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STOA Annual Report 2022

European Parliament

Panel for the Future of Science and Technology

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Scientific Foresight Unit (STOA)
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European Parliament
Panel for the Future of Science and Technology (STOA)

Annual Report 2022

May 2023

The STOA Panel approved this report on 11 May 2023.

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PE 740.256

Introduction by Marc Angel, Vice-President of the European Parliament responsible for STOA (2023-2024)

Dear readers,

The European Parliament represents the EU citizens and it is where a multicultural and visionary debate on the main issues affecting citizens' lives takes place. Besides being the EU co-legislator with the Council of the EU, working on the European Commission's proposals, the European Parliament oversees the implementation of European legislation by the Commission. So it is extremely important that the debate linked to scientific issues is founded on scientific evidence. Moreover, in times of crisis, we can see and experience how important science is directly. It is the only tool that gives us solutions and hope – not fear and disappointment.

I assume my new role as Vice-President responsible for the 'European Parliament's Science and Technology Options Assessment (STOA)' with great honour and look forward to promoting the role and development of STOA.

STOA's mission is to provide the Members of the European Parliament with policy options based on scientific foresight and assessments of existing and new technologies that are relevant to their legislative work. In order to achieve this goal, STOA publishes relevant studies and stimulates discussions with experts in high-level public workshops and conferences. STOA is open to any European Parliament body or Member who would like to submit a proposal to the STOA Panel for activities to be carried out. STOA also cooperates fruitfully with other parliamentary technology assessment bodies, especially those that are part of the European Parliamentary Technology Assessment (EPTA) network.

The past few years have brought unprecedented challenges, from both a scientific and a political viewpoint. The pandemic showed in a very direct way how critical good scientific advice is to a sound policy response. But it also showed that science is not at a standstill, it evolves as our knowledge improves: an open and free debate is at the heart of the scientific method. Policy must also follow; an open debate is crucial to finding the correct policy response. Therefore, the role of STOA has never been more important than it is now.

The European Science-Media Hub (ESMH) is a service within STOA that brings together scientists, journalists and policymakers. It makes information available to journalists, other media and citizens about new scientific developments and scientific topics that are being analysed by STOA and attract media attention. It also provides media monitoring and networking, creating a common working platform among policymakers, scientists and media, involving science, academia, and educational and research organisations. It is important that policymakers, scientists and journalists work together better to provide better science communication for all.

I would like to take this opportunity to express my thanks to the Chair, the Vice-Chairs, the Members and the Secretariat of the STOA Panel for their work throughout 2022.

Marc Angel

Vice-President, European Parliament

Preamble by Christian Ehler, Chair of STOA (2022-2024)

Exactly 35 years ago, STOA started working on its first studies, giving Members of the European Parliament access to state-of-the-art expertise on complex scientific and technological topics. For the first time, the European Parliament was on a par with the Commission and the Member States in matters of technology assessment. Now, STOA continues to provide MEPs with vital information in the form of studies, assessments, and events, always with one eye on Parliament's work and the other on current technological trends.

It was an honour for me, having been Vice-Chair since 2019, to take up the responsibilities of STOA Chair last year. As we look back on a challenging, but fruitful year, I am excited about the forward-looking and policy-relevant work STOA has delivered.

Staying ahead of current trends, STOA published a host of studies and technology assessments on artificial intelligence (AI) last year, before the topic started being on everyone's lips by the end of 2022. In all, STOA published 14 studies last year, hosted 13 events, and published just as many 'at a glance' papers; not counting the very well attended annual lecture. It was a productive year, during which we were slowly changing back to in-person events and the fruitful interactions they bring.

We were glad to continue our close cooperation with the Joint Research Centre (JRC) last year with a visit to the JRC facilities in Seville in July, following an invitation by Director Mikel Landabaso. On two occasions, we strengthened our institutional partnership with the European Parliamentary Technology Assessment (EPTA) network: at a conference in Berlin and at a directors' meeting in Karlsruhe.

