

TECHETHOS

FUTURE ○ TECHNOLOGY ○ ETHICS

Enhancing Legal Frameworks at the National and International Level

For the governance of climate engineering, neurotechnologies and
digital extended reality (D5.2)



TechEthos receives funding from the EU H2020 research and innovation programme under Grant Agreement No 101006249. This deliverable and its contents reflect only the authors' view. The Research Executive Agency and the European Commission are not responsible for any use that may be made of the information contained herein.

D5.2 Enhancing National and International Legal Frameworks

Work Package	WP5 Operationalise, complement and revise existing ethical frameworks		
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Due date	30 June 2023		
Submitted date	29 June 2023		
Version number	1.0	Status	Final version

Project Information

Grant Agreement number	101006249
Start date	01/01/2021
Duration	36 months
Call identifier	H2020-SwafS-2020-1
Topic	SwafS-29-2020 - The ethics of technologies with high socio-economic impact
Instrument	CSA

Dissemination Level

PU: Public	<input checked="" type="checkbox"/>
PP: Restricted to other programme participants (including the European Commission)	<input type="checkbox"/>
RE: Restricted to a group specified by the consortium (including the European Commission)	<input type="checkbox"/>
CO: Confidential, only for members of the consortium (including the European Commission)	<input type="checkbox"/>



Quality Control

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Ben Howkins (TRI UK)	22/06/2023

Revision history

Version	Date	Description
0.1	07/03/2023	Initial draft
0.2	12/05/2023	Working draft for input from consortium partners and members of the Impact and Advisory (ADIM) Board
0.3	01/06/2023	Draft for QA
1.0	28/06/2023	Final version

Keywords

Climate engineering; carbon dioxide removal; solar radiation modification; neurotechnologies; neuroscience; extended reality; virtual reality; augmented reality; international law; national law; human rights law; environmental law; climate law; privacy and data protection law; medical devices regulation; AI regulation; product safety law; consumer protection law.

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 technology families covered are **climate engineering**, including both carbon dioxide removal (CDR) and solar radiation modification (SRM), **neurotechnologies** and **digital extended reality**, including natural language processing (NLP). The project will produce operational ethics guidelines for these 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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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No.101006249.

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Definitions and abbreviations

Table 1: List of Definitions

Term	Explanation
Carbon dioxide removal (CDR)	A type of climate engineering technique, also known as “negative emissions techniques”, that removes atmospheric CO ₂ and stores it in geological, terrestrial, or oceanic reservoirs.
Climate engineering	Also known as geoengineering, refers to “... the deliberate large-scale intervention in the Earth’s climate system, in order to moderate global warming.” ¹ Considering the distinct characteristics and regulatory challenges of different climate engineering techniques, this report makes a split between carbon dioxide removal (CDR) on the one hand, and solar radiation modification (SRM), on the other.
Digital extended reality (XR)	Refers to AI-powered digital technologies (hardware and software) capable of perceiving and processing human sensorial outputs (e.g., voice, gestures, language, movement, emotions, and other elements of human communication), allowing extended or mixed virtual scenarios (e.g., visual, audio, linguistic or haptic) to be tailor-made or “customized” based on the user interest and behaviour (and thus profile, model, predict, discriminate, and influence the user’s behaviour or nudge their choices. ² XR can include a range of technologies, from software-based VR, AR and XR systems, digital twins, nudge and affective computing, and NLP, to hardware including headsets, contact lenses, and motion sensors. ³
Dual-use	Goods, software and technology that can be used for both civilian and military applications.

¹ Shepherd, J., Caldeira, K., Cox, P., Haigh, J., Keith, D., Launder, B., Mace, G., McKerron, G., Pyle, J Rayner, S, Redgwell, C, Watson, A, Parker, A, Garthwaite, R, Wilsdon, J. (2009) *Geoengineering the Climate: Science, Governance, and Uncertainty*. Available at: <http://royalsociety>.

² TechEthos (2022) *Technology Factsheet: Digital Extended Reality / TechEthos*, [Online]. Available at: https://www.techethos.eu/wp-content/uploads/2022/05/TechEthos_factsheet_Digital-Extended-Reality_website.pdf.

³ TechEthos (2022) *Technology Factsheet: Digital Extended Reality / TechEthos*, [Online]. Available at: https://www.techethos.eu/wp-content/uploads/2022/05/TechEthos_factsheet_Digital-Extended-Reality_website.pdf.



Ethics-by-design	An approach to research and innovation that consider ethical principles and considerations early on in the design and development phase.
Neurotechnologies	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. ⁴
Solar radiation modification	A type of climate engineering that aims to reflect some sunlight and heat back into space.

Table 2: List of Abbreviations

Term	Explanation
ADIM Board	TechEthos Advisory and Impact Board
AR	Augmented Reality
BCI	Brain-computer interface
BECCS	Bioenergy with carbon capture and storage
BMI	Brain-machine interface
CAT	Convention Against Torture
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CDR	Carbon dioxide removal
CEDAW	Convention on the Elimination of All Forms of Discrimination against Women
CIL	Customary international law
CO₂	Carbon dioxide
CoE	Council of Europe
COP	Conference of Parties (UNFCCC)
COPOUS	United Nations Committee on the Peaceful Uses of Outer Space
CPRMW	Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families

⁴ OECD. (2019) *Recommendation of the Council on Responsible Innovation in Neurotechnology*, OECD/LEGAL/0457.

CRC	Convention on the Rights of the Child
CRPD	Convention on the Rights of Persons with Disabilities
DAC	Direct Air Capture
DBS	Deep brain stimulation
DNA	Deoxyribonucleic acid
DoA	Description of Action
EC	European Commission
ECHR	European Convention on Human Rights (CoE)
ECtHR	European Court of Human Rights (EU)
EEG	Electroencephalogram
EU	European Union
fMRI	Functional magnetic resonance imaging
GDPR	General Data Protection Regulation (EU)
GHG	Greenhouse gas
HRC	Human Rights Council (UN)
IBC	International Bioethics Committee (UNESCO)
ICCPR	International Covenant on Civil and Political Rights
ICERD	International Convention on the Elimination of All Forms of Racial Discrimination
ICESCR	International Covenant on Economic, Social and Cultural Rights
IMO	International Maritime Organization
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
LC/LP	London Convention / London Protocol
LLM	Large language models
LULUCF	Land use, land use change & forestry sector
MR	Mixed Reality



NDC	Nationally Determined Contributions
OECD	Organisation for Economic Co-operation and Development
OHCHR	Office of the United Nations High Commissioner for Human Rights
Oviedo Convention	The Convention for the Protection of Human Rights and Dignity of the Human Being with regard to the Application of Biology and Medicine
PC	Project Coordinator
SRM	Solar radiation modification
UDHR	Universal Declaration of Human Rights
UN	United Nations
UNCBD	United Nations Convention on Biological Diversity
UNCLOS	United Nations Convention on the Law of the Sea
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNOOSA	United Nations Office for Outer Space Affairs
VR	Virtual Reality
WP	Work Package
XR	Digital extended reality

Executive Summary

This report provides an overview of the key regulatory challenges identified throughout the TechEthos legal analysis of three technology families, namely: **climate engineering**, **neurotechnologies** and **digital extended reality (XR)**.

This report provides recommendations to law- and policymakers at the national and international level on the changes needed to address these challenges. The regulatory challenges discussed in this report were identified in the TechEthos legal analysis of international and European Union (EU) law (published in June 2022),⁵ and a comparative analysis of nine national legal case studies (published in December 2022).⁶ This report seeks to inform policymakers at the **international level**, such as the United Nations (UN), as well as at the **level of national governments** on the changes needed in existing legal frameworks.⁷

The potential changes set out in this report are informed by relevant legal principles and ethical considerations identified by TechEthos and developed with input from TechEthos consortium partners and Advisory and Impact Board (ADIM Board). The report also sets out the likely circumstances required for the suggested change to happen, outlining the critical conditions for change.

Enhancing legal frameworks for the governance of climate engineering

The section on climate engineering addresses carbon dioxide removal (CDR) and solar radiation modification (SRM) separately, to reflect their distinct characteristics and regulatory challenges. The key takeaways for the governance of **CDR** are as follows:

- Greater consistency is needed at the national and international level as to the characterisation of CDR and the respective contribution of CDR towards the objectives of the Paris Agreement;
- There is a need to clarify the role of, and mandate for, various types of CDR methods under national and international law;
- Clarity is needed regarding the legal status of removals from CDR in the context of net-zero and meeting the objectives of the Paris Agreement;
- There is a need for international guidance or standards for the accounting of removals from CDR to ensure consistency between State Parties to UNFCCC and the 2015 Paris Agreement;
- There is a need to clarify and strengthen compliance with international law on access to information, transparency, public participation and access to justice in the context of CDR.
- There is a need to provide greater legal certainty regarding the applicability of existing environmental laws, including waste and chemicals regulation, both at the national and international level;

⁵ Santiago, N., Howkins, B., Vinders, J., Rodrigues, R., Warso, Z., Bernstein, M., Gonzalez, G., Porcari, A. (2022). TechEthos D4.1: *Analysis of international and EU law and policy*. TechEthos Project Deliverable. Available at: <https://zenodo.org/record/7650731>.

⁶ Vinders J., et al (2022) TechEthos D4.2: *Comparative analysis of national legal case studies*. TechEthos project deliverable. Available at: <https://www.techethos.eu/national-legal-cases-on-emerging-technologies/>.

⁷ TechEthos developed recommendations for enhancing laws at the European Union level in a series of policy briefs (TechEthos D6.2). See: Vinders, J., Howkins, B. (2023). *Policy Briefs on Enhancing EU legal frameworks for the governance of climate engineering, neurotechnologies and digital extended reality*. TechEthos Project Deliverable 6.2. Available at: <https://www.techethos.eu/enhancing-eu-law-emerging-technologies/>.

- There is a need to clarify the respective responsibilities of key actors at the national and international level to pay for the cost of CDR, taking into consideration the roles of States as well as private actors, such as corporations;
- There is a need for adequate liability regimes for CDR and legal certainty for CDR operators, specifically in the context of permanent and long-term CO₂ storage.

The key takeaways for enhancing legal frameworks for the governance of **SRM** are as follows:

- There is a need for clear and widely accepted definitions for SRM to delineate between SRM research and deployment, and between the types of research activities that constitute SRM research;
- There is a need for the acceleration of safe SRM research, discussions about the governance of SRM experiments that might have environmental risks, and consideration of how decisions about SRM might be made, taking into consideration the risks introduced by SRM in comparison to the risks of foregoing SRM and allowing the Earth to warm;
- It is pertinent to clarify the need for novel and specific governance arrangements at the national and international level for certain SRM research activities;
- There is a need to strengthen procedural justice of decisions regarding SRM use and SRM research to ensure full respect of rules on access to information, public participation and access to justice.

Enhancing legal frameworks for the governance of neurotechnologies

The key takeaways for enhancing legal frameworks for the governance of **neurotechnologies** are as follows:

- Clarity is needed regarding the existence of neurorights and the human rights protections related to the brain under national and international human rights law;
- There is a need for adequate protection of rights related to the brain and mental states of neurotechnology users and for the development of improved methods and requirements for obtaining informed consent from users;
- Wider recognition is needed at the international and national level for the risk of justice, equality and non-discrimination gaps and the risk of inadequate protection against neurodiscrimination. Appropriate legislative and policy interventions must be put in place to mitigate the risk of neurodiscrimination;
- There is a need for appropriate legislation to ensure the rights and safety of users for the non-medical (commercial) use of neurotechnologies and to govern dual-use applications of neurotechnologies;
- There is a need for strengthened compliance with existing laws that apply to neurotechnologies.

Enhancing legal frameworks for the governance of digital extended reality (XR)

The key takeaways for enhancing legal frameworks for the governance of **XR**, including natural language processing (NLP), are as follows:

- There is a need for improved protection from harmful online content to promote and strengthen compliance with human rights law at the national and international level;
- There is a need for enhanced compliance with the right to be free from discrimination and for the development of effective means of preventing, detecting and addressing bias in NLP;
- Appropriate privacy and data protection laws are needed to protect against harmful uses of data generated through XR technologies, such as nudging, manipulation and the spread of mis- and disinformation; there is a need for improved methods for obtaining informed consent from end-users;
- There is a need to clearly allocate and demarcate the responsibilities of developers and providers of XR and NLP technologies to monitor and address harmful content and the extent to which they are responsible for harmful content generated through their products;
- There is a need for strengthened compliance by XR and NLP developers and providers with laws applicable to such technologies.

1. Introduction

Climate engineering, neurotechnologies and digital extended reality (XR) present a range of regulatory challenges. The purpose of this report is to propose ways to enhance or adjust existing legal frameworks to improve the governance of these technology families at the international and national level.

This report provides an overview of the key regulatory challenges identified throughout the TechEthos legal analysis of three technology families, namely: **climate engineering**, **neurotechnologies** and **digital extended reality (XR)**. These challenges were derived from two deliverables: TechEthos deliverable 4.1 *Analysis of International and EU law and policies* (published in June 2022),⁸ and deliverable 4.2 *Comparative analysis of national legal case studies* (published in December 2022).⁹

Given the emerging and rapidly evolving nature of the three technology families, there are limited laws and legal frameworks specifically designed to govern them. Furthermore, these technology families raise certain regulatory challenges which put the adequacy of existing legal principles and frameworks to the test. This report proposes ways to enhance or adjust existing legal frameworks at the national and international level with a view to address the regulatory challenges identified.

Table 3 below outlines the legal frameworks at the **international level** within which the recommendations contained in this report are situated. The recommendations are aimed at international law- and policymakers, most notably the United Nations (UN) and associated bodies, including but not limited to the UN Human Rights Council (UNHRC), the United Nations Environment Programme (UNEP), the UN Economic Council for Europe (UNECE), UN Educational, Scientific and Cultural Organisation (UNESCO), Office of the UN High Commissioner for Human Rights (OHCHR), and UN Conference on Trade and Development (UNCTAD).

Table 3: Legal frameworks considered at the international level

Climate engineering	Neurotechnologies	Digital extended reality
<ul style="list-style-type: none"> ○ Human rights law ○ Environmental law ○ Climate change law ○ Space law ○ Maritime law 	<ul style="list-style-type: none"> ○ Human rights law ○ Privacy and data protection law 	<ul style="list-style-type: none"> ○ Human rights law ○ Privacy and data protection law ○ Consumer protection law

Table 4 sets out the legal frameworks at the **national level** within which the recommendations of this report are situated. The recommendations are aimed at national law- and policymakers. The table below

⁸ Santiago, N., Howkins, B., Vinders, J., Rodrigues, R., Warso, Z., Bernstein, M., Gonzalez, G., Porcari, A. (2022). TechEthos D4.1: *Analysis of international and EU law and policy*. TechEthos Project Deliverable. Available at: <https://zenodo.org/record/7650731>.

⁹ Vinders J., et al (2022) TechEthos D4.2: *Comparative analysis of national legal case studies*. TechEthos project deliverable. Available at: <https://www.techethos.eu/national-legal-cases-on-emerging-technologies/>.



also lists the countries that were analysed as part of TechEthos deliverable 4.2 *Comparative analysis of national legal case studies*.¹⁰ The recommendations themselves are non-country specific, but can be adapted to apply to specific national circumstances.

Table 4: Legal frameworks considered at the national level

Climate engineering	Neurotechnologies	Digital extended reality
<ul style="list-style-type: none"> ○ Constitutional/ human rights law ○ Environmental law ○ Climate change law 	<ul style="list-style-type: none"> ○ Constitutional/ human rights law ○ Privacy and data protection law ○ Product safety/liability law 	<ul style="list-style-type: none"> ○ Constitutional/ human rights law ○ Privacy and data protection law ○ Consumer protection law
<ul style="list-style-type: none"> ○ Australia ○ Austria ○ United Kingdom 	<ul style="list-style-type: none"> ○ Germany ○ Ireland ○ United States of America 	<ul style="list-style-type: none"> ○ Italy ○ France ○ United Kingdom

1.1 Structure of the report

The introduction is followed by **section 2**, which describes the methodology applied in the formulation of recommendations for enhancing or adjusting existing legal frameworks. The three subsequent sections are dedicated to the recommendations for each technology family. **Section 3** focuses on climate engineering, addressing CDR and SRM separately to reflect their distinct characteristics and regulatory challenges. **Section 4** focuses on neurotechnologies, and **section 5** on digital extended reality, including NLP. Sections 3 to 5 each summarise the major regulatory challenges identified in previous TechEthos work and provide an overview of the potential changes or enhancements at the international and national level, as well as the likely circumstances required to achieve the suggested change. **Section 6** provides an overall conclusion.

¹⁰ Vinders J., et al (2022) TechEthos D4.2: *Comparative analysis of national legal case studies*. TechEthos project deliverable. Available at: <https://www.techethos.eu/national-legal-cases-on-emerging-technologies/>.

2. Methodology

This report builds on the policy, legal and regulatory analysis (work package 4) of the TechEthos project. This section details the methodological approach to the development of recommendations at the international and national level.

This report takes a closer look at the regulatory challenges identified in previous TechEthos project deliverables¹¹ in order to formulate recommendations for the enhancement of relevant legal frameworks with a view to addressing these challenges. In doing so, the connection is made with the TechEthos ethical analysis, and the ethical values and principles derived from that analysis.¹² The approach to the development of recommendations for enhancing legal frameworks is an adaptation from the Horizon 2020 SIENNA project Deliverable 5.6 *Recommendations for the enhancement of the existing legal frameworks for genomics, human enhancement, and AI and robotics*.¹³ This report follows a similar structure, specifically by outlining a particular regulatory challenge and proposing a desired change or outcome, linking this to relevant legal principles/provisions and ethical considerations, before setting out the possible changes at the international and national level, and the circumstances necessary to effect the desired change. The legal principles/provisions and ethical considerations listed in this report are not intended to be exhaustive, and contradictory interpretations of relevant principles may result in different conclusions. Nevertheless, relevant legal principles and ethical considerations previously identified by TechEthos, most notably the ethical analysis (D2.2) and legal analyses (D4.1 and D4.2), are mentioned in this report.

