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Policy note: Analysis of expert scenarios addressing ethical implications of the selected technologies

D3.5

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D3.5 Analysis of expert scenarios addressing ethical implications of the selected technologies

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The TechEthos Project

Short project summary

TechEthos is an EU-funded project that deals with the ethics of the new and emerging technologies anticipated to have high socio-economic impact. The project involves ten scientific partners and six science engagement organisations and runs from January 2021 to the end of 2023.

TechEthos aims to facilitate “ethics by design”, namely, to bring ethical and societal values into the design and development of new and emerging technologies from the very beginning of the process. The project will produce operational ethics guidelines for three to four technologies for users such as researchers, research ethics committees and policy makers. To reconcile the needs of research and innovation and the concerns of society, the project will explore the awareness, acceptance and aspirations of academia, industry and the general public alike and reflect them in the guidelines.

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Abbreviations

TABLE 1: LIST OF ABBREVIATIONS

Term	Explanation
CDR	Carbon dioxide removal
CE	Climate Engineering
CO2	Carbon dioxide
DoA	Description of action
GDPR	General Data Protection Regulation
ML	Machine Learning
NLP	Natural Language Processing
PC	Project Coordinator
R&I	Research and Innovation
SAI	stratospheric aerosol injection
SRM	solar radiation management
STEEPV	Social, technical, economic, environmental, political and values
WP	Work Package
XR	Digital Extended Reality

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Executive Summary: Anticipating Ethical Issues to Inform Technology Development

Anticipating social and ethical isseus associated with technology development enables proactive governance of research and innovation (R&I) to benefit society. In this policy note, we draw on expert reflections about future scenarios to offer recommendations for climate engineeirng, digital extended reality, and neurotechnology R&I governance.

Technologies are not created from a blank slate. Technological development and deployment depend upon and integrate within human and natural systems. Therefore, it can be helpful to consider possible future developments and deployment of new or emerging technologies in social and ecological systems different from our present-day circumstances. Such consideration of possible futures helps one surface assumptions, ethical, and social blind-spots associated with technology development. It is in this spirit that we used scenarios – plausible narratives about possible future states of the world – to consider each of the three TechEthos technology families:

- Climate engineering – refers to: deliberate, "large-scale intervention in the Earth's climate system, in order to moderate" global climate change and its effects (Shepherd et al. 2009, p. 1).
- Digital extended reality – refers to technologies with the common functionality to emulate human traits and social circumstances and radically alter how people connect with each other and their surroundings.
- Neurotechnology – Neurotechnology family refers to devices and procedures used to access, monitor, investigate, assess, manipulate, and/or emulate the structure and function of the neural systems of natural persons (OECD 2019).

The results that follow are drawn from expert reflections shared in each of three participatory workshops using TechEthos-generated scenarios. Workshops focused on the ethical issues and social implications of the following three technology families. Significant ethical issues already accompany these technologies, whether they are in early or more advanced stages.

- With climate engineering technologies we observe issues related to irreversibility of consequences; social inequality perpetuated or created by application; transparency of decision-making around deployment; and responsibility towards current and future generations.
- With digital extended reality, ethical issues may include cognitive and physiological impacts and behavioural and social dynamics, such as influencing users' behaviours, and monitoring and surveiling people.
- With neurotechnology, concerns include personal data privacy management, integrity and responsibility, potential use of for unintended or untested purposes (e.g., off-label use), and misuse of such technology.

Methodological note

We used scenarios and participatory expert deliberation to explore these and other potential social and ethical issues. Each scenario was composed of different social, technical, economic, environmental, political and values (STEEPV) dimensions and designed to surface social and ethical issues. The creation of the scenarios followed a five-step process, repeated for each technology family: (1) research about trends and drivers, (2) identification of key factors, (3) creation of future projections based on the results, (4) clustering of projections and validation of results to (5) writing up of three narrative scenarios. We prepared three scenarios for each of the three TechEthos technology families (nine scenarios in total). When creating the scenarios, the team of authors was guided by the following parameters:

- Develop "plausible" scenarios: concrete, consistent and coherent narratives

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- Develop "contrasting" scenarios: diverse collections of social and technical factors in each narrative
- Use STEEPV for structuring the basic scenario development process as well as scenario narratives

Expert workshops conducted in late April 2022 were attended by gender balanced diverse groups of individuals recruited from research , education, industry, and civil society organizations. Fifteen experts attended the climate engineering workshop; eight attended for extended reality; eleven attended for neurotechnology. A total of nine scenarios were presented—three for each technology family. At every workshop, the appropriate three scenarios for the technology family were explored. Each scenario was discussed in-depth. Experts were identified in collaboration with consortium member experts responsible for conducting innovation system and ethical analyses. The workshops were held online, one for each technology family, lasting four-hours. Scenarios were sent in advance, and discussions were supported using the Miro virtual whiteboard platform.

In the workshop, participants were first asked to share initial impressions, reflections, and corrections to the scenarios themselves. Next, experts discussed ethical issues surfaced by the scenario (in breakout groups). Finally, a plenary discussion reviewed ethical issues discussed in all breakout groups, as well as possible responses. Divergent points of view were encouraged in the conversations, as our intent was to capture a wide range of expert opinions on the technology families and associated ethical issues and responses (i.e., not consensus). The scenarios were thus presented as provocations to critically reflect on what *might* happen and not forecasts or predictions of what might *likely* happen.

Brief descriptions of the scenarios in each workshop are found in corresponding sections. Full scenarios are available upon request and will be made public in the TechEthos Deliverable 3.1, released in December 2022.

Key results

The experts consulted emphasized that when considering the use of scenarios to elicit ethical issues and potential responses:

- Even when scenarios feature a single technology, there is no single solution. For example, stratospheric aerosol injection (SAI) ought not be seen as an alternative to, but intrinsically dependent on, emissions reductions if its use is to be limited in time.
- Scenarios featuring different technologies are difficult to compare. While the goal of this exercise was to surface a diverse set of ethical issues across climate engineering (CE) technologies, for example, a follow-up workshop using more closely related scenarios might help to more deeply probe ethical issues of each technology.
- Scenarios might be worth considering where similar technological and social developments unfold with and then without desired effects (e.g., in the case of CE, preventing catastrophic global climate change). While beyond the scope of the TechEthos project, such an effort might prove fruitful for those responsible for emergency preparedness and disaster response.

