recognition of uncertainties, and that certain things are just 'not known' according to some also could serve as a way to handle the reality that in many collaborations a distinction persists between 'technical' and 'social' issues, at least in the thinking of people. Acknowledging and emphasizing that some things are just 'not known', helps dissolving the divide between 'knowing' and 'unknowing' actors. This was e.g. the starting point in the PEP serious game which was developed in the UMAN project (cfr. presentation J. Haverkamp in session 1), which starts from discussions originating in the inherent uncertainties connected to radioactive waste management.

A participant raises the point that recognizing uncertainties and things 'not known' could indeed be an interesting approach, but might also prove sometimes very difficult, as different stances have evolved over certain 'unknowns'. The example of the linear non-threshold model is given in this light, which in essence

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

is an ethically motivated manner to deal with an unknown regarding the effects of very low doses of ionizing radiation.

Revolving back to discussions on the potential usefulness of transdisciplinarity in the nuclear field, a participant argues that transdisciplinary projects have become some kind of 'buzzword', and that the perception exists that nowadays things have to be 'transdisciplinary' just for the sake of transdisicplinarity, while in reality transdisciplinary collaborations might in fact not be needed, effective or desirable. The point is for example raised that some academics prefer not to collaborate in any way with nuclear industry actors, as their goals and objective are perceived to be too different to make any kind of meaningful research collaboration possible. Others agree that it is important to keep a critical distance towards the actors involved in transdisciplinary projects or the subjects of the collaboration, but that this should not de facto rule out any kind of collaboration.

It is recognized that transdisciplinary collaborations require that actors create some sort of 'new language' in which they also move beyond their own pre-conceptions and categorizations. In the nuclear field, moreover, some spaces seem to be fenced of from transdisciplinary encounters. It is for example remarked how discussions on new nuclear tend to be often (perceived as) excluding discussions on radioactive waste management (and vice versa). This also relates to comments by participants which emphasize the rather instrumental nature being attributed to many collaborations in the nuclear field, while transdisciplinary collaborations would essentially also require a recognition of the substantive nature of such collaborations: bringing together different knowledges, experiences, and/or frameworks can also/are a requirement for better outcomes.

Towards the end of the discussion, participant highlight again that transdisciplinarity should not be a goal in itself, and is also not an approach which should always be used. But if transdisciplinary collaborations take place, they require time, effort and care. In the current research landscape (in nuclear and beyond) this is often considered difficult, as a lot of the work conducted is project-oriented, and hence managed by strictly controlled timelines and resources.

Appendix A – Panel abstract

Transdisciplinary sensibilities in investigating nuclear research and innovation'

Societal shifts away from fossil-fuel reliance, whether rhetorical or realisable, have opened larger spaces for discussion on the future energy mix to be aimed for and the ways in which this can be achieved. Alongside, and post-Fukushima, there has been a marked divergence in views on the place of nuclear in this energy mix, both in national policies and local debates. For some nations, a resurgence in nuclear innovation is the proposed solution to meeting future energy demand, for others, nuclear is off the table.

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

The engagement of STS scholars in nuclear debate has come and gone over time. Meanwhile, inter- and trans-disciplinary ways of working have come more to the fore in terms of thinking and acting in STS. This panel will consider the intersections of inter/ transdisciplinary policy and practice and nuclear energy presents and futures. We aim to ask:

-What matters of concerns are present or absent in nuclear discussion?

-What new forms of STS engagement with nuclear have emerged and what are the specific challenges around STS interaction with nuclear? are productive forms of societal interaction possible with the nuclear realm?

-Are emerging nuclear innovations (e.g. small modular reactors) shifting debate and/or presenting new challenges to STS, to stakeholder engagement and to public discourse?

The panel invites contributions on the challenges and opportunities for trans- and interdisciplinary collaborations in research, development, innovation, and decision-making in the nuclear realm via studies of, and experiences with, inter/transdisciplinary interaction with technological innovation, and with a focus on conceptual frameworks and methodological approaches to understanding and challenging such collaborations. We welcome academic papers/presentations (ethnographic encounters, policy analysis, citizen science), video essays, storytelling and interactive formats.

The panel is organised with the ECOSENS project and SHARE research platform and will also involve a Workshop session (to be submitted separately).

Appendix B – Panel program

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

Session 1 Wednesday 17 July, 2024, 9:00-10:30

How the UN sustained the power of the nuclear haves: a transnational and transdisciplinary exercise

Maria Rentetzi (Friedrich-Alexadner-Universität Erlangen-Nürnberg) , Aske Hennelund Nielsen (Friedrich-Alexander-Universität Erlangen-Nürnberg) , Linda Marie Richards (Oregon State University) , Véronique Stenger

Lessons learnt from EURAD interaction with civil society (ICS)

Nadja Zeleznik (EIMV) , Alexis Geisler-Roblin (Ecole Normale Supérieure) , Jan Haverkamp (Nuclear Transparency Watch - WISE, Greenpeace)

Integrating social considerations in advanced nuclear reactor technology? Experiences from an ongoing interdisciplinary project

Robbe Geysmans (SCK CEN) , Catrinel Turcanu , Joke Kenens (SCK•CEN Belgian Nuclear Research Centre)

Developing a collaborative paradigm for engagement: towards transdisciplinary and community-engaged work at the intersection of STS and nuclear engineering

brandon costelloe-kuehn (Rensselaer Polytechnic Institute) , James Olson (Rensselaer Polytechnic Institute)

Session 2 Wednesday 17 July, 2024, 11:00-12:30

Making and doing session on transdisciplinarity in nuclear research and policy advice

Gaston Meskens (SCK CEN, the Belgian Nuclear Research Centre)

The ECOSENS project has received funding from the Euratom Research and Training programme, a complementary funding programme to Horizon Europe, under grant agreement No 101060920. Views and opinions expressed are those of the author(s) only and do not necessarily reflect those of the European Union, European Commission or European Atomic Energy Community (granting authority). Neither the European Union nor the granting authority can be held responsible for them.