Each chapter per technology family starts with a brief overview of the technology-specific regulatory challenges as derived from the TechEthos legal analyses. This is followed by a section on the challenges and options for enhancing legal frameworks. This section contains standardised tables per regulatory challenge, describing the following:

- Description of the regulatory challenge
- Level of priority (see introductory clarifications below)
- Relevant legal principles and provisions as identified in TechEthos D4.1 and D4.2 (legal analyses)
- Relevant ethical considerations as identified in TechEthos D2.2 (ethical analysis)
- Applicable legal frameworks
- Desired enhancement or change
- International level changes & key actors
- National level changes & key actors
- Circumstances necessary for change

¹¹ Santiago, N., Howkins, B., Vinders, J., Rodrigues, R., Warso, Z., Bernstein, M., Gonzalez, G., Porcari, A. (2022). TechEthos D4.1: *Analysis of international and EU law and policy*. TechEthos Project Deliverable. Available at: <https://zenodo.org/record/7650731>; Vinders J., et al (2022) TechEthos D4.2: *Comparative analysis of national legal case studies*. TechEthos project deliverable. Available at: <https://www.techethos.eu/national-legal-cases-on-emerging-technologies/>.

¹² Adomaitis, L., Grinbaum, A., Lenzi, D. (2022). TechEthos D2.2: *Identification and specification of potential ethical issues and impacts and analysis of ethical issues of digital extended reality, neurotechnologies, and climate engineering*. TechEthos Project Deliverable. Available at: www.techethos.eu.

¹³ Konrad Siemaszko, Rowena Rodrigues, & Santa Slokenberga. (2020). SIENNA D5.6: Recommendations for the enhancement of the existing legal frameworks for genomics, human enhancement, and AI and robotics (V2.0). Zenodo. <https://doi.org/10.5281/zenodo.4121082>.

2.1 Enhancing legal frameworks: introductory clarifications

The recommendations contained in this report are aimed providing key actors, predominantly law- and policymakers at the national and international level, with options for enhancing legal frameworks. The regulatory challenges themselves serve as a set of recommendations that require attention from regulators. On the basis of an assessment of the TechEthos key insights at the time of writing, each regulatory challenge is given a priority level, to indicate the speed at which action is likely to be needed. Each regulatory challenge is awarded a level between 1 and 4, taking into account the state of the art of the respective technology family, and the regulatory gaps and risks identified in the legal analyses. These priority levels were adopted from SIENNA Deliverable 5.6¹⁴ and reflect the TechEthos researchers' views at the time of drafting (March-June 2023):

- Level 1 (urgent; action is needed within the next 12 months)
- Level 2 (high; action needs to be taken within next 2 years)
- Level 3 (medium, action needs to be taken within next 3-5 years)
- Level 4 (low; action needs to be taken within next 5-10 years).

The recommendations contained in this report have been formulated based on insights from the TechEthos legal analyses, the researchers' interpretation of relevant legal principles and ethical considerations, as well as contributions received from TechEthos consortium partners and the Advisory and Impact (ADIM) Board. The draft recommendations were discussed during the 5th TechEthos ADIM Board meeting on 25th April 2023 and during a project consortium meeting on 31 May 2023. Furthermore, where applicable, some changes or enhancements were suggested based on existing academic literature reviewed and referenced.

2.2 Scope and limitations

The regulatory challenges and options for enhancing legal frameworks contained in this report are not intended to be exhaustive. Rather, they reflect the analysis of international and selected national legal frameworks pertaining to socio-economic equality and fundamental rights. Therefore, these include legal frameworks such as human rights law, environmental and climate change law, privacy and data protection law (see table 3 and 4), but exclude, for example, labour law, competition law and intellectual property law. Furthermore, the challenges listed in this report reflect the researchers' views on the most prevalent challenges related to the governance of the three technology families, based on a review of the TechEthos legal and ethical analyses.

The options for enhancing legal frameworks are proposed at the international and national level. Recommendations for enhancing legal frameworks at the European Union (EU) level are contained in TechEthos D6.2 *Policy briefs on enhancing EU law on climate engineering, neurotechnologies and digital extended reality*.¹⁵ The recommendations at the national level are derived from challenges and trends identified through the comparative analysis of nine national legal case studies (TechEthos D4.2) (see table 4). The recommendations themselves are non-country specific, due to language constraints preventing a detailed assessment of relevant national laws, but can be adapted to apply to specific national circumstances.

¹⁵ Vinders, J., Howkins, B. (2023). Policy briefs on enhancing EU legal frameworks. Deliverable 6.2 for the European Commission. TechEthos Project Deliverable. Available at: www.techethos.eu; and <https://www.techethos.eu/resources/>. For further policy recommendations on the AI Act, see also: Adomaitis, L. and Grinbaum A. (2023). XR and General Purpose AI: from values and principles to norms and standards.

3. Enhancing legal frameworks for the governance of climate engineering

Climate engineering raises a number of regulatory challenges. This section further explores these regulatory challenges and presents options for enhancing legal frameworks for the governance of climate engineering at the international and national level.

Whilst CDR and SRM raise distinct regulatory challenges further considered below, an overarching regulatory challenge relates to the characterisation of climate engineering, CDR, and SRM technologies, respectively. Their characterisation influences the regulatory frameworks that are applicable for their governance. Some regulatory frameworks, rules and decision may apply to climate engineering as a broader category and at a large scale, such as the UN Convention on Biological Diversity (UNCBD)¹⁶ decisions on geoengineering,¹⁷ whereas other frameworks may apply specifically and/or only to CDR or SRM.¹⁸ As such, the framing or characterisation of this technology family has legal implications, which is considered in detail in the two sections below.

3.1 Carbon Dioxide Removal

3.1.1 CDR-specific regulatory challenges

Whilst the objective of CDR is to avoid dangerous levels of climate change, various types of CDR may by themselves also present certain risks of harm and regulatory challenges. The key challenges are listed below, starting from the most prominent regulatory hurdle – the question of how to characterise CDR and what role CDR may play in the context of net-zero – moving to more specific and technical regulatory challenges, such as the legal status of removals from CDR in the context of net-zero, or the development of effective liability regimes:

- **The characterisation of CDR and CDR methods:** What is the appropriate characterisation of various types of CDR? How does this affect which legal frameworks are applicable?
- **The role of and mandate for CDR in the context of net-zero:** To what extent does international and/or national climate change law necessitate the consideration of CDR in light of achieving the goals of the Paris Agreement?
- **Legal status of removals from CDR in the context of net-zero:** What is the legal status of removals from CDR in the context of net-zero targets?
- **Removal accounting:** How to count removals from CDR and avoid the issue of double-counting?

¹⁶ Convention on Biological Diversity (UNCBD) (entered into force 29 December 1993) 1750 UNTS 79, 31 ILM 818.

¹⁷ The two non-binding UNCBD decisions in 2010 and 2016 on geo-engineering can be found at: UNEP/CBD/COP/DEC/X/33, Available at: <https://www.cbd.int/decisions/cop/10/33/8>; and UNEP/CBD/COP/DEC/13/14, available at: <https://www.cbd.int/decisions/cop/13/14>.

¹⁸ See, for instance, the interpretation of the mitigation measures under the Paris Agreement as including CDR: Honegger, M., Burns W. and Morrow D.R. (2021) 'Is carbon dioxide removal "mitigation of climate change"?' *Review of European, Comparative & International Environmental Law*, 30 (3), [Online]. Available at: <https://doi.org/10.1111/reel.12401>.

- **Public participation and access to justice:** How to facilitate public participation and access to justice in the context of CDR?
- **Environmental management regimes including waste and chemicals:** How to ensure existing environmental management regimes are fit for purpose for the governance of CDR?
- **Cost of CDR:** Who should pay for CDR? Could or should this cost be borne by the main polluters?
- **Liability for harms:** How to adapt existing environmental liability regimes for the governance of environmental harms caused by CDR? How to mitigate or compensate for the potential negative side-effects of CDR on human beings and the environment?

3.1.2 Challenges and options for enhancing legal frameworks

The effective governance of CDR is likely to require some degree of international collaboration. Not only is it likely that certain CDR methods may take place in multiple countries, the benefits, effects and risks of potential harms may be transboundary. Furthermore, the effective quantification of removals from CDR requires international collaboration to avoid the risk of double-counting and protect environmental integrity overall. Smaller scale and purely national CDR activities may be regulated at the national level alone. International guidance may nonetheless be beneficial to ensure consistency between States, particularly when undertaking and communicating CDR activities in the context of nationally determined contributions under the Paris Agreement.

The tables below further explore each regulatory challenges specific to CDR, and provide an overview of potential changes or enhancements of legal frameworks at the international and national level.

Regulatory challenge 1: The characterisation of CDR and various CDR methods

Description: The characterisation of CDR and various methods of CDR has legal implications, because it determines which legal frameworks are applicable. Inconsistent use of terms by key actors and regulators and evolving interpretations mean that there is a degree of legal uncertainty around the characterisation and governance of CDR. For instance, CDR at a large scale, could arguably be characterised as 'geo-engineering',¹⁹ making it the subject of the UNCBD decision on geo-engineering.²⁰ However, smaller scale CDR activities not constituting a 'large-scale intervention with the Earth's climate system'²¹ would arguably not be covered by this decision. Similarly, the characterisation of CDR as 'mitigation', such as by the Intergovernmental Panel on Climate Change (IPCC) in its sixth Assessment Report (AR6),²² would mean that provisions of the Paris Agreement on mitigation measures, apply to CDR and any measures aimed at reducing emissions.²³

¹⁹ Shepherd, J., Caldeira, K., Cox, P., Haigh, J., Keith, D., Launder, B., Mace, G., McKerron, G., Pyle, J., Rayner, S., Redgwell, C., Watson, A., Parker, A., Garthwaite, R., Wilsdon, J. (2009) *Geoengineering the Climate: Science, Governance, and Uncertainty*. Available at: <http://royalsociety.org>.

²⁰ Honegger, M., Burns W. and Morrow D.R. (2021) 'Is carbon dioxide removal "mitigation of climate change"? *Review of European, Comparative & International Environmental Law*, 30 (3), [Online]. Available at: <https://doi.org/10.1111/reel.12401>, p. 330.

²¹ Shepherd, J., Caldeira, K., Cox, P., Haigh, J., Keith, D., Launder, B., Mace, G., McKerron, G., Pyle, J., Rayner, S., Redgwell, C., Watson, A., Parker, A., Garthwaite, R., Wilsdon, J. (2009) *Geoengineering the Climate: Science, Governance, and Uncertainty*. Available at: <http://royalsociety.org>.

²² Skea J. et al (2021) *Climate Change 2022: Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change, [Online]. Available at: <https://www.ipcc.ch/report/ar6/wg3/>, Technical Summary, p. 94.

²³ Honegger, M., Burns W. and Morrow D.R. (2021) 'Is carbon dioxide removal "mitigation of climate change"? *Review of European, Comparative & International Environmental Law*, 30 (3), [Online]. Available at: <https://doi.org/10.1111/reel.12401>, p. 330; UNFCCC Conference of the Parties, Adoption of the Paris

Whilst the IPCC is seen as the principal scientific body on climate science at the international level, not all regulators have adopted its exact terminology. For instance, the UK government refers to greenhouse gas removal (GGR), which includes the possibility of removing greenhouse gases other than CO₂.²⁴ The EU uses the term 'carbon removal' to describe the 'storage of atmospheric or biogenic carbon [...], or the reduction of carbon release from a biogenic carbon pool to the atmosphere,' which arguably covers both the anthropogenic enhancement of sinks and protection and conservation of natural sinks and reservoirs.²⁵ Both definitions are distinct and broader than the IPCC's definition of CDR, which is limited to 'anthropogenic activities removing CO₂ from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products,'²⁶ and explicitly excludes 'natural CO₂ uptake not directly caused by human activities.'²⁷ The IPCC's terminology itself, has also evolved since the adoption of the 2015 Paris Agreement, with the Panel no longer referring to 'climate engineering' nor 'geoengineering', but instead stipulating CDR as climate mitigation.²⁸ Related to this, a regulatory distinction between 'nature-based' and 'engineered' CDR, such as suggested by the UNFCCC in an information note on article 6 (4) of the Paris Agreement,²⁹ may not be helpful considering that most, if not all, CDR methods involves a hybrid approach of natural and engineered carbon removal.³⁰

Whilst acknowledging that multiple legal frameworks may apply in conjunction, there is a risk that the inconsistent characterisation and governance of CDR by national and international regulators could result in the inconsistent monitoring of progress, and respective contribution of removals from CDR, towards achieving the goal of the Paris Agreement. The challenge for national and international regulators is to appropriately characterise CDR in the context of international climate change law. Considering the potential transboundary nature of CDR activities and impacts, international collaboration and guidance may be needed to reduce the risk of double-counting, and protect the integrity of the progress made towards achieving the goal of the Paris Agreement.

Priority level: 1 (urgent)

Agreement (Paris Agreement) (entry into force 4 November 2016) 3156 UNTS. Available at: https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf (Paris Agreement), article 4.

²⁴ UK Department for Business, Energy & Industrial Strategy (published 2013, last updated 2020) *Policy paper: Geo-Engineering: the government's view*. Department for Business, Energy & Industrial Strategy, [Online]. Available at: <https://www.gov.uk/government/publications/geo-engineering-research-the-government-s-view/uk-governments-view-on-greenhouse-gas-removal-technologies-and-solar-radiation-management>.

²⁵ European Commission proposal for a Regulation of the European Parliament and of the Council establishing a Union certification framework for carbon removals (30.11.2022 COM(2022) 672 final), article 2 (1) (a) [emphasis added].

²⁶ IPCC, 2018: Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 541-562. DOI: [10.1017/9781009157940.008](https://doi.org/10.1017/9781009157940.008).

²⁷ Ibid.

²⁸ Skea J. et al (2021) *Climate Change 2022: Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change, [Online]. Available at: <https://www.ipcc.ch/report/ar6/wg3/>, Technical Summary, p. 94.

²⁹ UNFCCC (2023). *Information note: Removal activities under the Article 6.4 mechanism*. Version 04.0, A6.4-SB005-AA-A09, [Online]. Available at: <https://unfccc.int/sites/default/files/resource/a64-sb005-aa-a09.pdf>.

³⁰ See, Carbon Business Council (2023), *Meeting the Goals of the Paris Agreement: Letter from 100+ Carbon Removal Experts / Carbon Business Council*, [Online]. Available at: <https://www.carbonbusinesscouncil.org/news/unfccc>.



<p>Relevant legal principles/provisions:</p> <ul style="list-style-type: none"> ○ UNCBD non-binding decision on geoengineering³¹ ○ Temperature goal and achieving a balance between emissions by sources and removals by sinks by 2050³² ○ Enhancement of removals by sinks³³ 	<p>Applicable legal frameworks:</p> <ul style="list-style-type: none"> ○ International climate change law: UNFCCC; 2015 Paris Agreement ○ International environmental law: Rio Declaration; UNCBD ○ National climate change laws ○ National environmental laws
<p>Desired enhancement/change: Greater consistency at the national and international level as to the characterisation of CDR and the respective contribution of CDR in the progress made towards achieving the goals of the Paris Agreement; clarity regarding the delineation and relation between CDR and natural carbon removal processes and the Land Use, Land Use Change and Forestry (LULUCF) sector.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> ○ Promote consistency in the regulatory characterisation of different types of CDR; ○ Provide guidance to national regulators on the characterisation of different types of CDR to avoid the risk of double-counting; ○ Evaluate the need for a technical advisory group to disambiguate definitions. <p>Key actors:</p> <ul style="list-style-type: none"> ○ IPCC ○ UNFCCC bodies including the Conference of the Parties (COP) and the Secretariat ○ UNCBD bodies including the COP and the Secretariat. 	<p>National level changes:</p> <ul style="list-style-type: none"> ○ Collaborate internationally and pursue consistency regarding the characterisation of different types of CDR, such as by adopting the terminology of the IPCC. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments
<p>Circumstances necessary for change: Likely to require international agreement and/or guidance for national regulators to facilitate the consistent characterisation of various types of CDR.</p>	

³¹ UNEP/CBD/COP/DEC/X/33, Available at: <https://www.cbd.int/decisions/cop/10/33/8>; UNEP/CBD/COP/DEC/13/14, available at: <https://www.cbd.int/decisions/cop/13/14>.

³² Paris Agreement, article 2 (1) (a) and 4 (1) as well as any national climate laws stipulating net-zero targets.

³³ United Nations Framework Convention on Climate Change (entry into force 21 March 1994) 1771 UNTS 107 (UNFCCC), article 4 (1) (d) and (2) (a).

Regulatory challenge 2: The role of, and mandate for, CDR in the context of net-zero and Nationally Determined Contributions (NDCs)

Description: The UNFCCC and 2015 Paris Agreement have been interpreted as permitting and providing a legal basis for CDR as a mitigation measure.³⁴ CDR may be characterised as ‘removals by sinks’,³⁵ where a sink refers to ‘any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.’³⁶ Parties to the Paris Agreement are committed to aiming ‘to reach global peaking of greenhouse gas emissions as soon as possible, [...], and to undertake rapid reductions thereafter [...], so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of the century [...].’³⁷ In doing so, State Parties to the Paris Agreement are committed to preparing, communicating and maintaining nationally determined contributions, and ‘pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.’³⁸

If CDR constitutes a mitigation measure, as has been suggested,³⁹ consideration of CDR as part of a State Party’s NDCs is permitted under the UNFCCC and 2015 Paris Agreement. It is unclear, however, whether the temperature goal set out in article 2 of the Paris Agreement *necessitates* the use of CDR. Indeed, the IPCC’s mitigation pathways published in 2018, rely on the assumption that CDR will be deployed to some extent in order to limit global warming in line with the objective of the Paris Agreement.⁴⁰ This begs the question whether State Parties to the Paris Agreement have an obligation to develop and adopt viable pathways to net-zero as part of their NDCs. And if they do, whether the evaluation of viable pathways to net-zero necessitates the consideration and use of CDR, alongside the evaluation of alternative mitigation measures.