The reflection on ethical and social issues presented herein should be viewed in complement to the additional analysis conducted in other TechEthos project activities (e.g., document-based and digital ethnographic analyses of ethical issues (Work Package 2); legal analysis (Work Package 4); media analysis (Work Package 3); public engagement exercises (Work Packages 3 and 5), etc.), and the varied works of other scholars, stakeholders and the public.

***Note:** The results presented are a synthesis of participating experts' opinions, and do not necessarily reflect the position of the TechEthos project or serve as an endorsement of the governance measures proposed.*

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1. Climate Engineering

1.1 Background: Climate Engineering Technologies

Climate engineering (CE) refers to technologies deployed for large-scale modification of planetary processes to mitigate the hazards of anthropogenic climate change. Across a range of technologies and approaches, one can distinguish two different proposed CE techniques. Carbon Dioxide Removal (CDR) technologies aim to capture and store carbon dioxide pollution. CDR is thus proposed as a slow-acting intervention to remove carbon from atmosphere. Solar Radiation Management (SRM) techniques, by contrast, are thought to be fast-acting, and do not seek to directly affect carbon balances. SRM technologies aim to reflect sunlight and radiant heat back into space, thereby potentially helping to mitigate adverse weather impacts of climate change.

Intentional, large-scale climate interventions implied by proposed CE technologies raise many potential ethical and social issues. We present results of expert-discussions based on three distinct, plausible scenarios of futures where CDR or SRM technologies have been widely deployed. The three climate engineering scenarios from which these results were generated feature contrasting social, technical, economic, environmental, political and value configurations of possible future worlds.

- In the first scenario, bioenergy with carbon capture and storage was considered in contexts of geopolitical tensions related to land-use (African and European Unions) and exacerbating social inequality;
- In the second scenario, solar radiation management was considered, in the context of shifting geopolitical dynamics (China-India alliance) and a major global public opinion change associated with climate-crisis denial.
- In the third scenario, large-scale implementation of carbon dioxide removal was considered, featuring afforestation, reforestation, and carbon sequestration methods especially, as well as shifting geopolitical dynamics (increasingly divided US; EU-China alliance).

What follows is condensation of workshop results in terms of three thematic concerns associated with plausible future CE directions; related social and ethical issues; and potential solutions for policy and practice.

1.2 Exploring Climate Engineering Futures: Issues and Potential Solutions

1.2.1 On development

Across all three climate engineering (CE) scenarios, experts touched on the problem of assuming a uniform approach to "development" across the planet. Such an assumption—that all countries by default “want” to “develop” in a singular mode of extractive, material consumption and environmental degradation as found in heavily industrialized countries—ignores varied cultural preferences about desired ways of living. Problematic too is the way it hides or side-steps the destructive aspects of economic growth contributing to anthropogenic climate change in the first place.

A number of ethical issues follow a position on assuming extractive development as a desired global norm . One, the position ignores **concerns of distributional justice** and unequal sharing of burdens and benefits of action or inaction. The costs to launch CDR and SRM technologies, and the benefits of their effects, may not be uniformly or equitably distributed. Without attention to the distributional dynamics, existing inequalities produced by current economic paradigms might worsen. In addition, ignoring problematic approaches to economic development runs the risk of re-creating issues when deploying environmental or social “solutions” to climate change. For example, any CE requiring land use (in the case of reforestation or bioenergy with carbon capture and storage) will have to recon with the associated political

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economy of land-grabbing, dispossession, ecologically devastating monocultures, perverse incentives for old growth forest deforestation, etc.

Solutions suggested as potentially useful for addressing this problematic assumption include the need to open-up to alternative development paradigms when discussing CE. This starts by not assuming an imperialistic, industrialized, extractive, exploitative mode of growth as the default assumption for desired deployment around the world. This could be aided by explicitly moving beyond a Euro-centric framing (or a framing dominated by any one large national or transnational bloc). Efforts to decouple concepts of enhanced quality of life and degradation of environmental and social systems in which people live offers a key opportunity to generate more equitable futures in which CE might feature.

1.2.2 On decision making

Across all three climate engineering scenarios, experts touched on the need to attend to the ethics of decision-making related to CE technologies. Questions were raised around whether to research or deploy some of these technologies, more than how or in what ways. Such questions are connected to the global and regional dynamics of climate systems where unilateral or adversarial multi-lateral deployment may have far-reaching regional and global ramifications—climatic or geopolitical. In addition, questions were raised around assumptions of incumbency in decision making structures, and whether (and how) decision making around CE might perpetuate injustices and sidestep ethical issues also associated with rapid decarbonization.

A number of ethical issues follow a concern for the ethics of decision making. For one, there are concerns, particularly related to unilateral deployment of technologies, like stratospheric aerosol injection (SAI), where regional consequences may play out beyond the zone of technology deployment. Closely related to the issue of deploying SAI was a call, still, to consider the alternative—the negative impacts of non-deployment. Related to carbon capture and storage, social and ethical concerns arose related to carbon storage siting. These touched on whether vulnerable communities would be included and / or further disadvantaged in decision-making about where to site storage facilities for captured carbon. An additional concern relates to abuse of political economic power; for example, of multinational fossil energy companies potentially standing to profit from removal of the very pollution they profited from emitting into the atmosphere (to say nothing of government economic subsidies enacted to enable such pollution).

Solutions suggested as potentially useful for addressing ethical issues include establishing governance regimes commensurate to the scale of CDR and SRM challenges. Such systems of governance might include international agreements to addresses decision-making procedures that strongly attend to unequal power relations (either across nations or between large multinational private actors and public entities). Agreements might also be considered within this context around SAI use with expanded research and collaboration so that all actors might better understand potential implications of SAI and CDR deployment and use. In addition, experts discussed the importance of parallel and related, empowered social dialogues (among civil society, small businesses, researchers, and publics) to articulate forward-looking, inclusive governance goals for CE.