The future of research funding and innovation has been a recurring theme at the numerous workshops and expert presentations that STOA organised this year, for example in the event on the 'Use of lump sum funding in EU research programmes'. Other events dealt with lessons learned from the COVID-19 pandemic and its ethical implication for health policy, as well as a wide range of other topics. In terms of studies, one topic sticks out this year: 6 out of 13 STOA studies were concerned with AI, covering issues of data governance, ethical challenges and more. Along with AI and academic freedom, another focus last year was on biotech and health science innovations, accounting for 7 of 2022's 13 'at a glance' notes. These papers treat exciting new developments that could help answer the donor organ shortage or reduce greenhouse gas emissions from the agri-food sector.

On this note, it was a special honour to have Özlem Türeci, co-founder and Chief Medical Officer at BioNTech, give the 2022 annual lecture on 'The future of RNA-based technology'. Her keynote speech touched on the cutting edge of the technology that enabled the quick rollout of the COVID-19 vaccine.

The end of 2022 also saw the launch of a new STOA project, the European Parliament Forum on Academic Freedom, at a high-level conference in November. Protecting the capacities of academics to generate knowledge and drive innovation is key to both our economic future and our identity as Europeans. With the endorsement of European Parliament President Roberta Metsola, who underlined the importance of enforcing academic freedom in the Union in her opening speech, this STOA initiative is off to an excellent start.

I would like to thank my Vice-Chairs – Ivo Hristov and Ivars Ijabs – with whom I look forward to working in the future, as well as the Scientific Foresight Unit within the European Parliamentary Research Service (EPRS), for their continued support and commitment to our common work.

Christian Ehler, STOA Chair (2022-2024)

Special foreword

Theo Karapiperis, Head of Unit of STOA from 1 March 2010 to 30 April 2022.

As many previous years, 2022 was filled with typical STOA activities as well as new, exciting projects such as the European Parliament Forum for Academic Freedom, which you can read all about in this Annual Report. But unlike the previous years, it was also marked by the retirement of the pillar of STOA, its long-term Head of Unit, our dear colleague Theo Karapiperis.

The history of STOA and the career of Theo are very much interlinked. STOA has been operating more than 35 years now, for 12 of those with Theo at the helm.

In 2000, Theo joined STOA for the first time as an administrator, and later he left but then returned. On 1 March 2010, he was appointed Head of the STOA unit, as it was called at the time.

Theo was perfectly placed to lead Parliament's work linking science with policy and politics. A scientist himself, with a Bachelor's degree from the University of Sussex (UK), a PhD in Physics from the MIT (US), and a career in fundamental and applied research before joining the Parliament in 1995, he was used to being meticulous in his work. Theo stirred and accompanied many stages of development and unprecedented recent expansion in the volume and diversity of STOA's products and activities. While he has always been a fan of technology assessment, his analytical and curious mind was open to new developments and approaches to serve Parliament better. Theo extended STOA's core business of science advice to parliamentary committees and Parliament as a whole to other areas, leading three formal teams – the STOA secretariat, the Scientific Foresight Service, and the European Science-Media Hub (ESMH) – as well as the transversal Centre for Artificial Intelligence (C4AI) team, and most recently the work on academic freedom.

There is no name more associated with STOA than Theo's. It is largely thanks to his work that STOA is today so well known and appreciated in the European scientific community.

With heartfelt thanks to Theo for his tireless devotion to European public service and the work of the European Parliament more specifically, we wish him a long, happy and healthy retirement. As for his successor, Marcus Scheuren, we wish him the very best of luck in filling Theo's shoes.

Wolfgang Hiller

Director for Impact Assessment and Foresight

EPRS

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List of abbreviations

AGRI	European Parliament Committee on Agriculture and Rural Development
AI	artificial intelligence
AIDA	European Parliament Special Committee on AI in a Digital Age
CULT	European Parliament Committee on Culture and Education
EC	European Commission
ECON	European Parliament Committee on Economic and Monetary Affairs
ECR	European Conservatives and Reformists
EMPL	European Parliament Committee on Employment and Social Affairs
ENVI	European Parliament Committee on Environment, Public Health and Food Safety
EPP	European People's Party
EPRS	European Parliamentary Research Service
EPTA	European Parliamentary Technology Assessment network
ERC	European Research Council
ESMH	European Science-Media Hub
EP	European Parliament
EU	European Union
Greens/EFA	The Greens/European Free Alliance
IMCO	European Parliament Committee on Internal Market and Consumer Protection
INTA	European Parliament Committee on International Trade
ITRE	European Parliament Committee on Industry, Research and Energy
JRC	Joint Research Centre of the European Commission
JURI	European Parliament Committee on Legal Affairs
LIBE	European Parliament Committee on Civil Liberties, Justice and Home Affairs
MEP	Member of the European Parliament
NI	non-inscrits (non-attached Members of the European Parliament)
REGI	European Parliament Committee on Regional Development
S&D	Progressive Alliance of Socialists and Democrats
SEDE	European Parliament Subcommittee on Security and Defence
S&T	science and technology
STOA	Panel for the Future of Science and Technology
TA	technology assessment
TRAN	European Parliament Committee on Transport and Tourism