The Paris Agreement obligates State Parties to ‘aim to reach global peaking of greenhouse gases as soon as possible’ and ‘to undertake rapid reductions thereafter in accordance with the best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks [...] in the second half of this century, [...]’.⁴¹ Whilst State Parties prepare, communicate and maintain their own NDCs,⁴² these must represent progression and ‘reflect its highest possible ambition.’⁴³ State Parties have an obligation to pursue domestic mitigation measures to help meet their NDCs. In relation to the obligation of State Parties under the Paris Agreement, the best available science is arguably summarised in the IPCC’s ARs. As indicated above, the IPCC’s pathways compatible with net-zero assume that CDR will be deployed in the future. This suggests that State Parties may need to consider CDR, if not at least set out how they intend to achieve their NDCs without CDR.

³⁴ Honegger, M., Burns W. and Morrow D.R. (2021) ‘Is carbon dioxide removal “mitigation of climate change”?’ *Review of European, Comparative & International Environmental Law*, 30 (3), [Online]. Available at: <https://doi.org/10.1111/reel.12401>.

³⁵ UNFCCC, article 4 (1) (b).

³⁶ UNFCCC, article 1 (8).

³⁷ Paris Agreement, article 4 (1).

³⁸ Paris Agreement, article 4 (2).

³⁹ Honegger, M., Burns W. and Morrow D.R. (2021) ‘Is carbon dioxide removal “mitigation of climate change”?’ *Review of European, Comparative & International Environmental Law*, 30 (3), [Online]. Available at: <https://doi.org/10.1111/reel.12401>.

⁴⁰ IPCC. (2018) *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. Cambridge University Press, Cambridge, UK and New York, USA, [Online]. Available at: <https://doi.org/10.1017/9781009157940>, 4.1.

⁴¹ Paris Agreement, article 4 (1).

⁴² Paris Agreement, article 4 (2).

⁴³ Paris Agreement, article 4 (3).

Furthermore, various State Parties have adopted domestic net-zero targets, either through national legislation, or through policy. This means that, even if it is viewed that the Paris Agreement does not necessitate the consideration of CDR, national climate change targets may necessitate it, or at least demand the development of an alternative mitigation pathway to net-zero. Whilst some governments, such as the United Kingdom (UK),⁴⁴ are actively pursuing CDR as part of their countries' climate mitigation strategies, others steer away from it or have imposed a moratorium on specific types of CDR, such as Austria's moratorium on carbon capture and storage (CCS).⁴⁵ Despite various governments setting ambitious net-zero targets through their NDCs, an implementation gap remains.⁴⁶

Priority level: 1 (urgent)

Relevant legal principles/provisions:

- Protection of the climate system for future generations⁴⁷
- Principle of common but differentiated responsibilities and respective capabilities⁴⁸
- Nationally determined contributions (NDCs)⁴⁹
- Precautionary principle⁵⁰
- No-harm rule⁵¹

Relevant ethical considerations:

- Future responsibility
- Distributive justice

Applicable legal frameworks:

- International climate change law: UNFCCC; 2015 Paris Agreement
- International environmental law: 1992 Rio Declaration; UNCBD; London Convention and London Protocol on the prevention of marine pollution and ocean dumping
- Customary international law and rules on State responsibility
- National climate change laws
- National environmental laws

⁴⁴ See, for instance, the UK national legal case study on climate engineering in Annex 9.3 of Vinders, J., et al. (2022). TechEthos D4.2: *Comparative analysis of national legal case studies*. Deliverable 4.2 for the European Commission. TechEthos Project Deliverable. Available at: <https://www.techethos.eu/national-legal-cases-on-emerging-technologies/>

⁴⁵ Federal Republic of Austria (2011b). 'On the ban of geological storage of carbon dioxide and amendment of the Environmental Impact Assessment Act 2000, the Federal Environmental Liability Act, the Industrial Code 1994 and the Mineral Resources Act (title translated with DeepL)' <http://extwprlegs1.fao.org/docs/pdf/aut147621.pdf>; Federal Ministry for Sustainability and Tourism (2019). 'Long-Term Strategy 2050 – Austria' [unfccc.int](https://unfccc.int/sites/default/files/resource/LTS1_Austria.pdf) https://unfccc.int/sites/default/files/resource/LTS1_Austria.pdf, p. 15, 17 and 37.

⁴⁶ See, Roelfsema M., et al (2020) 'Taking stock of national climate policies to evaluate implementation of the Paris Agreement', *Nature Commun*, 11 (2096), [Online]. Available at: <https://doi.org/10.1038/s41467-020-15414-6>.

⁴⁷ UNFCCC, preamble and article 3 (1).

⁴⁸ UNFCCC, preamble, article 3 (1) and 4 (1); Paris Agreement, preamble, article 2 (2), 4 (3) and (19).

⁴⁹ Paris Agreement, article 4 (2).

⁵⁰ U.N. Conference on Environment and Development. (1992) *Rio Declaration on Environment and Development*, A/CONT.151/26 (Vol. I) (1992 Rio Declaration) 12 August 1992, principle 15.

⁵¹ *Pulp Mills on the River Uruguay (Argentina v Uruguay)* (Judgment of 20 April 2010) ICJ Rep 14, para. 101: "A State is thus obliged to use all the means at its disposal in order to avoid activities which take place in its territory, or in any area under its jurisdiction, causing significant damage to the environment of another State."; Rio Declaration, principle 2; UNCBD, article 14 (1) (d); Birnie P., Boyle A., and Redgwell C. (2021). *International Law and the Environment*. 4th ed, Oxford: Oxford University Press.

<ul style="list-style-type: none"> Side-effects of CDR use and counter-factual risk of non-use 	
<p>Desired enhancement/change: Clarify the role of, and mandate for, various types of CDR methods under national and international law.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> Clarify the meaning of “protecting the climate system for future generations” under UNFCCC in the context of CDR to inform the possible role of or mandate for CDR methods;⁵² Evaluate the potential role of various types of CDR on an international level and provide guidance to national regulators as to the potential role of CDR in contributing to meeting the goals of the Paris Agreement. <p>Key actors:</p> <ul style="list-style-type: none"> UNFCCC bodies including the Conference of the Parties (COP) and the Secretariat UNCBD COP 	<p>National level changes:</p> <ul style="list-style-type: none"> Evaluate the role of CDR in the context of NDCs and pathways to achieving net-zero, including an evaluation of viable alternative pathways to achieving the objective of the Paris Agreement; Adapt national laws to accommodate CDR to the extent recognised and determined under a country’s NDCs; Develop appropriate governance regimes for permitting and licencing CDR activities under the right conditions. <p>Key actors:</p> <ul style="list-style-type: none"> National governments
<p>Circumstances necessary for change: Holistic assessment of the potential implications and role of various types of CDR in the context of net-zero and NDCs, taking into account scientific and technical implications, as well as wider socio-economic, human rights, biodiversity and sustainability considerations.</p>	

Regulatory challenge 3: Legal status of removals from CDR in the context of net-zero

Description: Ambiguity remains under the international and national climate change law as to the legal status of removals achieved through CDR, particularly in the context of net-zero targets. The goal of article 4 of the Paris Agreement is to ‘achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, (...)’.⁵³ Here, legal analysis has shown that CDR is a form of climate mitigation, and that the ‘enhancement of removals by sinks’ fits the definition of CDR.⁵⁴ This risks, however, that removals from CDR are treated in law as the negative equivalent to emission reductions, even though their quality and interim

⁵² UNFCCC, preamble and article 3 (1).

⁵³ Paris Agreement (entered into force 4 November 2016) 3156 U.N.T.S., signed by the UK on 22 April 2016, ratified on 18 November 2016, article 4 (1).

⁵⁴ Honegger, M., Burns W. and Morrow D.R. (2021) ‘Is carbon dioxide removal “mitigation of climate change”?’ *Review of European, Comparative & International Environmental Law*, 30 (3), [Online]. Available at: <https://doi.org/10.1111/reel.12401>, p. 329.

climate impact have been demonstrated to be asymmetric.⁵⁵ Whilst acknowledging that CDR is likely to play a role, particularly in removing hard-to-abate emissions, an equivalent legal status for emission reductions and removals from CDR could mean that the excessive reliance on CDR in achieving net-zero by 2050 could result in different and interim climate change impacts than when the majority of emissions is reduced. Having said that, the overarching objective of the Paris Agreement is the temperature goal of article 2, leaving the challenge to national regulators to define what level of CDR is needed as part of their NDCs.

Furthermore, article 4 (1) of the Paris Agreement refers to the obligation of State Parties to 'aim to reach global peaking of [...] emissions [...]'.⁵⁶ Here, it is unclear whether the reference to 'emissions' concerns gross or net emissions of greenhouse gases. Arguably, interpreting this as 'gross emissions' would indicate that reducing gross emissions should be prioritised over achieving net-zero emissions,⁵⁷ which would be a welcome clarification of international climate change law. The challenge for regulators is to appropriately recognise in law the nature and value of CDR in the context of net-zero climate targets, as distinct from emission reductions.

Priority level: 1 (urgent)

Relevant legal principles/provisions:

- Future generations
- Polluter-pays principle
- Precautionary principle
- Nationally determined contributions

Relevant ethical considerations:

- Moral hazard challenge of CDR and rapid emission reductions

Applicable legal frameworks:

- 1992 Rio Declaration
- 2015 Paris Agreement
- National climate change law

Desired enhancement/change: Clarity regarding the legal status of removals from CDR in the context of net-zero and meeting the objectives of the Paris Agreement.

International level changes:

- Clarify the meaning of 'removals by sinks' under article 4 (1) of the Paris Agreement and explicitly differentiate the legal status of carbon removals from emission reductions considering their

National level changes:

- Evaluate and define an acceptable level of CDR in the context of national climate targets and nationally determined contributions under the 2015 Paris Agreement with a view to avoid creating a moral hazard where CDR methods unduly legitimise a delay or reduced

⁵⁵ Zickfeld, K., Azevedo, D., Mathesius, S., et al., (2021) 'Asymmetry in the climate-carbon cycle response to positive and negative CO₂ emissions', *Nat. Clim. Chang.* 11, 613–617 (2021). <https://doi.org/10.1038/s41558-021-01061-2>.

⁵⁶ Paris Agreement, article 4 (1).

⁵⁷ Honegger, M., Burns W. and Morrow D.R. (2021) 'Is carbon dioxide removal "mitigation of climate change"?' *Review of European, Comparative & International Environmental Law*, 30 (3), [Online]. Available at: <https://doi.org/10.1111/reel.12401>.

<p>distinct nature and value in the context of achieving net-zero;⁵⁸</p> <ul style="list-style-type: none"> Clarify the meaning of 'emissions' when referring to the 'global peaking of greenhouse gas emissions' in article 4 (1) of the Paris Agreement and specify whether this concerns gross or net emissions; Promote international consistency by providing guidance to national governments developing net-zero laws and policies. <p>Key actors:</p> <ul style="list-style-type: none"> UNFCCC bodies including the Conference of the Parties (COP) and the Secretariat IPCC 	<p>ambition in achieving emission reductions.</p> <p>Key actors:</p> <ul style="list-style-type: none"> National governments
<p>Circumstances necessary for change: Likely to require clear guidance at the international level (UNFCCC) and national level to ensure consistency among State Parties to the 2015 Paris Agreement.</p>	

Regulatory challenge 4: Removal accounting

Description: Appropriate quantification of removals from CDR is likely to require strong international collaboration and transparency of information. This is because CDR activities may take place in more than one State, such as when biomass is imported for carbon capture and storage (BECCS). To avoid double-counting and ensure environmental integrity overall,⁵⁹ there may be a need for international standardisation to enable appropriate removal accounting.

The challenge for regulators is to develop standards fit for purpose, and to come to an international agreement on such standards, taking into account lessons that may be drawn from the accounting of emission reductions.⁶⁰

Priority level: 2 (high)

⁵⁸ See, for example, Carton W., Lund J.F., Dooley K. (2021) 'Undoing equivalence: Rethinking carbon accounting for just carbon removal' *Frontiers in Climate*, 3, [Online]. Available at: <https://doi.org/10.3389/fclim.2021.664130>.

⁵⁹ See, for instance, Poralla, M.; Honegger, M.; Gameros, C.; Wang, Y.; Michaelowa, A.; Sacherer, A.-K.; Ahonen, H.-M.; Moreno, L. (2022). *Tracking greenhouse gas removals: baseline and monitoring methodologies, additionality testing, and accounting*. NET-Rapido Consortium and Perspectives Climate Research, London, UK and Freiburg i.B., Germany, [Online]. Available at: <https://negative-emissions.climatestrategies.org/our-research-workplan/reports-resources/tracking-greenhouse-gas-removals/>.

⁶⁰ See, for example, criticism on the accounting of emission reductions under the EU Emission Trading Scheme (ETS): Müller, M. N. (2021). 'Directive 2003/4/EC as a Tool to Learn from the Successes and Failures of the EU ETS: Reflecting on the EU Emission Trading System', In M. Boeve, S. Akerboom, C. Backes, & M. van Rijswijk (Eds.), *Environmental Law for Transitions to Sustainability* (1st ed., pp. 109–128). Intersentia. <https://doi.org/10.1017/9781780689302.008>.



Relevant legal principles/provisions: <ul style="list-style-type: none"> Net-zero targets⁶¹ 	Relevant legal frameworks: <ul style="list-style-type: none"> International climate change law: UNFCCC; 2015 Paris Agreement National climate change law
Desired enhancement/change: Internationally standardised methodology for the accounting of removals from CDR.	
International level changes: <ul style="list-style-type: none"> Pursue international collaboration & standardisation of removal accounting methodologies; Promote transparency of information and evaluate the need for measures to reduce conflicts of interest; Evaluate the appropriateness of different removal accounting methodologies, including, for example, by bundling.⁶² Key actors: <ul style="list-style-type: none"> UNFCCC bodies including the Conference of the Parties (COP) and the Secretariat IPCC 	National level changes: <ul style="list-style-type: none"> Collaborate with international trade partners to streamline carbon removal accounting to protect environmental integrity and avoid the risk of double-counting; Promote transparency of information and evaluate the need to reduce conflicts of interest in removal accounting methodologies. Key actors: <ul style="list-style-type: none"> National governments
Circumstances necessary for change: Likely to rely on the availability of scientific knowledge regarding the effective capacity of sinks. Likely to require strong international guidance/agreement to promote transparency of information and ensure consistency in removal accounting methodologies to protect environmental integrity, reduce conflicts of interest and avoid the risk of double-counting.	

Regulatory challenge 5: Public participation & access to justice

Description: Public participation and access to justice are key principles of environmental decision-making recognised under international environmental law, most notably under the regional Aarhus Convention.⁶³ CDR may present various practical challenges to States when it comes to facilitating public participation and access to justice. Considering the possible international nature of CDR activities, it is not clear what the requirements are for facilitating public participation and access to

⁶¹ Paris Agreement, article 4 (1).

⁶² See, Macinante J., Ghaleigh, N.S., (2022) 'Regulating removals: Bundling to achieve fungibility in GGR "removal units"', *Edinburgh School of Law Research Paper No. 2022/05*, [Online]. Available at: <https://dx.doi.org/10.2139/ssrn.4064970>.

⁶³ Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (entered into force 30 October 2001) 2161 U.N.T.S. 447 (Aarhus Convention).

justice on an international level to satisfy States' responsibilities under the Aarhus Convention, and whether there is a need for a stronger regulatory framework to facilitate public participation at a global level.

The challenge for regulators is to define the requirements for facilitating good public participation and access to justice.⁶⁴

Priority level: 1 (urgent)

Relevant legal principles/provisions:

- Access to information, public participation in decision-making and access to justice in environmental matters⁶⁵

Relevant ethical considerations:

- Procedural justice

Relevant legal frameworks:

- UN Economic Commission for Europe (UNECE) Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters⁶⁶
- Espoo Convention on Environmental Impact Assessment in a Transboundary Context⁶⁷
- National environmental law

Desired enhancement/change: Strengthened compliance with international law on access to information, transparency, public participation and access to justice in the context of CDR.

International level changes:

- Collaborate internationally to facilitate and promote access to information, public participation and access to justice where CDR activities have cross-border implications;
- Clarify the responsibilities of State Parties to the Aarhus Convention and provide guidance to facilitate appropriate access to information, public participation and access to justice in the context of CDR technologies.

National level changes:

- Monitor national CDR activities and make information on CDR publicly available to meet the requirements of the Aarhus Convention;
- Evaluate and implement appropriate processes for the facilitation of effective public participation, particularly in the context of cross-border CDR activities.

Key actors:

- National governments

⁶⁴ Worth noting here is the evaluation of CDR in the context of the UN Sustainable Development Goals by Honegger M., Michaelowa A. & Roy J., (2021) Potential implications of carbon dioxide removal for the sustainable development goals, Climate Policy, 21:5, 678-698, DOI: [10.1080/14693062.2020.1843388](https://doi.org/10.1080/14693062.2020.1843388).

⁶⁵ Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (entered into force 30 October 2001) 2161 U.N.T.S. 447 (Aarhus Convention).

⁶⁶ Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (entered into force 30 October 2001) 2161 U.N.T.S. 447 (Aarhus Convention).

⁶⁷ Convention on Environmental Impact Assessment in a Transboundary Context (entered into force 10 September 1997) 1989 U.N.T.S. 309 (Espoo Convention).