Both for international governance agreements and large-scale public deliberations, experts urged the importance of not framing CE as an "easy thing" to discuss and solve—to honour the difficulty of the approach. They also noted the importance of explicitly addressing trade-offs and complementarities among different goals - climate, food, biodiversity, livelihood, etc. Experts discussed in depth the ethics of decision making about SRM considering not only worst-case but also more moderate scenarios, as well as the outcomes of non-intervention.

1.2.3 On technological fixes

Across all three CE scenarios, experts touched on the need to challenge the problematic assumption that climate change may be addressed through technological fixes alone. Such an assumption, experts warned, is dangerously misguided. First, any such technological fixes will be strongly conditioned by social forces (for example, see the 1.2.2 concerns related to perpetuation of injustices in decision making about CCS or

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other CDR technology). In addition, fixating on technological-fixes ignores systemic, socially-driven responses to climate change (whether through transit, farming, energy, built-environment, lifestyle or any number of others) – potent interventions in their own right.

A number of ethical issues follow from a focus on technological fixes. Using catastrophic forced-choice situations to make policies that push quick-acting, short-term technological fixes, represents a core ethical concern. Such an approach ignores potentially longer-lasting, more efficacious, non-technological and systemic interventions. Finally, approaching CE from the lens of technological fixes means ignoring serious environmental harms and human exploitation and harm not directly associated with levels of carbon pollution—for example various forms of water, air, and land pollution or ocean acidification.

Solutions suggested as potentially useful to address these ethical issues require looking beyond technological fixes to climate change. Importance was placed on situating climate engineering technologies amidst a broader tapestry of interventions in carbon and pollution mitigation and reduction, and adaptation—for example transportation, health, diet, agricultural, information, and food systems interventions. Actively countering misinformation came up as an important component of this discussion. In addition, discussion revolved around empowering stakeholders and communities in developing countries to build the expertise to have informed and respected seats at decision-making tables. Finally, participants discussed the importance of considering broader ecological concerns as part of CDR and SRM conversations.

TABLE 2: SUMMARY TABLE OF THEMES, EXEMPLARY ETHICAL ISSUES, AND POTENTIAL SOLUTIONS

Theme	Ethical Issues	Potential solutions
Assuming a uniform model of development	Generating distributional justice issues; unequal sharing of burdens or benefits Repeating known failures of other technical and social interventions (fuelling land-grabbing, dispossession, ecologically devastation, etc.)	Opening to alternative development paradigms when discussing CE Not assuming an imperialistic, industrialized, extractive, exploitative mode of growth as the default assumption for desired deployment around the world Decoupling concepts of enhancing quality of life for people across the world from environmental degradation
Not addressing concerns about decision making	Deploying technologies unilaterally Siting carbon dioxide storage facilities without consent of local communities (e.g., procedural justice) Abusing political economic power; for example, multinational fossil energy companies profiting from pollution created based on their actions and government incentives	Establishing governance regimes commensurate to the scale of CDR and SRM challenges Strongly attending to unequal power relations (either across nations or between large multinational private actors and public entities) Empowering social dialogues to articulate goals through forward-looking, inclusive governance of CE
Focusing on technological fixes	Using catastrophic forced-choice situations to push technological fixes	Looking beyond technological fixes to climate change issues Situating climate engineering technologies as part of a broader tapestry of interventions

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	Ignoring potentially longer-lasting, non-technological and systemic interventions represents Ignoring serious environmental harms and human exploitation and harm not directly associated with levels of carbon pollution	Countering misinformation Empowering stakeholders and communities in developing countries to build the expertise to have informed and respected seats at decision-making tables

1.3 Conclusion

Intentional, large-scale climate interventions implied by CE technologies raise many potential novel ethical and social issues. Such issues are driven in part by problematic underlying assumptions about whether and how such technologies might play out in the world. Particularly, concerns include: assuming a uniform model of development is held by all nations; implementing CE without broader reflection on decision-making approaches; and focusing on technological fixes in response to climate change. The ethical issues associated with these flawed assumptions can be addressed by opening-up to alternative models of development; empowering equitable international governance and civil-society deliberations about CE; and pursuing broad, diverse, well balanced and socially considerate responses to climate change.

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Digital Extended Reality

2.1 Background: Digital Extended Reality Developments

Digital Extended Reality (XR) could change how people connect with each other and their surroundings in physical and virtual settings. This cluster of technologies includes Artificial-Intelligence-based technologies emulating or connecting with human cognitive functions (e.g., voice, gesture, movement, choices, feelings), and human-digital machine interaction and data processing technologies that could reproduce, replace, adapt, and influence human actions. Potential fields of application for XR includes remote assistance for educational, medical, and training purposes through virtual and digital devices such as mobile phones, computers, and autonomous systems. Potential ethical repercussions of XR technologies include cognitive and physiological impacts and behavioural and social dynamics, such as influencing users' behaviours, and sanctioned or unsanctioned surveillance of people.

The three XR scenarios from which the results below were generated feature contrasting social, technical, economic, environmental, political and value configurations of possible future worlds. Scenario 1 "Remote Work" describes the implication of a shift in work environments and working conditions from in-person work situations to complete remote work. Following the assumptions, it explores themes like de-urbanization of cities, social isolations of workers and the re-organization of office buildings. Scenario 2 "Training in Virtual Reality" focusses on the virtual education system and follows a young student who learns with the help of an advanced VR system. The scenario reflects the social segregation caused by technologically enhanced education and parents who prefer their children to learn in a "natural" way. Scenario 3 "Speakers for the Dead" explores a future in which natural language processing (NLP) is used for artificial but authentic communication processes. In one case, a machine learning algorithm is used to automatically compose and send out emails based on the communication patterns of deceased persons.