Executive summary

In total, STOA published 14 studies in 2022, focusing on the three priority thematic areas defined by the Panel: artificial intelligence and other disruptive technologies; the European Green Deal; and quality of life. These were:

- Privacy and security aspects of 5G technology
- AI and digital tools in workplace management and evaluation: An assessment of the EU's legal framework
- Regulatory divergences in the draft AI act: Differences in public and private sector obligations
- Artificial intelligence in healthcare: Applications, risks, and ethical and societal impacts
- 'Splinternets': Addressing the renewed debate on internet fragmentation
- Governing data and artificial intelligence for all: Models for sustainable and just data governance
- Ethical and societal challenges of the approaching technological storm
- Auditing the quality of datasets used in algorithmic decision-making systems
- The Green Deal ambition: Technology, creativity and the arts for environmental sustainability
- How are we coping with the pandemic? Mental health and resilience amid the COVID-19 pandemic in the EU
- Genome editing in humans: A survey of law, regulation and governance principles
- Genome-edited crops and 21st century food system challenges
- Fostering coherence in EU health research: Strengthening EU research for better health
- A reimbursement system based on a fixed lump sum - Is it the right tool for the EU Framework Programme for research?

In addition to the standard studies, STOA kept up a lively rhythm of other publications, with 12 'What if...?' 'at a glance' publications providing awareness-raising and thought-provoking overviews of current and relevant techno-scientific trends, as well as 23 blog posts and 22 videos and podcasts.

STOA was able to organise a large number of events in 2022. They took place in hybrid mode: with attendance both in person and online. The events were either linked to published studies or held in their own right and covered a wide range of topics, such as: 'Quantum and chips: Developing European industrial capabilities in quantum technologies', Towards full digital language equality in a multilingual European Union', 'Artificial intelligence public perspectives', 'New European Bauhaus: The way forward', 'Ethical issues in the COVID-19 pandemic: The case of digital health applications', 'The use of animals for scientific research in Europe' and 'Creation of a public EU pharma R&D infrastructure'. One event focused on a critical aspect of scientific research itself, namely 'How to provide enforceable protection for academic freedom at EU level?'. STOA's 2022 annual lecture was dedicated to 'The future of RNA-based technology', with the keynote lecturer Professor Özlem Türeci, co-founder and Chief Medical Officer of BioNTech.

As part of its networking activities with key science and technology communities, STOA kept up its links with the European Parliamentary Technology Assessment network (EPTA), participating in its directors' meeting and its 2022 conference. STOA also had further exchanges with the Joint Research Centre of the European Commission (JRC), with its Director, Mikel Landabaso, and a visit to the JRC in Seville.

In 2022, the European Science-Media Hub (ESMH) continued to develop a network among policymakers, scientists and media and to promote science-based information, while also focusing on aligning its publications with STOA events and studies, publishing articles and interviews on its website and producing several video clips. The ESMH organised several events in 2022, such as the workshop 'Promoting trust in science to combat misinformation' and a big annual event – the summer school for young science journalists.

1. Scientific evidence for policy-making

The Panel for the Future of Science and Technology (STOA) was established in 1987 as a scientific advisory body to the European Parliament as a whole. Its mission is to provide Members of the European Parliament (MEPs) with independent expert assessment of scientific and technological developments and related policy options, all in the service of informed political decision-making. It conducts technology assessment and scientific foresight to provide Members with a strategic view on techno-scientific developments and their implications across many policy areas affecting society, the economy and the environment in a broad sense, in the near as well as the distant future.