<p>Key actors:</p> <ul style="list-style-type: none"> ○ Aarhus Convention bodies including State Parties and Working Group of the Parties, Compliance Committee and Task Force on Public Participation in International Forums. 	
<p>Circumstances necessary for change: Likely to require an evaluation of effective methodologies and means of facilitating and promoting access to information, public participation and access to justice, particularly in an international context such as where CDR activities take place in or affect more than one country.</p>	

Regulatory challenge 6: Environmental management, including waste and chemicals

Description: Despite there being limited regulation explicitly aimed at CDR, many aspects of CDR are subject to existing laws concerning environmental management. For instance, biomass production for BECCS would be subject to relevant land management and biodiversity regulations, and the use of chemicals to capture CO₂, such as amines, would be subject to relevant chemicals regulations. However, as a novel technology or technique, CDR creates some ambiguity as to whether certain laws are applicable or not. For example, whilst CO₂ is not currently listed as a hazardous waste under the Basel Convention, it may be argued that it should, considering that in the context of CCS, it exhibits some of the characteristics of hazardous wastes under the Convention.⁶⁸

Furthermore, the permanent disposal of CO₂ under the sub-seabed arguably qualifies as 'waste disposal' and 'ocean dumping' within international and national waste regulation. Whilst a 2006 amendment to the London Protocol on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Protocol)⁶⁹ seeks to clarify that CO₂ storage in offshore sites is compatible with international waste regulations, the amendment has yet to enter into force, meaning that legal certainty around the applicability of international waste regimes is lacking.⁷⁰ For comparison, the applicability of EU waste regulation to CDR methods such as biochar has been considered elsewhere.⁷¹

The challenge for regulators is to ensure that existing waste and chemicals regulations are adequate and appropriate for the governance of CDR, and that any gaps are filled to help increase legal certainty.

Priority level: 2 (high)

⁶⁸ CO₂ transport for storage: Regulatory regimes / UCL Carbon Capture Legal Programme [Online]. Available at: <https://www.ucl.ac.uk/cclp/ccstransport-int-waste-basel.php>.

⁶⁹ Amendment to Article 6 of the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter 1972 (adopted on 30 October 2009, not yet entered into force).

⁷⁰ Amendment to Article 6 of the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter 1972 (adopted on 30 October 2009, not yet entered into force).

⁷¹ See, Štrubelj L. (2022) 'Waste, fertilising product, or something else? EU regulation of biochar', *Journal of Environmental Law*, Volume 34, Issue 3, [Online]. Available at: <https://doi.org/10.1093/jel/eqac013>.

<p>Relevant legal principles/provisions:</p> <ul style="list-style-type: none"> ○ Precautionary principle ○ No-harm rule 	<p>Relevant legal frameworks:</p> <ul style="list-style-type: none"> ○ International environmental law including the 1992 Rio Declaration; London Convention and London Protocol⁷²; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention),⁷³ the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention),⁷⁴ and the Geneva Convention on Long-Range Transboundary Air Pollution (LRTAP)⁷⁵ ○ National environmental law
<p>Desired enhancement/change: Legal certainty regarding the applicability of existing environmental laws, including waste and chemicals regulation.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> ○ Promote the ratification of 2006 Amendment to London Protocol clarifying the status of CCS in the context of ocean dumping with a view to triggering the amendment's entry into force; ○ Provide guidance to national governments on the applicability of relevant international environmental laws, including but not limited to, the Basel Convention, the OSPAR Convention and the LRTAP. <p>Key actors:</p> <ul style="list-style-type: none"> ○ Relevant UN bodies ○ State Parties to international environmental agreements 	<p>National level changes:</p> <ul style="list-style-type: none"> ○ Evaluate the adequacy of existing environmental management regimes, including waste and chemicals, for the governance of various types of CDR; ○ Adapt national environmental laws, particularly around waste and chemical regulation, to accommodate and appropriately govern various types of CDR. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments

⁷² Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (entered into force 30 August 1975) 1046 U.N.T.S. 120 (London Convention); 1996 Protocol to the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (entered into force 24 March 2006) ATS 11 (London Protocol).

⁷³ Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (entered into force 5 May 1992) 1673 U.N.T.S. 57 (Basel Convention).

⁷⁴ Convention for the Protection of the Marine Environment of the North-East Atlantic (entered into force 25 March 1997) 2354 U.N.T.S. 67 (OSPAR Convention).

⁷⁵ Convention on Long-Range Transboundary Air Pollution (entered into force 16 March 1983) 1302 U.N.T.S. 217 (Geneva Convention).

Circumstances necessary for change: Likely to require some degree of international collaboration between key international actors and national governments for consistency and legal certainty.

Regulatory challenge 7: The cost of removals

Description: A further regulatory challenge of CDR concerns its cost. Under international environmental law, it is generally recognised that the polluter should bear the costs of pollution, also known as the polluter-pays principle.⁷⁶ In pursuit of stabilising atmospheric greenhouse gas concentrations,⁷⁷ the Paris Agreement recognises that country Parties have ‘common but differentiated responsibilities’ which may be reflected through Nationally Determined Contributions (NDCs).⁷⁸ This raises the question if and to what extent emitters of greenhouse gases have a responsibility to pay for the removal of the CO₂ they emitted. Indeed, article 9 of the Paris Agreement recognises the responsibility of developed country Parties to provide financial resources to developing parties, which not only resembles the respective capabilities of developed Parties, but is also a recognition of their responsibilities arising from their share in historical and current global emissions.⁷⁹ The challenge for regulators is to determine whether the polluter-pays principle gives rise to an obligation on developed States to pay for CDR, and whether this obligation can and/or should be transferred onto non-State actors, such as corporations, through national laws.

Priority level: 2 (high)

Relevant legal principles/provisions:

- Climate finance⁸⁰
- Principle of common but differentiated responsibilities and respective capabilities
- Polluter-pays principle

Relevant ethical considerations:

- Distributive justice

Relevant legal frameworks:

- 1992 Rio Declaration
- UNFCCC
- 2015 Paris Agreement
- 1992 Rio Declaration
- National climate change law

Desired enhancement/change: Clarity regarding the respective responsibilities of emitters to finance CDR, with respect to State actors, and private actors, such as corporations.

International level changes:

- Clarify the responsibility of developed States under the principle of common

National level changes:

- Explore the need for holding emitters/polluters responsible for

⁷⁶ U.N. Conference on Environment and Development. (1992) *Rio Declaration on Environment and Development*, A/CONT.151/26 (Vol. I) (1992 Rio Declaration) 12 August 1992, principle 16.

⁷⁷ United Nations Framework Convention on Climate Change (entry into force 21 March 1994) 1771 UNTS 107 (UNFCCC), article 2.

⁷⁸ Paris Agreement (entry into force 4 November 2016) 3156 UNTS (Paris Agreement), article 4 (3).

⁷⁹ Paris Agreement, article 9; UNFCCC, preamble.

⁸⁰ Paris Agreement, article 9.



<p>but differentiated responsibilities to explore and/or fund CDR; explore whether climate finance arrangements under article 9 of the Paris Agreement need to be expanded to assist developing countries? Explore under what conditions CDR may be integrated into emission trading schemes whilst recognising the distinct nature of removals from emission reductions.</p> <p>Key actors:</p> <ul style="list-style-type: none"> ○ UNFCCC bodies including the Conference of the Parties (COP) and the Secretariat 	<p>current and historical emissions such as by exploring the need for imposing a Carbon Removal Obligation.⁸¹</p> <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments ○ Non-State actors
<p>Circumstances necessary for change: Likely to require international agreement to ensure consistency between States and avoid a collective action problem and forum/jurisdiction shopping, where private actors move operations to more favourable jurisdictions to avoid stringent climate rules and national governments are disincentivised to transfer the cost onto private polluters to protect the economy and maintain foreign investment.</p>	

Regulatory challenge 8: Liability for harms

Description: CDR requires appropriate liability regimes in the case of harm, such as to the environment or human health. Comprehensive liability regimes can contribute to the sustainable development and deployment of CDR, because it encourages operators to prevent harm as much as possible, and enables access to justice in the case harm occurs, nonetheless. States' obligations to protect the environment under international environmental law are predominantly procedural.⁸² The lack of effective enforcement mechanisms within international environmental law poses a challenge to accountability for harms resulting from CDR.⁸³ Whilst existing national environmental liability regimes may be relevant and applicable, the nature of certain CDR methods may require legal reform to ensure laws are fit for purpose. A particular challenge may be establishing causation and accountability for environmental harm caused by certain CDR activities. For example, the leakage of CO₂ from a storage site may not result in direct harm to the environment other than the re-emission of previously removed CO₂ which now continues to contribute to climate change. Establishing a causal link between the leakage and the resulted change to the global climate system is arguably impossible. As such, there may be a need to develop risk-based or strict liability-based regimes for CDR.

⁸¹ See, for instance, Bednar, J., Obersteiner, M., Baklanov, A, et al (2021) 'Operationalizing the net-negative carbon economy', *Nature*, 596, 377–383, [Online]. Available at: <https://doi.org/10.1038/s41586-021-03723-9>; Stainforth, D.A. (2021) 'The effects of assigning liability for CO₂ removal' *Nature*, 596, [Online]. Available at: <https://media.nature.com/original/magazine-assets/d41586-021-02192-4/d41586-021-02192-4.pdf>;

⁸² Santiago, N., Howkins, B., Vinders, J., Rodrigues, R., Warso, Z., Bernstein, M., Gonzalez, G., Porcari, A. (2022). TechEthos D4.1: *Analysis of international and EU law and policy*. TechEthos Project Deliverable. Available at: <https://zenodo.org/record/7650731>, p. 77.

⁸³ United Nations Environment Programme. (2019) *Environmental Rule of Law First Global Report*. Available at: <https://www.unep.org/resources/assessment/environmental-rule-law-first-global-report>.

The challenge for regulators is to strike a balance between providing adequate liability regimes, and discouraging operators by overly stringent standards, such as ones resulting in open-ended liability in the context of permanent CO2 storage facilities.⁸⁴

Priority level: 2 (high)

Relevant legal principles/provisions:

- Future generations
- Polluter-pays principle
- No-harm rule

Relevant ethical considerations:

- Distributive justice
- Side-effects
- Future responsibility

Relevant legal frameworks:

- Customary international law; *Pulp Mills on the River Uruguay case*
- 1992 Rio Declaration, principle 2
- UN General Assembly (UNGA) Resolution 56/83, article 31 and 34-39.

Desired enhancement/change: Adequate liability regimes for CDR and legal certainty for CDR operators, specifically in the context of permanent and/or long-term storage.

International level changes:

- Evaluate the possibility of developing stronger international accountability mechanisms for transboundary environmental harms caused through CDR

Key actors:

- UN bodies, including UNEP

National level changes:

- Adapt national environmental liability mechanisms to accommodate CDR; explore options to overcome the challenge of proving causation between CDR activity and harm occurred (e.g. in case of CO2 leakage) such as by adopting risk-based or strict liability-based regimes.

Key actors:

- National governments

Circumstances necessary for change: Stronger accountability mechanisms at the international level are likely to depend on international collaboration, political willingness and agreement. To date, international environmental law on liability for harms has been predominantly procedural.

⁸⁴ Zhang H. (2021) 'Regulations for carbon capture, utilization and storage: Comparative analysis of development in Europe, China and the Middle East' *The Chinese University of Hong Kong Faculty of Law Research Paper No. 2021-38*, [Online]. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3871831&dgcid=ejournal_htmlmail_political:economy:development:environment:ejournal_abstractlink, p. 18.

3.2 Solar Radiation Modification

Solar radiation modification (SRM) comprises a variety of techniques which aim to reflect sunlight and heat back into space to reduce warming on earth. The objective of SRM is to alleviate climate change impacts and it is the only known way to quickly reduce global temperatures,⁸⁵ which means that it has the potential to significantly reduce the harms of global warming. However, the various techniques themselves present risks and are considered controversial. SRM therefore presents a “risk/risk” paradigm, where the risks of SRM can only be meaningfully evaluated in comparison to the risks of a warmer world.⁸⁶

This section discusses the challenges specific to the governance of SRM, including the governance challenges of rejecting SRM and allowing the planet to continue warming, followed by an overview of potential changes or enhancements of legal frameworks at the international and national level.

3.2.1 SRM-specific regulatory challenges

The key challenges related to the governance of SRM are listed below, including the question of what constitutes SRM and SRM research and how SRM might be governed, as well as good governance practices for SRM research and human rights considerations:

- **Defining SRM and delineating between SRM research and deployment:** What constitutes SRM? If it is decided that SRM research warrants novel and specific governance measures, how to define which activities are to be governed? What is the delineation between SRM research, particularly field testing, and SRM deployment?
- **Governance of and mandate for SRM:** To what extent are different types of SRM methods currently governed by law under international and national law? Is there a need to refine and strengthen the regulatory framework to govern SRM? By what authority may SRM be used or prevented from use? To what extent does or should the risk of climate tipping points or termination shock affect the governance of SRM? Does international law provide a mandate for SRM research? How to balance the risks of SRM deployment against the risks of non-use? Is there a need for international agreement on the governance of SRM?
- **Governance of SRM research:** To what extent is SRM research governed by existing environmental laws at the national and international level, such as air pollution controls, chemicals regulation, laws governing liability for harms? Is there a need adapt existing laws or create new laws to govern SRM research?
- **Procedural justice and human rights protection in SRM research decision-making:** How to ensure human rights are protected when any decision to use SRM, or to delay or reject its use,

⁸⁵ United Nations Environment Programme (2023). *One Atmosphere: An independent expert review on Solar Radiation Modification research and deployment*. Nairobi: Kenya, [Online]. Available at: https://wedocs.unep.org/bitstream/handle/20.500.11822/41903/one_atmosphere.pdf?sequence=3&isAlloved=y, p. 4.

⁸⁶ See, for instance, Wieners, C. E., Hofbauer, B. P., de Vries, I. E., Honegger, M., Visioni, D., Russchenberg, H., & Felgenhauer, T. (2023), ‘Solar Radiation Modification is risky, but so is rejecting it: A call for balanced research’, 3 *Oxford Open Climate Change*, 1, [Online]. Available at: <https://doi.org/10.1093/oxfclm/kgad002>; Florin, M.-V. (Ed.), Rouse, P., Hubert, A.-H., Honegger, M., Reynolds, J. (2020). *International governance issues on climate engineering. Information for policymakers*. Lausanne: EPFL International Risk Governance Center (IRGC); Harrison, N., Pasztor, J., & Barani Schmidt, K. U. (2021). *A risk-risk assessment framework for solar radiation modification*. International Risk Governance Center, [Online]. Available at: <https://doi.org/10.5075/epfl-irgc-287240>; and, Grieger, K.D., Felgenhauer, T., Renn, O. *et al.* (2019) ‘Emerging risk governance for stratospheric aerosol injection as a climate management technology’ 39 *Environ Syst Decis*, 371–382, [Online]. Available at: <https://doi.org/10.1007/s10669-019-09730-6>.



may have a global effect? How to protect the right to freedom of scientific research? What would effective (potentially global) public participation in decision-making look like?

3.2.2 Challenges and options for enhancing legal frameworks

The key consideration for the governance of SRM is the fact that SRM presents risk/risk dilemma. SRM is the only known way to quickly cool the planet, which means that risks of SRM can only be meaningfully evaluated in comparison to the risks of foregoing SRM and allowing the planet to warm further. The considerable ethical and legal challenges that SRM raises should be compared to the considerable challenges that would arise from rejecting SRM and allowing the planet to warm, and good governance measures need to take into account the risks on both sides.

The effective governance of SRM deployment may demand strong international collaboration and agreement, particularly in the case of possible transboundary effects. Not only is it possible that SRM methods may take place in multiple countries, the impacts of SRM deployment could be global, as will the impacts of rejecting SRM and allowing the planet to warm. International collaboration may therefore be needed to facilitate the debate on how to govern SRM and SRM research, taking into consideration the risks introduced by SRM in comparison to the risks of foregoing SRM and allowing the Earth to warm.

The tables below further explore each regulatory challenges specific to SRM, and provide an overview of potential changes or enhancements of legal frameworks at the international and national level.

Regulatory challenge 1: Defining SRM and delineating between SRM research and SRM deployment

Description: The definition of SRM and SRM research has legal implications, because it determines when SRM-specific rules are applicable. The IPCC defined SRM as “a range of radiation modification measures not related to *greenhouse gas (GHG)* mitigation that seek to limit *global warming*. Most methods involve reducing the amount of incoming solar radiation reaching the surface, but others also act on the longwave radiation budget by reducing optical thickness and cloud lifetime.”⁸⁷ SRM may, in some instances, be considered to be a form of climate engineering, or geoengineering, which is defined as ‘... the deliberate large-scale intervention in the Earth’s climate system, in order to moderate global warming.’⁸⁸ As such, SRM is the object of the UNCBD decision on geo-engineering, which called for parties to consider ensuring that no SRM activities that would have significant, adverse and transboundary impacts on biodiversity take place until there is a scientific basis to do so and relevant risks are considered.⁸⁹ However, small scale SRM research, such as open-air testing, are permitted by the decision if environmental impacts are assessed.

Both definitions include two key elements: one of intent (namely countering global warming), and one of scale (i.e. large-scale). Yet scale is not further defined. This ambiguity poses a problem for governments seeking to govern SRM research of various forms and deployment of SRM. One

⁸⁷ Skea J. et al (2021) *Climate Change 2022: Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change, [Online]. Available at: <https://www.ipcc.ch/report/ar6/wg3/>, Annex II, Glossary, p. 2923.

⁸⁸ Shepherd, J., Caldeira, K., Cox, P., Haigh, J., Keith, D., Launder, B., Mace, G., McKerron, G., Pyle, J., Rayner, S., Redgwell, C., Watson, A., Parker, A., Garthwaite, R., Wilsdon, J. (2009) *Geoengineering the Climate: Science, Governance, and Uncertainty*. Available at: <http://royalsociety.org>.