2.2 Exploring Digital Extended Reality Futures: Issues and Potential Solutions

2.2.1 Data ownership

Across all three XR scenarios, experts touched upon the question of data ownership. When machines start to create texts, audio, visuals or other XR media that resemble physical reality, intellectual property/ownership questions become relevant especially with regards to the copyright of the used data and the authorship of the created media. The training data used for machine learning (ML) algorithms to create these media comes from many different sources, and often without the knowledge of the sources, raising additional ethical issues about privacy and consent.

A number of ethical issues follow the issue of data ownership within the context of XR: One scenario described the application of NLP to generate communications appearing from deceased persons' accounts, sent to relatives, friends, and loved ones. Regarding the question of data ownership, neither the deceased person nor their heirs had the possibility to intervene or contradict the use of the data required to train and deploy the natural-language programme. This extreme example highlights areas where the regulation of personal data may be inadequate; for those living and deceased. This example also raises questions like: Who owns the product or service created based on data drawn from individuals or groups of people? If a machine creates a text based on the work of multiple authors, who might be considered the author of said novel text and receive licenses or payments?

Solutions suggested as potentially useful to address issues of data ownership include considering amendments to EU charters, such as the EU Charter of Fundamental Rights, which stipulates that EU citizens have the right to the protection of their personal data, and regulations, like the General Data Protection Regulation (GDPR). Such amendments could close any potential gaps related to protection for living and deceased persons. One solution would be an opt-in approach to ask users to permit/licence the data collected through the use of XR services (while maintaining smooth functionality). If users decline, the collected data might then not be used as training data for ML-based processes like NLP. Efforts to tackle data use and ownership issues may also be addressed through greater transparency. For example, making training data public and the used data traceable might help people comprehend ML algorithms and foster

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public control as well as individual consumer and user rights. With increased co-contributor traceability, individuals who own said data associated with XR media creation might be recognized and remunerated.

2.2.2 Digitalization of work and social interactions

Across all three XR scenarios, experts touched upon concerns related to how everyday life and social interactions may be digitalized. Digitalization may mean virtualization of everyday habits; creation of remote work environments that build upon globally available digital infrastructures; digital training, and education systems; the artificial (re-)creation of social interactions and communication practices through mediated content, etc. However, the seamlessness and consequences of such transitions of non-digital to fully virtual realities are far from clear.

A number of ethical issues follow the concern related to digitalization of work and social interactions. One exemplary set of issues relates to remote work. Such issues follow from certain types of jobs becoming increasingly possible through remote and/or virtual means. On the one hand, this might create or worsen societal divisions between groups of people who work remotely versus those requiring physical attendance. In addition, the increase of digital nomads—meaning people in sectors able to travel the world and work from anywhere with legal permission, electricity, and internet connections—may result in people working remotely for high-salaried positions but living in areas with low-cost of living. Consequently, the influx of such individuals might lead to distortions in rent, goods, and services for people working, paid, and living in areas with lower costs (currently observed, for example, in the Canary Islands in Europe or in Mexico City in the Americas).

Digitalization of work may also impact the social well-being of individuals. Working eight hours from home without meeting people face-to-face may result in diminished social units and fewer social contacts, affecting physical and mental well-being and resilience to external stressors in life. Such issues may become especially pronounced in cases where fragile digital infrastructures and associated systems (e.g., energy) fail, and no physical social redundancies exist—potentially affecting vulnerable members of society even more acutely.

Another challenge in this area relates to issues of authenticity in social interactions. As machine learning and deep fake videos become more advanced, it may be increasingly difficult to distinguish real and fake contacts, information, and data, wreaking potential havoc on interpersonal, cultural and political dialogue.

Solutions suggested as potentially useful to address issues with digitalization of work & social interactions ranged from algorithm-level interventions to enhanced democratic governance. To address the issues of social isolation, experts suggested implementing enhanced democratic mechanisms to correct social injustice and help people meet across physical and virtual divides: Targeted socialization programs might help counter isolation issues. To address social divides within the society, dedicated trainings for online work (especially for non-digital natives) might help overcome knowledge gaps in society. To tackle fragility of XR systems, experts suggested enhancing supporting infrastructures with guarantees for safeguarding local living and environmental standards. Efforts to address the potential risks of deep fakes and artificial social contacts might benefit from future regulation pertaining to labelling of machine created texts, speech, or other media. Furthermore, to tackle the issues of deep fakes, technical interventions at different levels in ML systems might be developed to check veracity, authenticity and the real-world grounding of the presented results.

2.2.3 Tech-Solutionism for social problems

Across all three XR scenarios, the experts questioned the existence of problems that XR technologies will help to solve. The potential use-cases presented in the scenarios (and in the discourse about this technology) are often replacing already existing areas of everyday life (e.g., public education, work, social interactions) while at the same time implying that the existing structures are decaying, failing for various (mostly social or political) reasons and are therefore in urgent need of improvement. While, for example in the case of public education, it is true, that the current system needs improvement, it remains debatable if an XR-transformation represents an actual solution or, rather, a vehicle for profiting off of the sector, creating new problems, exacerbating existing problems, or shifting existing problems to different areas in society.

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Several ethical issues follow the championing of XR as a technological solution chasing problems. Underlying the discourse of XR is the promise of a technological disruption and a replacement of already established structures with digital solutions. These digital solutions are often driven by a monetary logic of exploitation appearing in the guise of good-will. As experts pointed out, XR technology is most of the time developed by private companies whose main interest lays in turning individual habits into collectible data or exploiting publicly available services for private benefits instead of creating solutions that benefit the public.[1] In essence, creating XR infrastructures to become the platform for social interactions or the future of education raises questions around the political and economic power of such platforms, as well as questions of who determines, programs, curates content delivered through such platforms and who owns and has access to the data that are generated on such platforms. E.g., applied to remote work, the experts mentioned that disruption from XR raises issues of how the technology may be used to monitor and control workers, undermining exchange of information and organizing rights.