During the ninth parliamentary term (2019-2024), STOA has been focusing on the following three priority thematic areas and four priority policy areas:

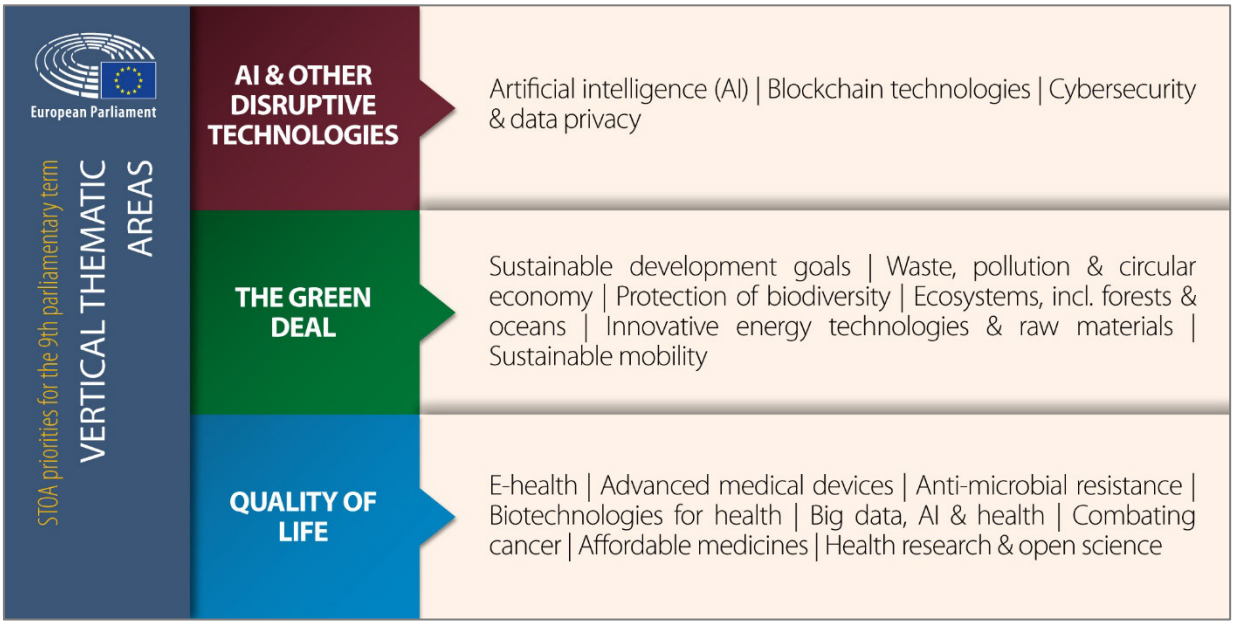
Priority thematic areas:

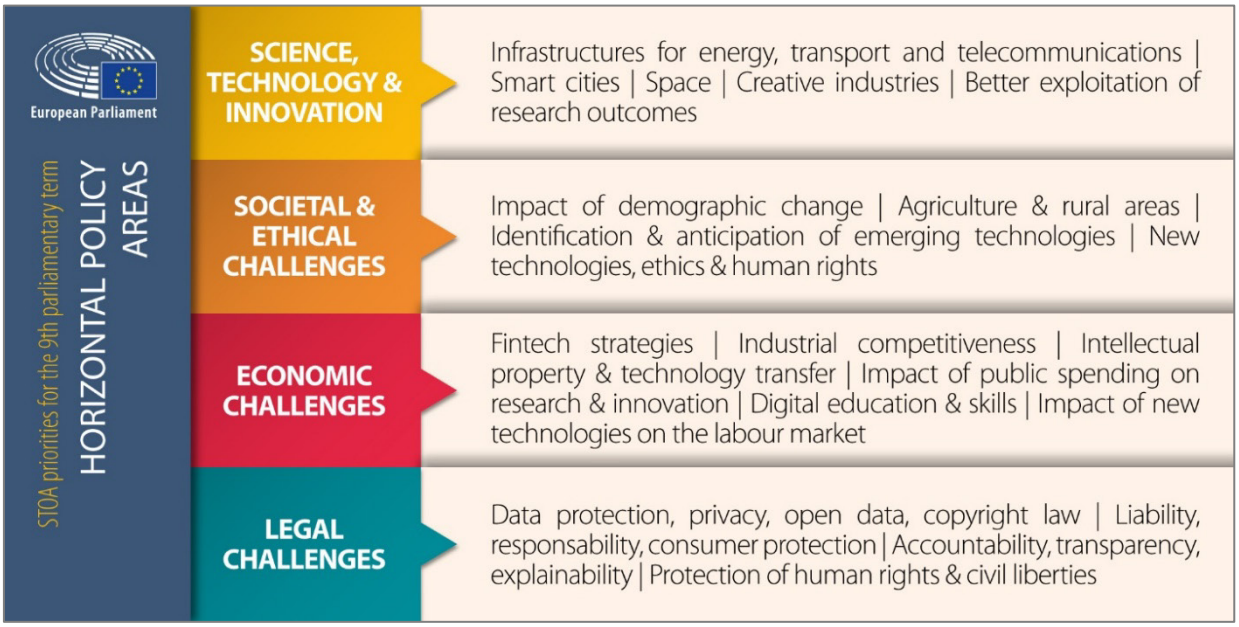
- artificial intelligence and other disruptive technologies;
- the European Green Deal;
- quality of life.