⁸⁹ UNEP/CBD/COP/DEC/X/33, Available at: <https://www.cbd.int/decisions/cop/10/33/8> and UNEP/CBD/COP/DEC/13/14, available at: <https://www.cbd.int/decisions/cop/13/14>.

particular SRM research activity, such as the Australian RRAP,⁹⁰ may not constitute climate engineering within the definition of affecting the Earth's climate system. Furthermore, the purpose of the RRAP is not to limit global warming per se, but rather to protect the Australian Great Barrier Reef from bleaching.⁹¹ Nevertheless, the same type of technique used at a larger scale, or the cumulative effect of various small scale SRM activities may affect the global climate system, even though each individual activity would still fall outside the scope of the UNCBD decision. The definition of and delineation of SRM and SRM research affects the types of activities that are subject to existing and any emerging international and national rules governing SRM.⁹²

If SRM research of particular form is deemed to require additional guidance or regulation, then the first challenge for regulators is to define what types of research activities should be included in such a category – and how to avoid erroneous inclusion of other research activities in this category by inaccurate definition causing infringement to the freedom of the scientific endeavour. A further challenge is to delineate SRM research from SRM deployment, particularly in the context of SRM field testing. Concern over possible 'slippery slope effects', where SRM field testing unduly increases the likelihood of SRM deployment may represent an important consideration when it comes to delineating what types of activities ought to potentially be included in such a category.⁹³

Priority level: 1 (urgent)

Relevant legal principles/provisions:

- Rules on chemical release
- Environmental impact assessments⁹⁴

Relevant ethical considerations:

- Research ethics

Relevant legal frameworks:

- International environmental law including 1992 Rio Declaration; UNCBD; Espoo Convention on Environmental Impact Assessment in a Transboundary Context
- National environmental law

Desired enhancement/change: Clear and widely accepted definitions for SRM and SRM research.

International level changes:

- Pursue a common definition of what constitutes SRM research, and how it is

National level changes:

- Examine whether definitions adopted at the international level may be suitable to

⁹⁰ *The Program / Reef Restoration and Adaptation Program*, [Online]. Available at: <https://qbrrestoration.org/the-program/>.

⁹¹ *The Program / Reef Restoration and Adaptation Program*, [Online]. Available at: <https://qbrrestoration.org/the-program/>.

⁹² UNEP/CBD/COP/DEC/X/33, Available at: <https://www.cbd.int/decisions/cop/10/33/8>.

⁹³ Quaas, Martin F., Johannes Quaas, Wilfried Rickels, and Olivier Boucher (2017) 'Are There Reasons against Open-Ended Research into Solar Radiation Management? A Model of Intergenerational Decision-Making under Uncertainty', *Journal of Environmental Economics and Management*, 84, 1–17, [Online]. Available at: <https://doi.org/10.1016/j.jeem.2017.02.002>.

⁹⁴ Rio Declaration, Principle 17: "Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment ..."; United Nations Convention on the Law of the Sea (UNCLOS) (entered into force 16 November 1994) 1833 U.N.T.S 3, Article 206 ; Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) (entry into force 10 September 1997) No.34028, Article 1(vi).

<p>to be differentiated from other forms of environmental research;</p> <ul style="list-style-type: none"> ○ Pursue a common definition of what constitutes SRM research and deployment, the extent to which local/regional activities amount to SRM, in order to provide guidance to governments on assessing SRM research versus deployment. <p>Key actors:</p> <ul style="list-style-type: none"> ○ IPCC ○ UNEP ○ UN General Assembly ○ Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) ○ UNCBD bodies including the COP 	<p>structure national regulation of SRM-related activities;</p> <ul style="list-style-type: none"> ○ Examine the extent to which categories of SRM-related activities are regulated through national law or fall under the purview of national authorities (including environmental impact assessments, research funding guidelines, and similar processes); ○ Develop a regulatory delineation between SRM research and deployment with scientific basis; ○ Collaborate internationally to align definitions of categories of SRM-related activities. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments
<p>Circumstances necessary for change: Any attempts to agree SRM-specific governance arrangements at an international level are likely to require international collaboration and agreement to develop a common definition of SRM research, and a delineation of SRM research and deployment.</p>	

Regulatory challenge 2: Governance of and/or mandate for SRM and SRM research

Description: SRM is the only known way to quickly reduce global temperatures, and the reason for considering SRM is its potential to alleviate adverse impacts of climate change.⁹⁵ However, SRM introduces risks of harm. Additionally, there are significant scientific uncertainties around the possible effects of both deploying different forms of SRM and of foregoing SRM and allowing the planet to warm.⁹⁶ In that sense, both using and rejecting SRM would be expected to have global implications. This raises the issue of decision-making processes for SRM, and the respective legal basis. Recently, a group of over 400 academics have called for the adoption of an international non-use agreement to 'prevent the normalisation of [SRM] as a climate policy action'.⁹⁷ In response, many SRM experts are calling for expanded SRM research. Some argue that refraining from SRM could increase the risk of reaching dangerous levels of climate change, particularly if the Earth's climate

⁹⁵ Honegger, M., Michaelowa A. and Pan J. (2021) 'Potential implications for solar radiation modification for the achievement of the Sustainable Development Goals' *Mitigation and Adaptation Strategies for Global Change*, 26 (21). Available at: <https://doi.org/10.1007/s11027-021-09958-1>, p. 21.

⁹⁶ See, for instance, United Nations Environment Programme (2023). *One Atmosphere: An independent expert review on Solar Radiation Modification research and deployment*. Nairobi: Kenya, [Online]. Available at: https://wedocs.unep.org/bitstream/handle/20.500.11822/41903/one_atmosphere.pdf?sequence=3&isAllo wed=y.

⁹⁷ *Open Letter / Solar Geoengineering Non-Use Agreement*, [Online]. Available at: <https://www.solargeoeng.org/non-use-agreement/open-letter/>.

sensitivity is high.⁹⁸ It has been suggested that, in such a scenario, increasing the Earth's albedo effect may be necessary to meet the temperature goal of the Paris Agreement with high confidence.⁹⁹

It is clear that the stakes are extremely high: SRM has the potential to be very helpful and very harmful, and humanity does not know enough to make an informed decision at this stage. As such, the evaluation of SRM requires an analysis of risks, reflecting on the risks introduced by SRM in comparison to the risks of foregoing SRM and allowing the Earth to warm.¹⁰⁰

Some international environmental law principles, such as the no-harm rule and the precautionary principle, do not offer guide to action in the case of SRM as they can be interpreted as both in favour of and against SRM. The no-harm rule holds that States have an obligation to prevent, reduce and control the risk of significant harm to the environment, which may affect present and future generations.¹⁰¹ This could be taken to agitate for the immediate use, or the immediate rejection of SRM. The precautionary principle holds that one should adopt a precautionary approach in light of scientific uncertainty.¹⁰² In the context of SRM, this could be interpreted as meaning that States should refrain from SRM to avoid risks of harm to the environment in light of associated risks and scientific uncertainty. An alternative interpretation could be that States may be obligated to engage in SRM to prevent risks of harm caused by dangerous levels of climate change.

Priority level: 2 (high)

Relevant legal principles/provisions:

- Precautionary principle
- No-harm rule
- Rule of law
- Principle of common heritage of mankind¹⁰³
- Territorial principle

Relevant legal frameworks:

- Customary international law
- International environmental law, including 1992 Rio Declaration; UNCBD; Convention on the Prohibition of Military or Any Other Hostile Use of

⁹⁸ Horton JB., Keith DW., Honegger M (2016) *Implications of the Paris Agreement for Carbon Dioxide Removal and Solar Geoengineering*. (Viewpoints Harvard Project on Climate Agreements), [Online]. Available at: https://www.belfercenter.org/sites/default/files/files/publication/160700_horton-keith-honegger_vp2.pdf, p. 4.

⁹⁹ Paris Agreement, article 2 (1) (a); Horton JB., Keith DW., Honegger M (2016) *Implications of the Paris Agreement for Carbon Dioxide Removal and Solar Geoengineering*. (Viewpoints Harvard Project on Climate Agreements), [Online]. Available at: https://www.belfercenter.org/sites/default/files/files/publication/160700_horton-keith-honegger_vp2.pdf, p. 4.

¹⁰⁰ Felgenhauer, T., et al. (2022) *Solar Radiation Modification: A risk-risk analysis*. Carnegie Climate Governance Initiative (C2G) (New York: US), [Online]. Available at: <https://www.c2g2.net/publications/>.

¹⁰¹ *Pulp Mills on the River Uruguay (Argentina v Uruguay)* (Judgment of 20 April 2010) ICJ Rep 14, para. 101: "A State is thus obliged to use all the means at its disposal in order to avoid activities which take place in its territory, or in any area under its jurisdiction, causing significant damage to the environment of another State."; Rio Declaration, principle 2; UNCBD, article 14 (1) (d); Birnie P., Boyle A., and Redgwell C. (2021). *International Law and the Environment*. 4th ed, Oxford: Oxford University Press.

¹⁰² Rio Declaration, principle 15.

¹⁰³ United Nations Convention on the Law of the Sea (UNCLOS) (entry into force 16 November 1994) 1833 U.N.T.S. 3, Parts II-IV, article 136; Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (Outer Space Treaty). 1967. 610 U.N.T.S. 205, article 1; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement) (entry into force 11 July 1984) 1363 U.N.T.S. 22, Article 11.

<p>Relevant ethical considerations:</p> <ul style="list-style-type: none"> ○ Distributive justice ○ Procedural justice ○ Research ethics 	<p>Environmental Modification Techniques (ENMOD)¹⁰⁴</p> <ul style="list-style-type: none"> ○ International law of the sea including the UN Convention on the Law of the Sea (UNCLOS) ○ International space law including the Outer Space Treaty¹⁰⁵ and the Moon Agreement¹⁰⁶ ○ National environmental law
<p>Desired enhancement/change: An acceleration of safe SRM research, discussions about the governance of SRM experiments that might have environmental risks, consideration of how decisions about SRM might be made.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> ○ Promote the adoption of a risk/risk analysis approach to the evaluation of SRM, taking into account the risks associated with SRM use as well as the risks associated with warming; ○ Revisit UNCBD decisions to clarify the guidance provided regarding SRM-related activities; ○ Examine all potential interpretations of applicable principles including the precautionary approach, no-harm rule in the context of assessing the desirability of and enacting legal norms on the permissibility of various SRM-related activities; ○ Consider the possibility of expanding the principle of 'common heritage of mankind' to the governance of the global climate system or the atmosphere, drawing on parallels with relevant provisions of the Outer Space Treaty¹⁰⁷ and UNCLOS,¹⁰⁸ whilst respecting the sovereignty of States under the territorial principle; 	<p>National level changes:</p> <ul style="list-style-type: none"> ○ Pursue international collaboration and consistency in the assessment of SRM on a risk/risk basis; ○ Control activities in domestic airspace and restrict for-profit SRM experiments¹¹¹ until there is more clarity regarding the governance of SRM at the national and international level. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments

¹⁰⁴ United Nations Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) (entry into force 5 October 1978) 1108 U.N.T.S. 151.

¹⁰⁵ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (Outer Space Treaty). 1967. 610 U.N.T.S. 205.

¹⁰⁶ Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement) (entry into force 11 July 1984) 1363 U.N.T.S. 22, Article 11.

¹⁰⁷ Outer Space Treaty, article 1.

¹⁰⁸ UNCLOS, article 136.

¹¹¹ To illustrate, see the US-based example of privately initiated SAI experiment, 'Make Sunsets'. Available at: <https://makesunsets.com/>.

<ul style="list-style-type: none"> Consider the possibility of expanding existing international environmental agreements to the governance of certain aspects of SRM, such as ENMOD¹⁰⁹ or the Montreal Protocol.¹¹⁰ <p>Key actors:</p> <ul style="list-style-type: none"> Relevant UN bodies, including the UN General Assembly, UNCBD COP 	
<p>Circumstances necessary for change: Achieving international agreement on the governance of SRM experimentation with significant transboundary risks is likely to require strong international coordination and agreement. Reaching international agreement may be challenging considering the controversy around SRM. Necessary steps toward multilateral decisions may include international dialogue and the facilitation of collaboration including in research and scientific assessment.</p>	

Regulatory challenge 3: Governance of SRM research

Description: A further challenge is to determine how to govern SRM research and work out whether certain research activities require novel and specific governance arrangements at the national and international level. Whilst there are limited to no laws specifically designed to govern SRM research, various existing environmental law frameworks, such as air pollution laws, chemicals regulation and laws governing liability for harms, may still be applicable to SRM research activities.

The challenge for regulators is to determine which SRM research activities warrant novel and specific governance arrangements, and whether such governance is best placed at the national or international level. Furthermore, regulators should evaluate the applicability of existing environmental laws for the governance of SRM research.

Priority level: 1 (urgent)

<p>Relevant legal principles/provisions:</p> <ul style="list-style-type: none"> Research activities for peaceful purposes¹¹² 	<p>Relevant legal frameworks:</p> <ul style="list-style-type: none"> Customary international law International environmental law, including 1992 Rio Declaration; UNCBD;
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¹⁰⁹ See, for example, McGee, J., Brent, K., McDonald, J., & Heyward, C. (2021) 'International Governance of Solar Radiation Management: Does the ENMOD Convention Deserve a Closer Look?' *Carbon & Climate Law Review*, Volume 14, Issue 4, pp. 294 - 305, Available at SSRN: <https://ssrn.com/abstract=3806914>.

¹¹⁰ Montreal Protocol on Substances that Deplete the Ozone Layer (entry into force 1 January 1989) 1522 UNTS 3 (Montreal Protocol); Shikha Bhasin, Bhuvan Ravindran, and Eleonora Moro (2022). "Solar Geoengineering and the Montreal Protocol – A Case for Global Governance". CEEW Issue Brief I June 2022, [Online]. Available at: <https://www.ceew.in/publications/solar-geoengineering-and-montreal-protocol>.

¹¹² United Nations Convention on the Law of the Sea (UNCLOS) (entry into force 16 November 1994) 1833 U.N.T.S 3, Parts II-IV, articles 141 and 143.

<ul style="list-style-type: none"> ○ Rights of research participants¹¹³ <p>Relevant ethical considerations:</p> <ul style="list-style-type: none"> ○ Research ethics 	<p>LRTAP; Gothenburg Protocol on Long-Range Transboundary Air Pollution¹¹⁴</p> <ul style="list-style-type: none"> ○ International law of the sea including the UN Convention on the Law of the Sea (UNCLOS)¹¹⁵ ○ International space law including the Outer Space Treaty ○ International human rights law ○ National environmental law
<p>Desired enhancement/change: Clarity regarding the need for novel and specific governance arrangements at the national and/or international level for certain SRM research activities.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> ○ Encourage international cooperation over SRM research and governance; ○ Consider which SRM research activities might require novel and specific governance arrangements and how these might fit under existing international environmental law, including UNCBD, international space law, UNCLOS article 143 on marine scientific research, air pollution regulation including LRTAP and the Gothenburg Protocol; ○ Provide guidance to national governments on the interpretation of applicable international environmental frameworks and principles; ○ Facilitate communication and knowledge-sharing of any SRM research activities at an international level. <p>Key actors:</p> <ul style="list-style-type: none"> ○ Relevant UN bodies ○ UNCBD COP 	<p>National level changes:</p> <ul style="list-style-type: none"> ○ Follow international guidance on SRM research governance and whether specific types of SRM-related activities require additional regulation or guidance; ○ Monitor the adequacy of national environmental laws for the governance of SRM research and adapt laws where necessary. ○ Identify or establish appropriate means for transparent and accountable decision-making on national research activities and appropriate means of governing and monitoring domestic SRM research activities. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments
<p>Circumstances necessary for change: International agreement on the governance of SRM research may be challenging to achieve. That said, SRM activities that do not have significant, transboundary</p>	

¹¹³ International Covenant on Civil and Political Rights (entry into force 23 March 1976) G.A. Res 2200A (XXI), Article 7.

¹¹⁴ Protocol to the 1979 Convention on Long-range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-level Ozone (entry into force 17 May 2005) 2319 UNTS 81 (Gothenburg Protocol).

¹¹⁵ United Nations Convention on the Law of the Sea (UNCLOS) (entry into force 16 November 1994) 1833 U.N.T.S 3, Parts II-IV.

impacts are unlikely to need or achieve international agreement and will need to be governed at the national level. For larger, riskier experiments that might have significant transboundary impacts, there may be the possibility to go through existing mechanisms (such as updating/elaborating on the non-binding UNCBD decision regarding geo-engineering), or expanding existing international environmental agreements to the governance of SRM, such as has been suggested in relation to ENMOD,¹¹⁶ or the Montreal Protocol.

Regulatory challenge 4: Procedural justice and human rights protection in SRM research decision-making

Description: A key challenge concerning the governance of SRM research is procedural justice and the facilitation of public participation in environmental decision-making, particularly in the context of SRM research with possible transboundary effects. The Aarhus Convention recognises that the ‘public concerned’, meaning “the public affected or likely to be affected by, or having an interest in, the environmental decision-making [...]”,¹¹⁷ has the right of access to information, public participation and access to justice. SRM research decision-making raises the challenge of facilitating public participation for potentially affected parties, particularly if the research activity is likely to have transboundary implications.¹¹⁸ A further challenge concerns the protection of human rights, such as the right to freedom of scientific research,¹¹⁹ in research decision-making including any decisions to slow or to restrict research.

Decision-making processes in the context of research activities are typically at the national level. However, decision-making over any SRM activities with transboundary impacts requires a holistic approach to the evaluation of the effects of SRM for procedural justice and the protection of human rights, taking into account normative values of legitimacy, and global and intergenerational justice.¹²⁰ Similar consideration should be given to how procedural justice and the protection of human rights might be impacted if SRM is delayed or rejected. An evaluation of comparable, intergovernmental governance regimes related to research activities with global implications, such as research activities in the International Seabed Area governed by the International Seabed Authority under the UNCLOS, may be beneficial for the governance of SRM research activities.