Solutions suggested as potentially useful to tech-solutionism were versatile. With regard to the problem of private versus public interests, the experts suggested developing publicly owned and operated XR infrastructures at municipal, regional, or national governing institutions. Financed through tax incomes, these might act to discipline private market actors and advance public interests beyond profit.[2] When it comes to XR-enhanced working and teaching environments, hybrid solutions combining XR and real-life approaches may prove promising. Instead of "only tech" or "no tech at all," middle grounds and options to choose between such extremes may prove more fruitful for individual and societal well-being. Finally, the experts pointed out the importance of examining the visions and potential use-cases circulating in the discourse of XR. Often the visions discussed may be only marketing rhetoric reflecting business interests, or being created for alternative, non-disclosed purposes (e.g., collecting data).

TABLE 3 SUMMARY TABLE OF THEMES, EXEMPLARY ETHICAL ISSUES, AND POSSIBLE SOLUTIONS

Theme	Exemplary Ethical Issues	Possible Solutions
Data ownership	Gaps in regulation of NLPs reliant on personal data content Lack of definition of authorship of NLP-generated content Devaluation of human creative labor vs. the output of an algorithm	An opt-in approach to ask users for permission to use collected data as training data for AI-generated content. If users decline, the collected data cannot be used as training data Making training data public, where feasible and the used data traceable Increasing co-contributor traceability to recognize and remunerated contributors to the training data (e.g., through smart contracts or other means)
Digitalization of work and social interactions	A potential social divide between people working in remote jobs and people working in jobs that rely on attendance Increase of digital nomads will mix salaries from high-income areas with rents from low-income areas	Regulation to mark machine created texts, speeches, and other media in general; Different levels in machine learning systems to check veracity and real-world grounding; Addressing social isolation and social divide through democratic mechanisms and letting people meet across the divides

[1] Similar arguments are also raised under the term "tech-solutionism" (Morozov, 2014).
[2] One example given was the Smart City project in Barcelona (Bakici, Almirall & Wareham, 2012). In 2011 the municipal established new technological infrastructure like different types of sensors, providing real-time feedback on everything from air quality to noise, energy and waste management. The infrastructure as well as the data is completely run by public institutions and thus acts in the interest of the public.

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Theme	Exemplary Ethical Issues	Possible Solutions
	Shrinking social units and fewer social contacts due to remote work Fragility of digital infrastructures will affect vulnerable members of the society who rely on social contact and community for a healthy living or in cases of emergency Deep fake videos creating potential problems cultural and political dialogue	Dedicated trainings for online work (especially for nondigital natives) to overcome the knowledge gap within society Targeted socialization programs to counter isolation issues More readily available communication technology and the infrastructure (e.g., 5G) to stabilize technological infrastructure in rural areas
Purpose of XR	Technology presents itself as a solution without a problem solely for the purpose of turning freely available goods into commodities (e.g., education or social interactions) Replacing existing infrastructures with XR infrastructures means new platform and new power structures – from public to private Buying into the rhetoric of some tech companies that have a self-interest in promoting these technologies as potential solutions for non-existing problems	XR infrastructures advaced by public municipal or state governments XR enhanced working and teaching environments should follow a hybrid solution that combines XR and real-life approaches; Instead of “only tech” or “no tech at all” it needs a middle ground between the extremes A critical reflection of the XR-visions that are circulating and the interests they represent to avoid to follow a false premise or a hype

2.3 Conclusion

The extension and augmentation of our reality through digital means can take many different forms, each of which will result in different use cases and ethical problems. Many of these problems are caused by the collection and usage of the data used to create this extended reality. Although the digitalization of the society is not a new phenomenon, regulations on ownership of data is an ongoing issue that will gain importance in discussions on XR, especially when discussing the question of who owns the data and has access to it. The replacement of physical infrastructures with digital infrastructures shifts responsibilities from the public sector to the private sector. While this can improve certain situations, it often means getting caught up in visions of XR technologies as solutions to non-existing problems (or problems requiring political, rather than a technological, redress). Finally, as experts pointed out, environmental impacts is often not considered in conversations about XR but ought not be forgotten. Widespread deployment of XR systems would impact CO2 emissions and increase depletion of rare earths, fossil fuels and other limited resources (e.g., through product development, server operation, and network requirements).

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Neurotechnology: Future Ethical Issues and Potential Solutions

3.1 Background: Neurotechnology Developments

Neurotechnology focusses on devices that directly monitor, assess, mediate, manipulate and emulate the structure, functions, and capabilities of the human brain. Such technologies are expected to change existing medical practices and re-define clinical and non-clinical monitoring and interventions. Neuro-devices are currently being researched to treat Parkinson's and Alzheimer's diseases, the consequences of strokes and severe trauma, and other conditions. There is also an emerging trend to use neurotechnology outside clinical contexts for the enhancement of brain functions. The use of neurotechnology products and services triggers various concerns, including personal data privacy management, integrity and responsibility, and potential off-label (i.e., beyond prescribed medical use) and misuse of such technology. They also raise further issues around what has been called "neuro-determinism": The belief that our mind is equivalent to the electrical impulses between neurons.

Three neurotechnology scenarios created by TechEthos were used as impulses for the discussions. Scenario 1, "Smith vs. Jones," raises questions of personal liability and the use of neurotechnology. Following a car crash, an ethical dilemma emerges in which party to the subsequent trial attests that the crash happened because of the function or malfunction of implanted neuro devices. Scenario 2, "Brain Data," explores a possible future in which neurotechnological devices are used as consumer gadgets for emotional regulation (e.g., to combat anxiety or create a state of focused concentration). It also examines the business model of the companies behind these devices and how they link brain data with other information (e.g., geographic location, age, behaviour, etc.) to create user profiles and sell them to corporations or governments. Scenario 3, "Ageing Society," focuses ageing and how neurotechnology might preserve memories and counter declining cognitive capacities. Furthermore, it outlines what happens if companies providing such services suddenly cease to exist, leaving potentially dependent customers stranded.