Priority policy areas:

- science, technology and innovation;
- societal and ethical challenges;
- economic challenges;
- legal challenges.

STOA's activities are wide-ranging, and include technology assessment (TA) and scientific foresight studies, events and visits, with specific kinds of activities performed using dedicated instruments such as the European Science-Media Hub (ESMH).





1.1 STOA methods: Technology assessment and scientific foresight

STOA is a member of the European Parliamentary Technology Assessment network (EPTA), which brings together TA offices specialising in providing advice for parliaments. Like other EPTA members, STOA advises the European Parliament on the possible social, economic and environmental impact of new science and technologies.

Technology assessment is the study and assessment of the effects of new technology on society. It is a scientific, interactive and communicative process that aims to contribute to the formation of public and political opinion on the societal aspects of science and technology. According to this definition, TA (i) provides knowledge and is evidence-based; (ii) involves societal interactions with stakeholders; and (iii) includes an element of communication, contributing to the formation of public and political opinion.

In addition, STOA applies a foresight-based approach to its science advice activities. This ensures that the focus is on preparedness for what could happen or could be needed in the future. It puts an emphasis on the possible future impacts of new technological developments on all of society. Basic traits of foresight exploration involve investigating the effects of new technologies on society in a holistic way, namely they are inclusive (stakeholders from the 'broad spectrum'), participatory (including conversations among stakeholders about possible future concerns) and interdisciplinary (in the initial TA as well as in the analysis of the stakeholder views). The foresight element is particularly important when dealing with controversial or complicated issues, such as, for instance, genome editing or climate change.

STOA Panel members – Second half of ninth parliamentary term (as of 1 February 2023)

	Panel member	Committee		Panel member	Committee
	Marc Angel (S&D, LU) **EP Vice-President STOA Bureau member**			Rosa D'Amato (Greens/EFA, IT)	**REGI**
	Christian Ehler (EPP, DE) **STOA Chair STOA Bureau member**	**ITRE**		Jakop Dalunde (Greens/EFA, SE)	**TRAN**
	Ivo Hristov (S&D, BG) **1st STOA Vice-Chair - STOA Bureau member**	**ITRE**		Pietro Fiocchi (ECR, IT)	**ENVI**
	Ivars Ijabs (Renew Europe, LV) **2nd STOA Vice-Chair - STOA Bureau member**	**ITRE**		Emmanouil Fragkos (ECR, EL)	**AGRI**
	Atidzhe Alieva-Veli (Renew Europe, BG)	**EMPL**		Lina Galvez Muñoz (S&D, ES)	**EMPL**
	Adam Bielan (ECR, PL)	**IMCO**		Maria Grapini (S&D, RO)	**TRAN**
	David Cormand (Greens/EFA, FR)	**IMCO**		Martin Hlaváček (Renew Europe, CZ)	**AGRI**