The challenge for regulators is to evaluate the effect of SRM and SRM research activities, and any decisions to slow or limit SRM research, on the protection and implementation of human rights and fundamental principles, taking into account normative values of legitimacy and global justice.¹²¹ A

¹¹⁶ McGee, J., Brent, K., McDonald, J., & Heyward, C. (2021) ‘International Governance of Solar Radiation Management: Does the ENMOD Convention Deserve a Closer Look?’ *Carbon & Climate Law Review*, Volume 14, Issue 4, pp. 294 - 305, Available at SSRN: <https://ssrn.com/abstract=3806914>.

¹¹⁷ Aarhus Convention, articles 2 (5), 5, 6 and 9.

¹¹⁸ Adomaitis, L., Grinbaum, A., Lenzi, D. (2022). TechEthos D2.2: *Identification and specification of potential ethical issues and impacts and analysis of ethical issues of digital extended reality, neurotechnologies, and climate engineering*. TechEthos Project Deliverable. Available at: www.techethos.eu, p. 112.

¹¹⁹ International Covenant on Economic, Social and Cultural Rights (entry into force 3 January 1976) G.A. Res 2200A (XXI), Article 15(3).

¹²⁰ See, for instance, Grasso, M., (2022) ‘Legitimacy and Procedural Justice: How might stratospheric aerosol injection function in the public interest?’ *Humanities and Social Sciences Communications*, 9 (187), [Online]. Available at: <https://doi.org/10.1057/s41599-022-01213-5>.

¹²¹ Worth noting here is the evaluation of SRM in the context of the UN Sustainable Development Goals by Honegger, M., Michaelowa, A. & Pan, J. Potential implications of solar radiation modification for achievement of the Sustainable Development Goals. *Mitig Adapt Strateg Glob Change* 26, 21 (2021). <https://doi.org/10.1007/s11027-021-09958-1>.



further challenge is to devise and deploy effective and inclusive ways of promoting public participation in decision-making in relation to SRM research.

Priority level: 1 (urgent)

Relevant legal principles/provisions:

- Rights related to the freedom of scientific research¹²²
- Access to information, public participation in decision-making and access to justice in environmental matters
- Rule of law
- Right to a fair and public hearing¹²³

Relevant ethical considerations:

- Procedural justice including global and intergenerational justice
- Research ethics

Relevant legal frameworks:

- Customary international law
- UNECE Aarhus Convention
- International human rights law
- National human rights law, including constitutional law

Desired enhancement/change: Strengthened procedural justice of decisions regarding SRM use and SRM research to ensure full respect of rules on access to information, public participation and access to justice.

International level changes:

- Evaluate normative values such as legitimacy and global justice and the implications of SRM and SRM research, as well as rejecting SRM, for the protection of human rights;
- Develop means for effective public participation at global level under existing international law such as the Aarhus Convention;
- Evaluate the potential of alternative mechanisms to facilitate effective means of public participation, such as the role of the International Seabed Authority in governing activities in the International Seabed Area within the meaning of UNCLOS.

National level changes:

- Promote transparency about any emerging national SRM research activities, ensure public accountability, and strengthen compliance with the Aarhus Convention by re-evaluating means of facilitating effective public participation in the context of SRM research.

Key actors:

- National governments
- National human rights agencies/committees

¹²² International Covenant on Economic, Social and Cultural Rights (entry into force 3 January 1976) G.A. Res 2200A (XXI) (ICCPR), Article 15(3).

¹²³ Universal Declaration of Human Rights (10 December 1948), G.A. Res. 217(A) III (UDHR), Article 8; ICCPR, Article 2(3).

<p>Key actors:</p> <ul style="list-style-type: none"> ○ UN bodies including human rights agencies ○ Working Group of the Parties to the Aarhus Convention 	
<p>Circumstances necessary for change: Likely to require a reasonably uniform understanding at the international level of procedural justice and human rights protection in the context of both continued warming and SRM, including normative values of legitimacy and global justice. Likely to require extensive international dialogue and collaboration, as well as political willingness and transparency.</p>	

4. Enhancing legal frameworks for the governance of Neurotechnologies

Neurotechnologies, as an emerging technology family, raise a number of regulatory challenges. This section explores these regulatory challenges and presents options for enhancing legal frameworks for the governance of neurotechnologies at the international and national level.

4.1 Neurotechnologies

Neurotechnologies represent a family of technologies, the common purpose of which is directly monitoring, assessing, mediating, manipulating and/or emulating the structure, functions, and capabilities of the human brain.¹²⁴ Neurotechnologies have the potential to bring significant benefits to end-users by improving their health and well-being. Despite this potential, neurotechnologies also raise certain regulatory challenges, such as around the protection of human rights, personal data, and the increasingly commercial use cases and potential dual-use applications of neurotechnologies.

This section sets out the challenges specific to the governance of neurotechnologies, followed by an overview of potential changes or enhancements of legal frameworks at the international and national level.

4.1.1 Neurotechnology-specific regulatory challenges

The key challenges related to the governance of neurotechnologies are summarised below. Addressing these challenges at the international and national level are likely to be a priority for regulators attempting to mitigate the potential risks associated with the development, deployment and use of neurotechnologies.

- **Neurorights:** Is there a need to recognise neurorights within human rights law frameworks? Are neurorights integral to existing human rights, such as the right to privacy, integrity and autonomy? Can neurorights be recognised through a reinterpretation of existing human rights, or is there a need to adopt a 'new' set of rights?
- **Protection of brain and other neural data under privacy and data protection law:** Are existing data protection laws adequate for the protection of brain and other neural data? Do users have a sufficiently clear understanding of their rights as data subjects, and how their data may be processed as a condition for providing informed consent?
- **Justice, equality and non-discrimination concerns:** How can justice, equality and non-discrimination concerns in neurotechnology applications and use cases best be addressed in order to avoid discrimination on the basis of brain and other neural data, also known as 'neurodiscrimination'.
- **Emerging consumer and dual-use (military) applications:** How to regulate emerging use cases of neurotechnologies, such as the commercial and/or military use of neurotechnologies? To what extent is there a need for international agreement on this matter, similar to international weapons conventions?

¹²⁴ OECD. (2019) *Recommendation of the Council on Responsible Innovation in Neurotechnology*, OECD/LEGAL/0457.

- **Compliance and enforcement:** How to improve compliance with and enforcement of existing laws applicable to neurotechnologies? Is there a need for international collaboration on the governance of neurotechnologies?

4.1.2 Challenges and options for enhancing legal frameworks

A key consideration for the governance of neurotechnologies is the legal status and protection of brain and other neural data. This gives rise to the idea of a need to recognise neurorights, either through the reinterpretation of existing human rights law, or through the adoption of a new set of rights. Furthermore, it raises the challenge of privacy and data protection law, and the extent to which brain and other neural data is currently protected by such laws, and whether there is a need to amend existing legislation to better accommodate and protect the type of data generated through neurotechnologies. Inadequate legal frameworks could lead to increased justice, equality and non-discrimination gaps based on neural features, so called 'neurodiscrimination'.¹²⁵ Furthermore, emerging consumer and dual-use applications of neurotechnologies, means that such use cases may fall outside the scope of traditional medical devices law, and require a revisit of consumer protection and product safety laws, as well as the potential misuse of neurotechnologies as through weapons regulation. Finally, the appropriate forum and level of regulation is a key consideration for the effective governance of neurotechnologies.

The tables below further explore each regulatory challenges specific to neurotechnologies, and provide an overview of potential changes or enhancements of legal frameworks at the international and national level.

Regulatory challenge 1: Neurorights

Description: The emergence of neurotechnologies and their potential to affect human rights has given rise to a scholarly debate around the need for so-called 'neurorights', such as the right to mental privacy, mental integrity, cognitive liberty and psychological continuity.¹²⁶ Scholars argue that the existing human rights law framework may not be suitable to provide adequate safeguards against possible negative impacts and intrusive applications of neurotechnologies. Recognising neurorights may also be essential for the protection of other human rights.¹²⁷

The challenge for regulators is to determine whether there is a need to recognise neurorights, and if so, define the best way of doing so. Neurorights could be recognised as a new set of human rights. Acknowledging the risk of rights inflation, however,¹²⁸ it may be preferable to recognise neurorights as an aspect of and integral to existing human rights, such as the right to privacy, the right to integrity and dignity, and the right to autonomy.

Priority level: 1 (urgent)

¹²⁵ Ienca, M. (2021) *Common Human Rights Challenges Raised by Different Applications of Neurotechnologies in Biomedical Fields*. Council of Europe. Available at: <https://rm.coe.int/report-final-en/1680a429f3>.

¹²⁶ See, Ienca M. and Andorno R. (2017) 'Towards new human rights in the age of neuroscience and neurotechnology', *Life Sciences, Society and Policy*, 13 (5) [online]. Available at <https://doi.org/10.1186/s40504-017-0050-1>.

¹²⁷ Ienca M. and Andorno R. (2017) 'Towards new human rights in the age of neuroscience and neurotechnology', *Life Sciences, Society and Policy*, 13 (5) [online]. Available at <https://doi.org/10.1186/s40504-017-0050-1>, p. 9.

¹²⁸ Ienca M. (2021) 'On Neurorights', *Frontiers in Human Neuroscience*, 15 (701258) [online]. Available at: <https://doi.org/10.3389/fnhum.2021.701258>.

<p>Relevant legal principles/provisions:</p> <ul style="list-style-type: none"> ○ Right to autonomy ○ Right to privacy ○ Right to integrity <p>Relevant ethical considerations:</p> <ul style="list-style-type: none"> ○ Autonomy ○ Responsibility ○ Privacy 	<p>Relevant frameworks:</p> <ul style="list-style-type: none"> ○ International human rights law ○ National human rights law (including constitutional law)
<p>Desired enhancement/change: Clarity regarding the existence of neurorights and human rights protections related to the brain in the context of national and international human rights law.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> ○ Recognise neurorights through the interpretation of existing rights at the international level to avoid the risk of rights inflation, which would dilute the core idea of human rights.¹²⁹ ○ Consider adding protocols to key human rights treaties on human rights and neurotechnologies, or reinforcing existing human rights treaties.¹³⁰ ○ Define neurorights and consider the possibility for an international memorandum on neurorights or Declaration on Human Rights and Neurotechnologies.¹³¹ <p>Key actors:</p> <ul style="list-style-type: none"> ○ UN human rights agencies including the Office of the High Commissioner (OHCHR) and UN human rights treaty bodies¹³² 	<p>National level changes:</p> <ul style="list-style-type: none"> ○ Recognise existence of neurorights at the national human rights law level (including constitutional laws), such as through the interpretation of existing human rights. ○ Pursue international consistency by following guidance at the international level and participating in international dialogue and collaboration. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments ○ National human rights agencies/committees

¹²⁹ Ienca M. (2021) 'On Neurorights', *Frontiers in Human Neuroscience*, 15 (701258) [online]. Available at: <https://doi.org/10.3389/fnhum.2021.701258>.

¹³⁰ UNESCO International Bioethics Committee (2021) *Report of the International Bioethics Committee of UNESCO (IBC) on the Ethical Issues of Neurotechnology*. Paris, United Nations Educational, Scientific and Cultural Organisation, [Online]. Available at: <https://unesdoc.unesco.org/ark:/48223/pf0000378724>, p. 38.

¹³¹ UNESCO International Bioethics Committee (2021) *Report of the International Bioethics Committee of UNESCO (IBC) on the Ethical Issues of Neurotechnology*. Paris, United Nations Educational, Scientific and Cultural Organisation, [Online]. Available at: <https://unesdoc.unesco.org/ark:/48223/pf0000378724>, p. 38.

¹³² The seven core treaties and their respective treaty bodies are: (1) Human Right Committee (HRC) - International Covenant on Civil and Political Rights (ICCPR); (2) Committee on Economic, Social and Cultural

Circumstances necessary for change: Likely to require political willingness to expand the interpretation of human rights law and recognise the risks posed by neurotechnologies. Likely to require some degree of international collaboration for consistency in the interpretation of international human rights law.

Regulatory challenge 2: Protection of brain and other neural data under privacy and data protection law

Description: Neurotechnologies raise new challenges regarding the protection of privacy and personal data. Existing privacy and data protection laws may need to be adapted to adequately protect brain and other neural data generated by neurotechnologies. An important consideration in that regard is the admissibility of brain and other neural data as evidence in a criminal justice setting, and the characterisation of brain and other neural data as either biometric data, or as testimony, of which the latter would be protected under the right to remain silent. Furthermore, users may not be sufficiently aware or have a sufficiently clear understanding of the types and amounts of data that may be processed in order to give informed consent prior to and during the use of neurotechnological devices. For example, it might be challenging to fulfil the rights of data subjects under the EU General Data Protection Regulation (GDPR), such as the 'right to be forgotten' in the case of 'unconscious' brain and other neural data of which the data subject is unaware.¹³³

To address possible privacy and data protection gaps at the national and international level, it is important to define what sort of data constitutes brain and other neural data that is deserving of appropriate privacy and personal data protection. Furthermore, the challenge for regulators is to devise appropriate privacy and data protection laws for the protection of this type of data. Finally, the means of obtaining and maintaining informed consent may need to be revised in the context of invasive and non-invasive applications of neurotechnologies, particularly considering the more permanent nature of invasive neurotechnologies that may not be easily removed from a human body in case the data subject no longer consents to its use.

Priority level: 1 (urgent)

Relevant principles/legal provisions:

- Right to autonomy
- Right to dignity and integrity
- Informed consent
- Right to privacy & data protection

Relevant legal frameworks:

- International human rights law¹³⁴
- National human rights law (including constitutional law)

Rights (CESCR) – International Covenant on Economic, Social and Cultural Rights (ICESCR); (3) Committee on the Elimination of Racial Discrimination (CERD) – International Convention on the Elimination of All Forms of Racial Discrimination (CERD); (4) Committee on the Elimination of Discrimination Against Women (CEDAW) – Committee on the Elimination of Discrimination Against Women (CEDAW); (5) Committee Against Torture (CAT) – Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (CAT); (6) Committee on the Rights of the Child (CRC) – Convention on the Rights of the Child (CRC); (7) Committee on Migrant Workers (CMW) – International Convention on Protection of the Rights of All Migrant Workers and Members Their Families (ICMRW).

¹³³ Ienca, M. et al. (2022) 'Towards a Governance Framework for Brain Data', *Neuroethics*, vol.15. DOI: <https://doi.org/10.1007/s12152-022-09498-8>.

¹³⁴ The right to privacy is protected in international human rights law under UDHR, Article 12; ICCPR, Article 17; CRC, Article 16; CPMW, Article 14; CRPD, Article 22.



<ul style="list-style-type: none"> Right to a fair trial including the right to remain silent Rights of data subjects <p>Relevant ethical considerations:</p> <ul style="list-style-type: none"> Responsibility Integrity 	<ul style="list-style-type: none"> Privacy and data protection laws (including the GDPR for EU Member States) National criminal law including the law of evidence
<p>Desired enhancement/change: Adequate protection of rights related to users' mental states; improved methods and requirements for obtaining informed consent from users.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> Determine the extent to which brain and other neural data is currently protected by the right to privacy and evaluate the need to recognise the right to mental privacy. Provide guidance to national governments on the interpretation of the international right to privacy in the context of neurotechnologies, focusing on the legality of the types of activities that may interfere with the right to privacy. <p>Key actors:</p> <ul style="list-style-type: none"> UN human rights agencies including the OHCHR and UN human rights treaty bodies 	<p>National level changes:</p> <ul style="list-style-type: none"> Evaluate the right to privacy under national human rights law in the context of neurotechnologies and assess the need to recognise the right to mental privacy; Evaluate the need for a soft law mechanism, such as the Digital Rights Charter in Spain,¹³⁵ to enhance the protection of brain and other neural data. <p>Key actors:</p> <ul style="list-style-type: none"> National governments National human rights agencies/committees National privacy and data protection bodies/authorities
<p>Circumstances necessary for change: Likely to require a widely accepted understanding of what constitutes brain and other neural data. Likely to require international collaboration and political willingness to expand the scope of existing privacy and data protection laws.</p>	

Regulatory challenge 3: Justice, equality and non-discrimination concerns

Description: One particular challenge, likely exacerbated by the growth in the availability and variety of consumer neurotechnologies, relates to the right to non-discrimination, with neurotechnologies creating a risk of "neurodiscrimination",¹³⁶ whereby brain and other neural data provides insights into

¹³⁵ *Carta Derechos Digitales* (Spanish Charter of Digital Rights), Article I (1) and XXIV.

¹³⁶ Ienca, M. (2021) *Common Human Rights Challenges Raised by Different Applications of Neurotechnologies in Biomedical Fields*. Council of Europe. Available at: <https://rm.coe.int/report-final-en/1680a429f3>.

mental health status, or cognitive performance, which may lead to differential treatment in various socio-economic contexts, including employment and insurance.¹³⁷

The US Genetic Information Non-discrimination Act (2008)¹³⁸ and the Council of Europe Oviedo Convention,¹³⁹ both of which prohibit discrimination on the basis of genetic information, could be expanded to include a specific provision safeguarding against the risk of neurodiscrimination, or otherwise be used as a framework on which to model comparable restrictions on the misuse of brain and other neural data.¹⁴⁰

The challenge for regulators is to devise appropriate interventions to address possible justice, equality and non-discrimination concerns in neurotechnology applications and use cases to avoid 'neurodiscrimination,' i.e., discrimination on the basis of brain and other neural data. The TechEthos ethical analysis indicated several potential sources of discrimination and bias due to the use of neurotechnologies.¹⁴¹ Although there are promises of alleviating certain cognitive biases through "neuroeducation", it can also promote reductive and deterministic ways of understanding the developing child, ignoring phenomenological, psychosocial, or cultural influences.¹⁴²

Priority level: 2 (high)

Relevant legal principles/provisions:

- Right to autonomy
- Right to privacy
- Right to be free from discrimination
- Right to a fair trial
- Informed consent

Relevant ethical considerations:

- Neurodiscrimination

Relevant legal frameworks:

- International human rights law
- National human rights law (including constitutional law)
- Civil and criminal law

Desired enhancement/change: Wider recognition at the international and national level of the risk of justice, equality and discrimination gaps and inadequate protection against neurodiscrimination. Appropriate legislative and policy interventions in place to mitigate the risk of neurodiscrimination.