3.2 Exploring Neurotechnology Futures: Assumptions, Issues, Responses

3.2.1 Neuro-discrimination and the constant optimisation of the body

In each of the three neurotechnology scenarios, different devices and potential use cases are explored. Experts pointed out, across all three scenarios, an assumption that neurotechnology devices could be used beyond medical treatments to enhance human bodies. While currently, devices are used mainly in medical contexts to assist people with disabilities, there are already tendencies to pursue neurotechnologies for self-optimization and human enhancement beyond the purview of medical treatment. Devices promising human enhancement thereby create a concern that only people who can afford such a technology might benefit from its use. In addition, socioeconomic divisions related to use could lead to discrimination against those who do not have the means access to such technologies.

A number of ethical issues follow concerns about neuro-discrimination. As for the use of neurotechnology as a tool to enhance the human body, experts pointed to several ethical issues. For example, if the technology can alter the ability to concentrate / focus, the device could become a mandatory requirement for certain jobs. This challenges values such as equality, by leading to discrimination against people who are not willing, do not have access to or cannot afford to use neurotechnologies. For example, one promise of neurotechnological devices is the ability to intervene in the body's own functions and regulate emotional states such as anxiety, sadness, or stress. According to the experts, this might lead to a re-definition of such feelings. Is a little anxiety a good thing or does this already become a mental 'disease' that needs to be treated? Is stress in a work context a common feeling or considered as a handicap? Counteracting these human emotional states through technological enhancements, with the goal of optimizing one's body (or rising one's efficiency at work) raises questions about what constitutes a "desirable" state of consciousness. According to the experts, this discussion might also lead to a new definition of what it means to be 'healthy' as it shifts the threshold away from what we currently define as a healthy body towards a technologically enhanced body.

Solutions suggested as potentially useful pointed out by the experts included the education of users about the potential and limits of neurotechnology and its effects. A discussion is needed about changes in

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values, definitions of 'human' and 'normal', and the acceptability of enhancement across society. These discussions will (if not already occurring) take place across various fora of society. At the political level, equal access to neurotechnology could be championed to avoid creating new social divides. Experts also pointed out that neurotechnology might be quite valuable for addressing certain medical disorders, rather than for human enhancement. However, as neurotechnology progresses, experts also noted that definitions of what it might mean to be 'healthy' and what counts as a necessarily treatable state of mind might also change. As definitions of 'healthy' or 'normal' change, the dividing lines between medical use and human enhancement may blur (one can see this in the example of cosmetic surgery, originally developed to treat soldiers injured in combat, becoming normalized and even prized in certain cultures for non-medical alterations).

3.2.2 Neurodependency and the addiction to biotechnologies

Across all three neurotechnology scenarios, experts pointed out that the use of neurotechnology may come with physical dependence on certain devices. As neurotechnology changes and affects human functions (e.g., emotional regulation), experts noted our bodies may adapts and becomes dependent on the technology, whether for medical treatment or enhancement. As neurotechnological devices are generally provided by specific companies, users of such devices might become dependent on said companies for regular updates or servicing. This dependency can cause major problems, as the support or the constant development of the technology cannot be guaranteed by the developer (e.g. companies go bankrupt, merge with other, change strategies, or in the case of monopolized motorized wheelchair manufacturers in the US force consumers to use only approved parts and service stations marked up to near unaffordable rates). Compared to other technologies which can be easily replaced, repaired, or discontinued (e.g. smartphones), technology that becomes part of a human body may not be so easily modified, and thus carries additional risks.

A number of ethical issues are associated with concerns about neurodependency. A biotech company going bankrupt and ceasing development of its product line is a scenario that is already all too real.[3] In such a case, users that depend on the neurotechnological device, would be left without the necessary support. Especially if the device is linked to an external cloud system which provides the infrastructure for the usage. This also touches on another ethical problem: data accessibility. Currently, most technical systems are proprietary and do not allow data transfer between devices from different developers. In case a company cannot provide the original service anymore, it may leave users with no alternatives, as they cannot transfer their profile data from one system to another. As participating experts pointed out, the users (especially their bodies) become dependent on the technology in general, and on the company that provides the technology and the service in particular. Furthermore, even if companies persist, they may be acquired by other companies, change their direction, adopt new strategies, or adapt their business models to address unforeseen market developments. This can also impact the original function of the device. New features that users may not agree with may be installed years after the purchased device was introduced (also known as "function creep"). Due to the user's physical dependence and since the device is interwoven with the human body, the user may not be able to easily opt out.

Solutions suggested as potentially useful to issues of neurodependency included: (1) Reduce the dependency of the user by taking the developer of the technology more into account. Developers might be required guarantee user capability to opt out, when necessary, without any harm. This can for example include providing a standalone versions that function without connection to a cloud service needing permanent maintenance. Function creep can be avoided, for example, by limiting the function of the device to the explicit selection of what users have or have not consented to. This consent might be made binding for future use of the data or technology and cannot be changed, e.g., by unilaterally changing the

[3] See for example the case of the US biotechnology company Second Sight. The company provides neurotechnological implants for customers with visual impairments. The Argus product line offers bionic eyes to help blind individuals detect light and dark shapes. In the beginning of 2022, Second Sight merged with Nano Precision Medical, another neurotech company, and since changed their strategy. Part of this change has meant abandoning the support and development of the Argus line, leaving their customers without a functioning device (Strickland & Harris, 2022).

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company's terms and conditions. (2) Preservation of an individual's neural profile must be ensured so that individuals be permitted to transfer their personalized profiles to other services. At the policy level, such efforts might be done by regulating neurotechnology development and ensuring interoperable systems. Companies must ensure that the software they use and the data they collect can also be adapted by other companies to allow users easier and safer transitions, when needed.

3.2.3 Neurosurveillance and the constant monitoring of the 'mind'

Across all three scenarios, experts pointed out that devices may constantly monitor concentration levels and brain activity throughout the day. The constant monitoring and tracking raise questions about data privacy and ownership: Who owns brain data? Are these data medical data or behavioural data? What happens to the data collected after a user dies? What will the data be used for? How private are the data, given that they represent the internal state of users' 'minds'? Finally, the process of commercializing brain data and profiling based on the users' brain activity may affect peoples freedom of thought.