	Panel member	Committee		Panel member	Committee
	Marina Kaljurand (S&D, EE)	**LIBE**		Susana Solís Pérez (Renew Europe, ES)	**ENVI**
	Radan Kanev (EPP, BG)	**EMPL**		Barbara Thaler (EPP, AT)	**TRAN**
	Maria-Manuel Leitão-Marques (S&D, PT)	**IMCO**		Patrizia Toia (S&D, IT)	**ITRE**
	Victor Negrescu (S&D, RO)	**CULT**		Marion Walsmann (EPP, DE)	**JURI**
	Michèle Rivasi (Greens/EFA, FR)	**ENVI**		Pernille Weiss (EPP, DA)	**ITRE**
	Bronis Ropė (Greens/EFA, LT)	**AGRI**		Juan Ignacio Zoido Alvarez (EPP, Spain)	**INTA**
	Jordi Solé (Greens/EFA, ES)	**ITRE**	AGRI: Agriculture and Rural Development CULT: Culture and Education EMPL: Employment and Social Affairs ENVI: Environment, Public Health and Food Safety IMCO: Internal Market and Consumer Protection INTA: International Trade ITRE: Industry, Research and Energy JURI: Legal Affairs LIBE: Civil Liberties, Justice and Home Affairs REGI: Regional Development TRAN: Transport and Tourism		

2. STOA activities in science, technology and innovation

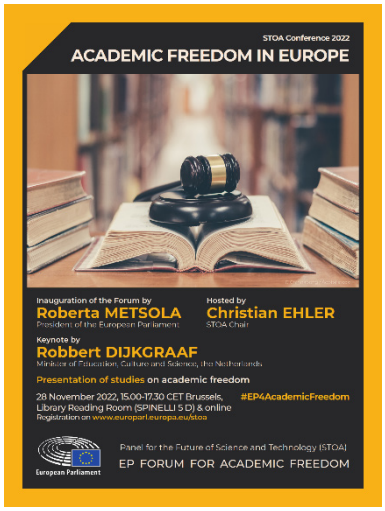
Over the course of 2022, STOA developed several activities that are transversal to science and technology, rather than falling within any specific thematic areas. These involved science funding at EU level, as well as a first foray into what should be a continuing look into the critical topic of academic freedom.

2.1 STOA high-level conference | How to provide enforceable protection for academic freedom at EU level?

Lead Panel Member: Christian Ehler (EPP, DE)

Date: 28 November 2022

Relevant to European Parliament committees: ITRE, CULT, LIBE



Academic freedom is a universal right and essential to the quality of education, teaching and research. It is a driver of innovation, enhances the capacity of academics and students to acquire and generate knowledge, thereby protecting societies' capacity for self-reflection. While states and universities throughout the world have long committed to respecting and protecting academic freedom, it remains poorly understood – and is under attack in many places.

The STOA high-level conference on academic freedom in Europe invited all relevant institutional stakeholders and academia to discuss how to enforce the protection of academic freedom in the EU. The European Parliament's President Roberta Metsola launched the new STOA initiative, 'EP Forum for Academic Freedom', that will seek to produce an annual academic freedom monitor, a truly independent report on the state of play of academic freedom in the EU Member States.

2.2 STOA study | A reimbursement system based on a fixed lump sum – Is it the right tool for the EU framework programme for research?

Lead Panel Member: Christian Ehler (EPP, DE)

Date: 5 May 2022

Relevant to European Parliament committees: ITRE, CONT

Should the EU framework programmes for research use the recently piloted lump-sum (LS) system instead of traditional, expense-based reimbursement? The idea behind LS is that payments are made based on obtained results according to the agreed project plan. It aims to simplify the system by removing cost reporting, and helping to shift the focus from financial management to the technical and scientific content of projects. This study has collected input from 167 individuals from 29 countries, working for universities, research and technology

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organisations, small and large corporations, government organisations and European institutions, complemented by in-depth interviews with five randomly selected respondents. The most important result is that the general attitude towards the LS system is quite positive – it is perceived as better than the traditional system, at least for some funding schemes, and is seen as meeting its aims. However, the system could be modified further to reach its full potential.