¹³⁷ Ienca, M. (2021) *Common Human Rights Challenges Raised by Different Applications of Neurotechnologies in Biomedical Fields*. Council of Europe. Available at: <https://rm.coe.int/report-final-en/1680a429f3>.

¹³⁸ 42 U.S.C. §2000ff(4)(A)(i)-(iii).

¹³⁹ Convention for the Protection of Human Rights and Dignity of the Human Being with regard to the Application of Biology and Medicine: Convention on Human Rights and Biomedicine (entry into force 1 December 1999), E.T.S 164 4.IV.1997, Article 11.

¹⁴⁰ See, e.g., Jwa, A.S. and Poldrack, R.A. (2022) 'Addressing privacy risk in neuroscience data: from data protection to harm prevention', *Journal of Law and the Biosciences*, Vol.9:2, pp.1-25. DOI: <https://doi.org/10.1093/jlb/lzac025>; Ienca, M. (2021) *Common Human Rights Challenges Raised by Different Applications of Neurotechnologies in Biomedical Fields*. Council of Europe. Available at: <https://rm.coe.int/report-final-en/1680a429f3>.

¹⁴¹ Adomaitis, L., Grinbaum, A., Lenzi, D. (2022). TechEthos D2.2: *Identification and specification of potential ethical issues and impacts and analysis of ethical issues of digital extended reality, neurotechnologies, and climate engineering*. TechEthos Project Deliverable. Available at: www.techethos.eu, p. 86.

¹⁴² Busso, D. S., & Pollack, C. (2015). No brain left behind: consequences of neuroscience discourse for education. *Learning, Media and Technology*, 40(2), 168–186. <https://doi.org/10.1080/17439884.2014.908908>



<p>International level changes:</p> <ul style="list-style-type: none"> ○ Evaluate the need to adapt existing human rights laws to enhance protection against the risk of neurodiscrimination; ○ Provide guidance to national governments on possible interventions to mitigate risks of neurodiscrimination. <p>Key actors:</p> <ul style="list-style-type: none"> ○ UN human rights agencies including the OHCHR and UN human rights treaty bodies 	<p>National level changes:</p> <ul style="list-style-type: none"> ○ Evaluate the adequacy of national laws to protect against risks of neurodiscrimination and devise appropriate legislative and policy interventions to mitigate risks; ○ Collaborate internationally to promote consistency and legal certainty and the sharing of best practices. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments ○ National human rights agencies/committees ○ National privacy and data protection bodies/authorities
<p>Circumstances necessary for change: Likely to require some degree of international collaboration for consistency in regulation. Likely to require political willingness to recognise and address the risks of neurodiscrimination.</p>	

Regulatory challenge 4: Emerging consumer and dual-use (military) applications

Description: A key issue in legal and policy debates on neurotechnologies focuses on how to best regulate and govern the use, misuse and unintended use of these technologies. Historically, the primary use case of neurotechnologies has been in biomedical and clinical contexts. However, rapidly emerging consumer-facing¹⁴³ and “dual-use” applications¹⁴⁴ of neurotechnologies raise new regulatory challenges, considering that existing regulation, such as medical devices regulation, may not or only in a limited way be applicable.

The primary challenge for regulators is to consider the need for neuro-specific updates to existing medical devices regulation,¹⁴⁵ as well as the possible need for an international weapons convention,¹⁴⁶ to ensure the effective governance of emerging neurotechnology use cases. Whilst soft law measures may have limited effectiveness, such solutions may be the most achievable solution at the international level.

¹⁴³ See, for example, Musk, E. and Neuralink. (2019) ‘An Integrated Brain-Machine Interface Platform With Thousands of Channels’, *Journal of Medical Internet Research*, 21(10). DOI: <https://doi.org/10.2196/16194>.

¹⁴⁴ See, for example, *DARPA and the Brain Initiative* [Online]. Available at: <https://www.darpa.mil/program/our-research/darpa-and-the-brain-initiative>; Brain Research Through Advancing Innovative Neurotechnologies (BRAIN) Working Group Report to the Advisory Committee to the Director, NIH. (2014) *Brain 2025 – A Scientific Vision*, p.5. Available at: https://braininitiative.nih.gov/sites/default/files/pdfs/brain2025_508c.pdf.

¹⁴⁵ See, for example, Ienca, M. et al. (2022) ‘Towards a Governance Framework for Brain Data’, *Neuroethics*, Vol.15:20. DOI: <https://doi.org/10.1007/s12152-022-09498-8>.

¹⁴⁶ Ienca, M., Jotterand, F. and Elger, B.S. (2018) ‘From Healthcare to Warfare and Reverse: How Should We Regulate Dual-Use Neurotechnology?’, *Neuron: NeuroView*, Vol.97:2, pp.269-274. DOI: <https://doi.org/10.1016/j.neuron.2017.12.017>.

Priority level: 1 (urgent)	
Relevant legal principles/provisions: <ul style="list-style-type: none"> ○ Right to privacy ○ Product safety rights ○ Consumer rights Relevant ethical considerations: <ul style="list-style-type: none"> ○ Risk-reduction ○ Dual-use of generative AI and large language models (LLM)¹⁴⁷ 	Relevant legal frameworks: <ul style="list-style-type: none"> ○ International human rights law ○ National human rights law (including constitutional law) ○ Product safety laws ○ Consumer protection laws
Desired enhancement/change: Appropriate legislation in place to ensure rights and safety of non-medical (commercial) use of neurotechnologies; appropriate legislation in place to govern dual-use applications of neurotechnologies.	
International level changes: <ul style="list-style-type: none"> ○ Consider the need for an international memorandum on the minimum standard requirements for neurotechnologies; ○ Evaluate the need to update international weapons conventions for the governance of dual-use applications of neurotechnologies;¹⁴⁸ ○ Evaluate the need to update the UN Guidelines for Consumer Protection¹⁴⁹ and Organisation for Economic Cooperation and Development (OECD) Recommendation on Consumer Protection in e-Commerce (2016).¹⁵⁰ Key actors: <ul style="list-style-type: none"> ○ UN bodies including the UN Office of Disarmament Affairs 	National level changes: <ul style="list-style-type: none"> ○ Pursue the appropriate level of regulating emerging consumer-facing and dual-use applications of neurotechnologies on the basis of common historical & ethical backgrounds; ○ Collaborate and participate in international dialogue for the appropriate regulation of dual-use applications of neurotechnologies. Key actors: <ul style="list-style-type: none"> ○ National governments ○ National human rights bodies/agencies including consumer rights bodies ○ National military/defence departments

¹⁴⁷ Grinbaum A. and Adomaitis L. (2023) 'Dual use concerns of generative AI and large language models', Arxiv Computers and Society, [Online]. Available at: <https://doi.org/10.48550/arXiv.2305.07882>.

¹⁴⁸ See, Ienca, M., Jotterand, F. and Elger, B.S. (2018) 'From Healthcare to Warfare and Reverse: How Should We Regulate Dual-Use Neurotechnology?', *Neuron: NeuroView*, Vol.97:2, pp.269-274. DOI: <https://doi.org/10.1016/j.neuron.2017.12.017>; Ienca, M., Jotterand, F. and Elger, B.S. (2018) 'From Healthcare to Warfare and Reverse: How Should We Regulate Dual-Use Neurotechnology?', *Neuron: NeuroView*, Vol.97:2, pp.269-274. DOI: <https://doi.org/10.1016/j.neuron.2017.12.017>.

¹⁴⁹ United Nations Conference on Trade and Development (UNCTAD), United Nations Guidelines for Consumer Protection, 2016. UNCT AD/DITC/CPLP/MISC/2016/1. Available at: https://unctad.org/system/files/official-document/ditccplpmisc2016d1_en.pdf.

¹⁵⁰ OECD (2016), *Consumer Protection in E-commerce: OECD Recommendation*, OECD Publishing, Paris. Available at: <http://dx.doi.org/10.1787/9789264255258-en>.

- UN Conference on Trade and Development (UNCTAD)
- UN human rights agencies including the OHCHR and UN human rights treaty bodies
- OECD

Circumstances necessary for change: Likely to require international agreement and political willingness to govern dual-use applications of neurotechnologies.

Regulatory challenge 5: Compliance and enforcement

Description: Compliance with and enforcement of applicable laws is a key consideration in the governance of neurotechnologies and the protection of end-users. Neurotechnologies, as an emerging technology family, may require some degree of regulatory reform, requiring regulators to evaluate the appropriate forum for proposed regulatory changes, such as at the national, international and/or supranational level (such as the EU or the Council of Europe). The governance of this technology family is complicated by the variety of kinds of neurotechnologies, such as invasive and non-invasive applications, each raising different issues.

With regard to neurorights, the UN may be best positioned to create momentum for the protection of human rights in the context of neurotechnologies.¹⁵¹ Existing ethical guidelines and soft law mechanisms provide a governance framework for neurotechnologies, both at the national¹⁵² and international level¹⁵³. In addition, various legal frameworks are applicable, such as international human rights law,¹⁵⁴ consumer protection law,¹⁵⁵ and data protection law.¹⁵⁶ Nevertheless, there may

¹⁵¹ Genser, J., Herrmann, S., and Yuste, R. (2022) *International Human Rights Protection Gaps in the Age of Neurotechnology*. NeuroRights Foundation, pp.29. Available at: <https://static1.squarespace.com/static/60e5c0c4c4f37276f4d458cf/t/6275130256dd5e2e11d4bd1b/1651839747023/Neurorights+Foundation+PUBLIC+Analysis+5.6.22.pdf>.

¹⁵² See, for example, Greely, H.T. et al. (2018) 'Neuroethics Guiding Principles for the NIH BRAIN Initiative', *Journal of Neuroscience*, Vol.38:50, pp.10586-10588, Table 1. DOI: <https://doi.org/10.1523/JNEUROSCI.2077-18.2018>.

¹⁵³ See, for example, OECD. (2019) *Recommendation of the Council on Responsible Innovation in Neurotechnology*, OECD/LEGAL/0457; Declaration of the Inter-American Juridical Committee on Neuroscience, Neurotechnologies and Human Rights: New Legal Challenges for the Americas CJI/DEC.01(XCIX-0/21). Available at: http://www.oas.org/en/sla/iajc/docs/CJI-DEC_01_XCIX-O-21_ENG.pdf.

¹⁵⁴ See, e.g., Ienca, M. and Andorno, R. (2017) 'Towards new human rights in the age of neuroscience and neurotechnology', *Life Sciences, Society and Policy*, Vol.13:5. DOI: <https://doi.org/10.1186/s40504-017-0050-1>; Yuste, R., Genser, J. and Herrman, S. (2021) 'It's Time for Neuro-Rights', *Horizons*, 18, pp.154-164. Available at: <https://www.cirs.org/en/horizons/horizons-winter-2021-issue-no-18/its-time-for-neuro-rights>.

¹⁵⁵ See, e.g., Wexler, A. and Reiner, P.B. (2019) 'Oversight of direct-to-consumer neurotechnologies', *Science*, Vol.363, pp.234-235. DOI: <https://doi.org/10.1126/science.aav0223>.

¹⁵⁶ Ienca, M. and Malgieri, G. (2022) 'Mental data protection and the GDPR', *Journal of Law and the Biosciences*, Vol.9:1, pp.1-19. DOI: <https://doi.org/10.1093/jlb/lisac006>.

be a need to further strengthen governance efforts and link the governance framework for neurotechnologies to related emerging technologies, such as Artificial Intelligence (AI).¹⁵⁷

The challenge for regulators is to devise and adapt appropriate legislative and policy interventions to strengthen compliance with and enforcement of applicable rules for the governance of neurotechnologies.

Priority level: 2 (high)

Relevant legal principles/provisions:

- Right of access to justice

Relevant ethical considerations:

- Responsibility

Relevant legal frameworks:

- International human rights law
- National human rights law (including constitutional law)
- Product safety laws
- Consumer protection laws
- AI regulations

Desired enhancement/change: Strengthened compliance with existing laws that apply to neurotechnologies.

International level changes:

- Evaluate the need to adapt and/or strengthen existing international law, particularly human rights law, for the governance of neurotechnologies, in order to strengthen compliance with and enforcement of such rules;
- Provide guidance to national governments on the interpretation and enforcement of international human rights law in the context of neurotechnologies.

Key actors:

- UN human rights agencies including the OHCHR and UN human rights treaty bodies

National level changes:

- Evaluate the need to adapt national laws for the governance of neurotechnologies to strengthen compliance with and enforcement of applicable rules, including national human rights law, consumer protection law and privacy and data protection law;
- Pursue international collaboration to facilitate transferability and cross-border compliance as well as the sharing of best practices.

Key actors:

- National governments
- National human rights bodies/agencies including consumer rights bodies
- National privacy and data protection bodies/authorities

Circumstances necessary for change: International collaboration on conditions for data transfer and cross-border compliance with privacy and data protection laws.

¹⁵⁷ See, e.g., legislative developments around the governance of AI at the European Union level: Proposal for a Regulation of the European Parliament and of the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) And Amending Certain Union Legislative Acts COM/2021/206 final.

5. Enhancing legal frameworks for the governance of digital extended reality

Digital extended reality (XR), as an emerging technology family, raise a number of regulatory challenges. This section further explores these regulatory challenges and presents options for enhancing legal frameworks for the governance of digital extended reality at the international and national level.

5.1 Digital extended reality (XR) including natural language processing (NLP)

XR technologies combine advanced computing systems (hardware and software) that can change how people connect with each other and their surroundings and influence or manipulate human actions through interactions with virtual environments. The emergence of this technology family poses certain risks and regulatory challenges, particularly around the protection of privacy and personal data, the regulation of AI and harmful online content, the right to freedom of expression, non-discrimination, and the protection of special categories of persons, especially children.

This section sets out the challenges specific to the governance of XR and NLP, followed by an overview of potential changes or enhancements of legal frameworks at the international and national level.

5.1.1 XR and NLP-specific regulatory challenges

The key challenges related to the governance of XR and NLP are summarised below. Addressing these challenges at the international and national level are likely to be a priority for regulators attempting to mitigate the potential risks associated with the development, deployment and use of XR and NLP technologies.

- **Harmful online content:** How to protect fundamental rights such as the right to autonomy and the right to dignity from nudging, manipulation and/or the spread of mis/disinformation? Is there a need to adapt existing laws to better accommodate 'virtual crimes' and other harms experienced virtually? In the case of XR, certain harms experienced online may fall outside the scope of adequate legal protection if existing laws explicitly require a physical components (e.g., crime of assault requiring physical contact).
- **Bias in AI-enabled NLP:** How to avoid algorithmic bias? Is there a need for regulatory reform to better protect against bias in AI-enabled NLP?
- **Privacy and data protection:** Are existing privacy and data protection laws sufficient to protect the broad range and depth of user data generated by XR and NLP technologies? Should privacy and data protection laws be expanded to protect against potentially harmful data processing activities, such as nudging and manipulation? Do users have a sufficiently clear understanding of how their data may be processed in order to give informed consent?
- **Roles and responsibilities of XR and NLP providers:** What are the roles and responsibilities of XR and NLP providers? Can or should XR and NLP providers be held responsible for online harms?
- **Compliance and enforcement:** How to improve compliance with and enforcement of existing laws that apply to XR and NLP? Is there a need to address divergent national/regional approaches to the regulation of XR and NLP?



5.1.2 Challenges and options for enhancing legal frameworks

A key consideration for the governance of XR technologies is the protection and potential trade-offs between various human rights, such as the protection of users by removing harmful online content, against the right to freedom of expression. The emergence of Artificial Intelligence (AI) in XR technologies introduces further challenges regarding the regulation and control of risks, and the respective roles and responsibilities of XR developers and providers to avoid possible harms. Whilst many human rights are widely recognised in international human rights law, often complimented by national human rights law such as through constitutional law, the enforcement and compliance of such rights in the context of XR technologies can be a key challenge.

The tables below further explore each regulatory challenges specific to XR technologies, and provide an overview of potential changes or enhancements of legal frameworks at the international and national level.

Regulatory challenge 1: Harmful online content	
<p>Description: Regulating harmful online content, such as online violence, hate crime, harassment (including sexual harassment), nudging, and mis/disinformation, is a significant regulatory challenge posed by XR technologies. The immersive and increasingly realistic nature of technologies such as VR, may render the harms experienced by victims comparable to those occurring in the physical world.¹⁵⁸ Yet, such incidences may not be treated as equivalent under existing laws. As such, there may be a need to adapt existing laws to better govern harmful activities experienced virtually. A careful balance must be struck with the protection of fundamental freedoms, such as the right to freedom of expression.</p> <p>The challenge for regulators is to strike a balance between the protection of the right to freedom of expression, and the regulation of harmful online content for the protection of other fundamental freedoms. This balance may be highly culture-dependant and specific to the national regulatory context, requiring tailored approaches for individual countries.</p>	
Priority level: 2 (high)	
<p>Relevant legal principles/provisions:</p> <ul style="list-style-type: none"> ○ Right to autonomy ○ Right to dignity ○ Right to privacy ○ Right to be free from discrimination ○ Right to freedom of expression <p>Relevant ethical considerations:</p> <ul style="list-style-type: none"> ○ Autonomy¹⁵⁹ ○ Dignity 	<p>Relevant legal frameworks:</p> <ul style="list-style-type: none"> ○ International human rights law ○ National human rights law (including constitutional law) ○ Privacy and data protection law ○ Civil and criminal law

¹⁵⁸ Petter O. (2022) *Why Is No One Taking Sexual Assault In the Metaverse Seriously?* / Vogue [Online]. Available at: <https://www.vogue.co.uk/arts-and-lifestyle/article/sexual-assault-in-the-metaverse>.