A number of ethical issues follow concerns related to neurosurveillance. Depending on the context, the monitoring of brain activities can have different impacts. In the employment context for example, a device could be used to monitor brain activities in fields where people need to be attentive and in constant focus (e.g., in medical surgery or air traffic controllers). Although devices could help focus, there is a trade-off between privacy and legitimate concerns about performance. The latter issue becomes a problem when people are monitored to assess their productivity or as a form of efficiency control. Based on the datasets collected by monitoring the brain activities of different users, companies could create brain-activity-profiles, and create judgments on the individual mind of users that might have serious consequences. Profiling brain activities might lead to new definitions of identity, privileging certain people that show better profiles than others, leading to a new premise for discrimination of people based on their brain profiles and creating new groups of vulnerable people. As we can already see with similar profiling processes based on behavioural data, these profiles become commodities that can be sold for targeted advertisements. Only here, what is sold is the 'mind' of the user. What's missing to regulate such a scenario is a clear definition of the data that is measured by devices: Is the measuring of the brain activity behavioural data or medical data? Depending on such definitions, different measures regarding use and commodification will be needed.

Solutions proposed as useful were manifold and oscillate from the philosophical to the regulatory. According to the experts, an updated human rights framework to protect people's 'minds' – or rather the activity in the brain that can be measured using neurotechnology – may be essential. Depending on the definition of this data, different issues might occur. If these data are defined as the 'mind' of a person, ethical questions arise about 'identity' or what defines a 'person'. If it is defined as medical or behavioral data, this already affects how data may be handled (e.g. behavioral data can be sold to third companies more easily then medical data). As the experts emphasized, the philosophical answers to these questions will feed into legal definitions, which is why a public debate is needed to define the character of neurological data. A technical solution would be to encrypt the information with a private key to which only the user has access. A policy response could involve the regulation of neurodata and prohibitions on its sale (e.g. in the form of user profiles, as we already see in the context of behavioral data). In general, there was agreement on the need for a multi-level governance approach that is context-sensitive, adaptable and includes elements of regulation, consumer protection, self-regulation, codes of conduct and philosophy of mind.

TABLE 4 SUMMARY TABLE OF THEMES, EXEMPLARY ETHICAL ISSUES, AND POSSIBLE SOLUTIONS

Theme	Exemplary Ethical Issues	Possible Solutions
Neuro-discrimination	Device could become a mandatory requirement for jobs	Education of users about the possibilities and limits of the technology and its effects

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	Challenges values such as equality by leading to discrimination against people who are not willing or cannot afford to use neurotechnologies Change our understanding of what a "healthy" or "normally gifted" person is A redefinition of emotional states: Is stress in a work context a 'normal' feeling or something that needs to be treated? Optimizing one's body or performance raises the question of what constitutes a "good" or desirable state of consciousness	Discussion about the change in values, definition of 'human' and 'normal' and how much enhancement we as society want Equal access technology to counteract a possible social divide Emphasize technology developed to find solutions to medical problems, rather than enhancements.
Neurodependency	Users depending upon neurotechnological devices may be left without necessary support if companies change Most technical systems are proprietary systems and do not allow data transfer between different devices If companies, change their direction, adopt new strategies, or adapt their business models to unforeseen market developments (function creep), users can not opt-out anymore	Reduce dependence on technology by shifting liability to the developer of the technology Limiting the function to the explicit selection of what users have or have not consented to. This consent may be used to bind future use of the data or technology Regulating interoperability of neurotechnology systems Companies must ensure that the software they use and the data they collect be adapted by other companies to allow the user an easier and safer transition when needed
Neurosurveillance	As devices may constantly monitor brain activities trade-offs may emerge between privacy and legitimate concerns about individual performance Neuro-monitoring to control office productivity Profiling brain activities leads to new definitions of identity, leading to a new premise for discrimination of people based on their brain profiles; Commodification of neurodata	Need for an updated human rights framework to protect people's "minds" Need for a definition as medical or behavioral data A public debate to define the character of neurological data Encryption Regulation of neurodata, which as very personal data must not be marketed (e.g. in the form of user profiles, as we already see in the context of behavioural data) Companies need permission from the user when using the collected data in a specific context A multi-level governance approach: context-sensitive, adaptable and including regulation, consumer protection, self-regulation, codes of conduct and philosophy of mind

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3.3 Conclusion

Ethical issues regarding the use of neurotechnologies in the future will very much depend on the context in which this technology is used. The above examples show that the use of neurotechnology in the context of enhancing the body will raise ethical questions that call for political responses. How might society change, if neurotech-enhancements were to become a norm? What if the companies, are offering services, cannot keep up with responsibilities to maintain the devices sold? How might a neurotech-based market economy look? According to the experts, most of the questions that are debated currently can be subsumed under a term like, “Neurocapitalism” and revolve around issues of data privacy, business models, and transparency. Ethical reflection on neurotechnology cannot therefore be separated from the cultural and economic context in which the technology is imagined, developed, and deployed.

Experts also pointed out the predominance of one assumption appearing across scenarios: That neurotechnological devices might find use cases outside of medical contexts. In medicine, devices might be used to help people with disabilities communicate, move, or otherwise interact with their environment. In the current discourse, devices may also enhance people without disabilities. It is unclear whether the commodification of neurotechnology will happen or if it represents the ambitions of profit-seeking private technology companies. Moreover, discussion of the ethical issues arising from this assumption diverts attention from ethical discussions related to the actual development of neurotechnology. For example, devices may often be tested on animals (e.g. monkeys, mice or pigs), raising an ethical issue in its own right. In the future, questions may also arise around testing prototypes in human subjects. Here again, medical testing (e.g. vaccines, birth control pills, etc.) also raises ethical concerns, as the histories of drug and procedure development include many examples of non-consensual experimentation on the bodies of marginalized persons—persons often from communities who can less frequently access the benefits of the innovations made possible by their unethical treatment.

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4 Concluding thoughts from expert reflections

4.1 Social and ethical issues identified across technology families

Across all three technology families, we observed several common social and ethical issues. One relates to a fixation on technological solutions to more-than-technological-problems. This illuminates how the industrial capitalist paradigm shaping the development of these technology families manifests uniquely in each area. In climate engineering technologies, this manifests as pursuing CDR and SRM sometimes independent of larger social solutions to comprehensive energy, transit, built environment, agriculture and industrial system transformation. In extended reality technologies, this manifests as a seemingly headlong rush to embrace potentially profitable innovations, as well as a blurring of lines between physical and virtual worlds with little care or concern for social or political consequence. In neurotechnology, this fixation manifests as a drive toward technological interventions in human identity with little regard to consequences for social discrimination, and broader mental healthcare pursuits.

A second social and ethical issue common across the three technology families relates to environmental concerns. In the case of climate engineering, there are the potentially significant disruptive effects on land use, agriculture, terrestrial, and marine and freshwater systems, and human settlements. Such effects might emerge from climate interventions gone awry – or from being insufficient, in the end, to address the scale of climatic changes that are affecting the planet. For extended reality and neurotechnology, environmental concerns relate more to material production energy intensity, and water and land use associated with the creation, operation, and end-of-use of technological devices.

A third set of common social and ethical concerns relates to issues of procedural[4] or distributional justice[5]. In the case of climate engineering, concerns relate to the way incumbent firms and governments responsible for climate pollution in various forms might end up as beneficiaries of technological solutions developed or deployed (and frontline communities deprived of vital resources to respond to climate change hazards). Alternatively, there is a concern in climate engineering with the way states might unilaterally deploy SRM or CDR, with serious negative, non-consensual consequences for neighbours or regions across the planet. With extended reality come problems of unilateral decisions to deploy surveillance or "labour saving technologies" that negatively impact large groups of society to further enrich ever smaller groups of economic and political actors. There are concerns with the way such technologies might distort or manipulate access to information in such a way as to strengthen minority rule or autocratic regimes. In the case of neurotechnology, there is basic concern with who might have access to potentially beneficial medical interventions, and who might rather simply access such interventions for human enhancement. There are also concerns related to altering definitions of people with disabilities or enhancements, with discriminatory consequences. For extended reality and neurotechnologies, these issues of justices and abuse of power closely relate to concerns over data access, privacy, and valuation.

4.2 Win-win responses to social and ethical issues posed by featured technologies

Addressing the social and ethical concerns raised above by climate engineering, extended reality, and neurotechnologies will require a range of technical, economic, and ultimately decisive societal responses.

In the case of CE, research and innovation rules, guidelines, and practices may need to shift away from privileging the unquestioned pursuit of technological solutions to societal problems. Research and innovation across all three domains might focus more on illuminating the social contexts that such

[4] Procedural justice asks questions like, "how are decisions made and who is involved?". Procedural justice concerns include issues of fairness and legitimacy in decision making (e.g., with the marginalization or outright exclusion of key stakeholders or communities impacted by decision-making).

[5] Distributional justice asks questions like, "who benefits from these technologies; who is burdened by these technologies; do those bearing the burden also realize benefit?". Distributional justice concerns include the way benefits or burdens associated with the implementation or outcomes of a decision may be unequally apportioned across populations.

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technologies might disrupt or exploit by considering socially-focused solutions. Innovative rules, guidelines, and practices could inform policy change at local, regional, national, and international scales. Concretely, such interventions in research and innovation may need to reverse incentives for accumulation of technological patents (without regard for social and ethical concerns); engage diverse knowledge types; involve users and potentially affected communities in research process; and ensure significant, meaningful public consultation.

The above interventions might apply also to common social and ethical issues associated with procedural and distributional justice concerns. In addition, research and innovation rules, guidelines, and practices might do more to intentionally shift the political economy of scientific and technological pursuits. Concretely, efforts require open access to results of publicly-funded or public-partnered research; enforcement against monopolization of technology platforms and public and stakeholder involvement in agenda setting and monitoring and enforcement of violations that affect human and environmental systems. For climate engineering, this might manifest as efforts toward capacity building and harmonization of international agreements on CDR or SRM. For digital extended reality, this might manifest as efforts to explicitly strengthen labour rights, legal recourse for vulnerable communities and enforcement to safeguard public resources and wellbeing from exploitation. For neurotechnology, this might manifest as efforts to ensure greater human rights associated with mental status, freedoms from discrimination, and robust data security, protection and compensation for data harvested from individuals and communities (for XR as well).

In the case of responding to environmental concerns, rules, guidelines and practices might be designed to help R&I communities to grapple with questions like "do no significant harm" to environmental objectives[6,7] Such efforts might practically consider material and energy use associated with research and creation of technological objects or services. Such efforts might also include holistic lifecycle assessment or incentives to connect waste and resource systems in material production. Any efforts on environmental concerns should also ensure affected communities have a voice in decision-making processes and that the distribution of benefits and burdens is equitable and fairly done.

4.3 Closing remarks

European research and innovation framework programmes continue to invest in scientific and technological development for economic growth. In this context, people from all aspects of research and innovation systems increasingly appreciate the potential of these scientific and technological developments to raise significant social and ethical concerns. The TechEthos project, focussed attention on three areas of technological development – climate engineering, digital extended reality, and neurotechnology – to support anticipation of and response to such social and ethical issues. In presenting an early reflection on such potential issues, drawn from expert participant reflections, our aim is to inform policy discussions on development of guidelines to align technological developments with the desires and concerns of the societies in which they embed. Any of the proposed responses above would benefit from, and indeed require, additional elaboration, specification, and testing. Moving forward, the TechEthos project will consider pursuing, as feasible and in alliance with a cluster of related projects, measures to encourage researchers and innovation policy makers to reflect on the expert perspectives shared above.

[6] (i) climate change mitigation; (ii) climate change adaptation; (iii) the sustainable use and protection of water and marine resources; (iv) the transition to a circular economy; (v) pollution prevention and control; and (vi) the protection and restoration of biodiversity and ecosystem.
[7] Per the European Green Deal, Sustainable Europe Investment Plan, and Regulation EU 2020/852, ensuring that significant harm is not done will be integral to future public and private European financial investment.

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