¹⁵⁹ See, for example, Grinbaum, A., Adomaitis, L. Moral Equivalence in the Metaverse. *Nanoethics* **16**, 257–270 (2022). <https://doi.org/10.1007/s11569-022-00426-x>.

<ul style="list-style-type: none"> ○ Non-manipulation and the control of nudging in XR ○ Fair labour and economic conditions ○ Non-discrimination and avoiding bias 	
<p>Desired enhancement/change: Strengthened promotion of and compliance with human rights through enhanced protection from harmful online content.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> ○ Provide guidance to national regulators to address harmful online content and encourage the adoption of 'ethics-by-design' approaches by XR and NLP developers and providers; ○ Encourage the creation of user empowerment tools to help address harmful online content; <p>Key actors:</p> <ul style="list-style-type: none"> ○ UN human rights agencies including the Office of the High Commissioner (OHCHR) and UN human rights treaty bodies¹⁶⁰ 	<p>National level changes:</p> <ul style="list-style-type: none"> ○ Provide guidance to XR and NLP developers and providers explaining criteria for assessing what constitutes harmful online content; ○ Work with industry and civil society to develop (voluntary) codes of practice, such as a national equivalent of the EU's Code of Practice on Disinformation; ○ Promote the adoption of 'ethics-by-design' approaches and promote user empowerment tools, such as self-reporting tools to address harmful online content. ○ Promote dialogue with industry and technology providers to address harmful online content. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments ○ National human rights agencies/committees
<p>Circumstances necessary for change: Likely to require clear guidance for and willingness by XR and NLP developers and providers to monitor and control harmful online content. Likely to rely to some degree on cultural differences and culture/context specific interpretations of human rights, particularly the right to freedom of expression.</p>	

¹⁶⁰ The seven core treaties and their respective treaty bodies are: (1) Human Right Committee (HRC) - International Covenant on Civil and Political Rights (ICCPR); (2) Committee on Economic, Social and Cultural Rights (CESCR) – International Covenant on Economic, Social and Cultural Rights (ICESCR); (3) Committee on the Elimination of Racial Discrimination (CERD) – International Convention on the Elimination of All Forms of Racial Discrimination (CERD); (4) Committee on the Elimination of Discrimination Against Women (CEDAW) - Committee on the Elimination of Discrimination Against Women (CEDAW); (5) Committee Against Torture (CAT) – Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (CAT); (6) Committee on the Rights of the Child (CRC) – Convention on the Rights of the Child (CRC); (7) Committee on Migrant Workers (CMW) - International Convention on Protection of the Rights of All Migrant Workers and Members Their Families (ICMRW).

Regulatory challenge 2: Bias in AI-enabled NLP

Description: Bias is a regulatory challenge posed by the emergence of AI-enabled NLP. Bias could interfere with various fundamental human rights, such as the right to be free from discrimination, or the right to autonomy, and dignity. Specific bias challenges in NLP are related to the exclusory use of language and perpetuating stereotypes in generated (output) language.¹⁶¹ There may be a need for regulatory reform to better protect against potential bias, including unconscious or hidden bias.

The challenge for regulators is to develop appropriate tools and interventions for the avoidance, detection and mitigation of bias in NLP.

Priority level: 1 (urgent)

Relevant legal principles/provisions:

- Right to be free from discrimination

Relevant ethical considerations:

- Autonomy
- Non-discrimination and avoiding bias
- Respect for cultural differences

Relevant legal frameworks:

- International human rights law¹⁶²
- National human rights law (including constitutional law)
- National online safety laws

Desired enhancement/change: Enhanced compliance with the right to be free from discrimination; effective means of preventing, detecting and addressing bias in NLP.

International level changes:

- Provide guidance for national regulators, NLP developers and industry providers on the protection of human rights in the context of bias in NLP and large-language models (LLM);

National level changes:

- Develop and encourage the adoption of 'ethics-by-design' standards;
- Evaluate appropriate tools and interventions for the prevention, detection and mitigation of bias;

¹⁶¹ Weidinger, L., Mellor, J., Rauh, M., Griffin, C., Uesato, J., Huang, P.-S., et al. (2021). Ethical and social risks of harm from Language Models. *arXiv preprint arXiv:2112.04359*. See also TechEthos D2.2 on several groups of NLP-specific biases, including those based on culture, gender and age, at: Adomaitis, L., Grinbaum, A., Lenzi, D. (2022). TechEthos D2.2: *Identification and specification of potential ethical issues and impacts and analysis of ethical issues of digital extended reality, neurotechnologies, and climate engineering*. TechEthos Project Deliverable. Available at: www.techethos.eu, p. 71-72.

¹⁶² Universal Declaration of Human Rights (UDHR) (10 December 1948), G.A. Res. 217(A) III, article 7; International Covenant on Civil and Political Rights (ICCPR) (entered into force 23 March 1976), G.A. Res. 2200A (XXI), Articles 2(1), 3 and 26; Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) (entered into force 3 September 1981), 1249 U.N.T.S. 13, Article 2; International Convention on the Elimination of All Forms of Racial Discrimination (ICERD) (entry into force 4 January 1969) G.A. Res. 2106 (XX), article 2; International Covenant on Economic, Social and Cultural Rights (ICESCR) (entered into force 3 January 1976), G.A. Res. 2200A (XXI), 993 U.N.T.S. 3, articles 2 and 3; Convention on the Rights of the Child (CRC) (entered into force 2 September 1990) GA Res. 44/25, 1577 U.N.T.S. 3, article 2; Convention on the Rights of Persons with Disabilities (CRPD) (entered into force 3 May 2008), GA Res. A/61/106, Articles 1, 3, 4 and 5; Convention for the Protection of the Rights of All Migrant Workers and Members of their Families (entry into force 1 July 2003) GA Res.45/158 (CPRMW), article 1.

<ul style="list-style-type: none"> ○ Evaluate the need for international standards on ‘ethics-by-design’ such as through the International Organisation for Standardisation (ISO); <p>Key actors:</p> <ul style="list-style-type: none"> ○ UN human rights agencies including the OHCHR and UN human rights treaty bodies. ○ ISO 	<ul style="list-style-type: none"> ○ Collaborate internationally to pursue the highest degree of consistency possible whilst respecting cultural differences. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments ○ National human rights committees or agencies
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Circumstances necessary for change: Likely to require a clear understanding of what constitutes bias within different contexts, and political willingness to address bias. Furthermore, this will require a clear understanding of the scope of human rights protection in the context of XR and NLP, including the right to autonomy, freedom of expression, and non-discrimination.

Regulatory challenge 3: Privacy and data protection

Description: XR technologies can process a significant amount and variety of data types, which gives rise to regulatory challenges of adequate privacy and data protection. A recent study has shown the depth and breadth of data that may be collected through XR technologies, including the possible tracking or inference of sensitive information such as sexual or political orientation.¹⁶³ Furthermore, the ability of XR technologies to fully or partially immerse users into a virtual world creates risks for the protection of privacy and personal data, particularly if this data is collected involuntarily, such as from bystanders, and/or unconsciously, such as through eye or other forms of physiological or psychological tracking.¹⁶⁴ There is also a risk that users of such technologies may not have a sufficiently clear understanding of what data is collected and how it may be processed (including storage, retention and security) in order to provide informed consent.

The challenge for regulators is to strike a balance between enabling positive user experiences for which data collection and processing is key, and protecting users and bystanders (such as in augmented reality), against associated risks to infringement with protected rights to privacy and/or data protection.

Priority level: 1 (urgent)

<p>Relevant legal principles/provisions:</p> <ul style="list-style-type: none"> ○ Right to privacy ○ Right to be free from discrimination ○ Right to autonomy ○ Right to dignity 	<p>Relevant legal frameworks:</p> <ul style="list-style-type: none"> ○ International human rights law ○ National human rights law (including constitutional law)
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¹⁶³ Nair, V., Munilla Garrido, G., and Song, D. (2022) ‘Exploring the Unprecedented Privacy Risks of the Metaverse’, *arXiv:2207.13176*. DOI: <https://doi.org/10.48550/arXiv.2207.13176>.

¹⁶⁴ Pahi S. and Schroeder C. (2022) ‘Extended Privacy for Extended Reality: XR Technology Has 99 Problems and Privacy is Several of Them’, *Notre Dame Journal of Emerging Tech*, 4 (forthcoming 2023), [Online]. Available at: <https://dx.doi.org/10.2139/ssrn.4202913>.

<ul style="list-style-type: none"> ○ Informed consent <p>Relevant ethical considerations:</p> <ul style="list-style-type: none"> ○ Privacy ○ Autonomy ○ Dignity ○ Transparency ○ Environmental and security risk reduction ○ Non-manipulation ○ Responsibility 	<ul style="list-style-type: none"> ○ Privacy and data protection laws (including the GDPR for EU Member States)
<p>Desired enhancement/change: Appropriate privacy and data protection laws to protect against harmful uses of data generated through XR technologies, such as nudging, manipulation and the spread of mis- and disinformation; improved methods for obtaining informed consent from end-users.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> ○ Evaluate the scope of international human rights law, such as the right to privacy, in the context of XR technologies and the extent of protection offered against risks associated with XR technologies; ○ Evaluate the need for AI watermarks, and explore the need for international standards or guidance to national governments on AI watermarking.¹⁶⁵ <p>Key actors:</p> <ul style="list-style-type: none"> ○ UN human rights agencies including the OHCHR and UN human rights treaty bodies 	<p>National level changes:</p> <ul style="list-style-type: none"> ○ Evaluate the need for and consider mandating the use of AI watermarks to help identify AI-generated content; ○ Assess the adequacy of existing national privacy and data protection laws including regional data protection laws (such as the EU General Data Protection Regulation (GDPR)); ○ Pursue international dialogue and sharing of good practices between national governments. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments ○ National human rights committees/agencies ○ National privacy and data protection bodies/authorities
<p>Circumstances necessary for change: Likely to require some degree of international collaboration and guidance for national regulators on the interpretation of human rights and to ensure consistency between regulatory frameworks to enable data transfer and interoperability of XR technologies and systems.</p>	

¹⁶⁵ See, for instance, Grinbaum, A., and Adomaitis, L. (2022) 'The Ethical Need for Watermarks in Machine-Generated Language', arXiv:2209.03118, [Online]. Available at: <https://doi.org/10.48550/arXiv.2209.03118>.

Regulatory challenge 4: The roles and responsibilities of XR and NLP providers

Description: In regulating XR technologies, and addressing some of the regulatory challenges identified above, a further challenge is to determine the role and responsibilities of XR and NLP providers. Issues to consider include the following: can and/or should XR and NLP providers be held responsible for harmful content generated by their systems or spread through their platforms? What responsibility do developers and providers have with regard to monitoring and controlling the spread of mis/disinformation, hate speech, conspiracy theories, or the avoidance and detection of bias in their AI algorithms?

The challenge for regulators is to define the roles and responsibilities of XR and NLP developers and providers in avoiding and addressing risks associated with their technologies.

Priority level: 1 (urgent)

Relevant legal principles/provisions:

- Right to privacy
- Right to be free from discrimination
- Right to autonomy
- Right to dignity
- Right to redress
- Right to consumer education

Relevant ethical considerations:

- Responsibility
- Privacy
- Autonomy
- Dignity

Relevant legal frameworks:

- International human rights law
- National human rights law (including constitutional law)
- Privacy and data protection law
- Online safety regulation
- Product safety/liability law
- Consumer rights law
- Libel law

Desired enhancement/change: Clear allocation and demarcation of the responsibilities for developers and providers of XR and NLP technologies to monitor and address harmful content and the extent to which they are responsible for harmful content generated through their products.

International level changes:

- Provide guidance to national governments on possible interventions and measures to define the role of XR and NLP providers in the national context for the protection of human rights;
- Promote international consistency and encourage the sharing of best practices.

Key actors:

- UN human rights agencies including the OHCHR and UN human rights treaty bodies

National level changes:

- Define the roles and responsibilities of XR and NLP providers with regard to the monitoring and removal of harmful online content in the context of XR and NLP technologies, as well as the education of consumers in order to obtain informed consent.

Key actors:

- National governments
- National human rights committees/agencies

	<ul style="list-style-type: none"> ○ National privacy and data protection bodies/authorities
<p>Circumstances necessary for change: Likely to require some degree of international collaboration and consistency to strengthen compliance by XR and NLP providers operating in different jurisdictions.</p>	

Regulatory challenge 5: Compliance and enforcement

Description: Divergent approaches to regulation may have various implications for the development, provision and use of XR technologies. The creation of a metaverse as an integrated, immersive, and borderless virtual world raises challenges regarding compliance with and enforcement of applicable laws, particularly if users are located in different jurisdictions. Whilst providers operating in the European Union (EU), for instance, would be bound by EU laws, they may also be bound by national laws of non-EU Member States, such as the UK, the US or other parts of the world. The potential for differing or incompatible requirements between these regulatory regimes may exact a significant and onerous regulatory burden, which may make total and complete compliance unfeasible. As such, there is a risk that XR providers, such as those operating a metaverse, may attempt to move their platform entirely outside the reach of regulatory frameworks, thereby making the enforcement of different legal requirements challenging, if not impossible.¹⁶⁶ The challenge for regulators is to seek more widespread and international consistency to improve compliance with and enforcement of laws that govern XR technologies, and avoid creating an overly onerous regulatory burden for XR and NLP providers.

Priority level: 2 (high)

<p>Relevant legal principles/provisions:</p> <ul style="list-style-type: none"> ○ Legal compliance & enforcement <p>Relevant ethical considerations:</p> <ul style="list-style-type: none"> ○ Dual-use and misuse ○ Environmental and security risks ○ Responsibility ○ Security & traceability 	<p>Relevant legal frameworks:</p> <ul style="list-style-type: none"> ○ International human rights law ○ National human rights law (including constitutional law, where applicable) ○ Privacy and data protection law ○ Online safety regulation ○ Consumer protection law ○ Product safety/liability law ○ Civil and criminal law
<p>Desired enhancement/change: Strengthened compliance by XR and NLP developers and providers with laws applicable to such technologies.</p>	
<p>International level changes:</p> <ul style="list-style-type: none"> ○ Provide guidance to national governments on the regulation of XR 	<p>National level changes:</p> <ul style="list-style-type: none"> ○ Collaborate internationally to promote the compatibility between different

¹⁶⁶ Boyd M. (2022) *Regulating The Metaverse: Can We Govern The Ungovernable?* / Forbes [Online]. Available at: <https://www.forbes.com/sites/martinboyd/2022/05/16/regulating-the-metaverse-can-we-govern-the-ungovernable/?sh=19f0941c1961>.



<p>technologies to promote compatibility of national laws and reduce conflicting legal obligations on XR and NLP providers and developers.</p> <p>Key actors:</p> <ul style="list-style-type: none"> ○ UN human rights agencies including the OHCHR and UN human rights treaty bodies 	<p>regulatory systems and facilitate data transfer and cross-border compliance with applicable laws;</p> <ul style="list-style-type: none"> ○ Pursue international collaboration to the highest possible level to promote consistency and legal certainty between jurisdictions, likely to be determined by and limited to the existence of a common historical and cultural background. <p>Key actors:</p> <ul style="list-style-type: none"> ○ National governments
<p>Circumstances necessary for change: International collaboration likely required on the conditions for data transfer/cross-border compliance with privacy and data protection laws. The level of harmonisation of laws is likely to be restricted by cultural differences and therefore potentially limited to those countries with a common historical and ethical background.</p>	

6. Conclusion

Climate engineering, neurotechnologies and digital extended reality each present their own regulatory challenges at the national and international level. This report explored what changes might be needed at the national and international level to address these regulatory challenges. It has also set out what circumstances are likely needed to make the change happen.

This report has explored the key regulatory challenges per technology family in greater detail, and has sought to identify what interventions could be taken by key actors at the national and international level to help overcome each regulatory challenge.

A cross-cutting challenge between all three technology families, is the protection of human rights, such as in relation to the protection of the environment and human livelihoods in the context of **climate engineering** and mitigating climate change, or the protection of fundamental freedoms, such as the right to autonomy, dignity and freedom of expression, and the right to be free from discrimination, in the context of **neurotechnologies** and **digital extended reality**. What all three technology families have in common is that they have potential to both enhance and interfere with human rights. The manner in which, and purposes for which these emerging technologies are deployed is therefore instrumental in the effect they are likely to have on the protection and promotion of human rights.

A further overarching challenge related to the governance of emerging technologies is the trade-off between adopting regulation specifically designed for the governance of a technology, on the one hand, and adopting a more rights-based approach (such as around human rights and environmental protection), on the other. In case of the former approach, there is a risk that specific regulation could soon become outdated as the technology continues to evolve. As for a rights-based approach, there is a risk that the applicability and interpretation of relevant rights and principles remains ambiguous in the context of a specific technology or use case. As such, differing interpretations could result in different regulatory outcomes.

Further research is likely needed to further inform the nature of the changes needed at the national, regional and international level, and to guide law- and policymakers to take the necessary steps for the adoption of appropriate legislative changes. Furthermore, more detailed research is needed at country-level, to adapt the recommendations to the national context of a specific country and inform the appropriate regulatory changes needed at that level. Lessons may be drawn from the comparative analysis of regulatory approaches in different national, regional and international legal frameworks or jurisdictions. Finally, it is recommended that further research is conducted to identify the implications of the three technology families in relation to legal frameworks not considered by the TechEthos project, for example investment law, labour law, competition law and intellectual property law.

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