3. STOA activities relating to artificial intelligence (AI) and other disruptive technologies

The European Parliament as EU co-legislator and its committees have been busy during this legislature in intensive AI-related legislative work, for instance on the: Digital Markets Act, the Digital Services Act, the Data Governance Act, the Data Act, the European Declaration on Digital Rights and Principles for the Digital Decade, the Decision establishing 2030 Policy Programme 'Path to the Digital Decade', the AI Act, the Digital Resilience Act, the Directive on liability for defective products and the Directive on adapting non-contractual civil liability rules to AI. Most of the discussions relating to these files took place during the 2022 and included the presentation by Parliament's Special Committee on AI in a Digital Age (AIDA) of its final report. EU digital policy is based on numerous policy documents, including various initiatives of EU presidencies such as the Lisbon Declaration – Digital Democracy with a Purpose (June 2021), the Berlin Declaration on Digital Society and Value-based Digital Government (December 2020) and the Tallinn Declaration on eGovernment (October 2017), as well as the European Commission's digital strategy as formulated in its communication Shaping Europe's Digital Future (February 2020). For further information, you can consult: (i) the AI Repository of documents and other online resources published by Parliament's Panel for the Future of Science and Technology (STOA), including STOA's European Science Media Hub (ESMH), and various units of EPRS, and (ii) the AI legislative overview of European Parliament decisions and other EU policy documents relating to AI.

The events and publications described below have made a substantial contribution to policy debates on AI and disruptive technologies in the European Parliament and beyond.

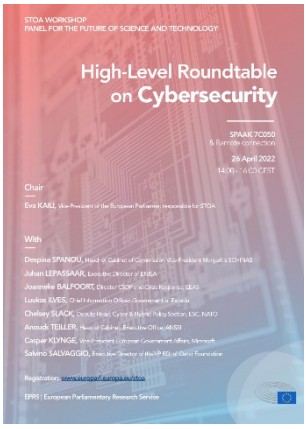
3.1 STOA high-level roundtable | Cybersecurity

Lead Panel Member: Eva Kaili (NA, EL)

Date: 26 April 2022

Relevant to European Parliament committees: ITRE, IMCO, SEDE, LIBE, AIDA

Relevant European Parliament files: Revision of Directive on the Security of Network and Information Systems (NIS2), Critical entities resilience directive, Joint cyber unit recommendation of the EU Commission, Cybersecurity Resilience Act.



Understanding, containing, deterring, preventing and responding to cyber threats and attacks is a generational challenge. In the Council's Versailles Declaration of 11 March 2022, European leaders committed to ensuring the Union's preparedness for fast-emerging challenges, such as hybrid warfare, by strengthening collective cyber-resilience and protecting the Union's critical infrastructure from threats.

With this workshop, STOA brought together the relevant stakeholders for a fruitful exchange. With its new EU cybersecurity strategy and new rules to make physical and digital critical entities more resilient, the European Commission proposed to strengthen supply chain cybersecurity for key information and communication technologies. The most recent European proposals were discussed to tackle cybersecurity challenges such as the revision of the NIS Directive, the Critical Entities Resilience Directive, the proposal for a joint cyber unit and the expected cybersecurity resilience act.

3.2 STOA workshop | Quantum and chips: Developing European industrial capabilities in quantum technologies

Lead Panel Member: Ivars Ijabs (Renew, LV)

Date: 12 October 2022

Relevant to European Parliament committees: ITRE, IMCO, SEDE

Relevant European Parliament files: Chips Act, Chips Joint Undertaking

We are now on the brink of a second quantum revolution: beyond simply understanding the quantum world, we are able to manipulate it. The potential future applications of this quantum technology are staggering: from ultra-fast computers to tamper-proof communications, from novel simulations of drug molecules to new industrial processes that vastly cut down on CO_2 emissions.

The European Union strongly supports research in this field, in particular through the Quantum Flagship. It is also supporting the deployment of quantum computers through the EuroHPC joint undertaking, and promoting the development of a European quantum communication infrastructure through the EuroQCI initiative. Ultimately, it is necessary to translate this research excellence into real-world applications. The past few years have seen the appearance of a substantial number of quantum technology related start-ups, and the upcoming chips act will play a crucial role in promoting the production of quantum chips in Europe.

This STOA workshop opened with remarks by European Commission Executive Vice-President Margrethe Vestager on the European chips act and quantum technologies. The discussion was divided into two panels: the first focused on research and innovation aspects of quantum technology, including speakers from academia, research organisations and industry. The second brought policy to the fore, looking into the impact of the chips act on the development of quantum technology, and among other speakers featured several MEPs directly involved in the chips act and the related chips joint undertaking: Panel members Ivars Ijabs (Renew, LV) and Lina Gálvez Muñoz (S&D, ES), as well as Eva Maydell (EPP, BG) and Dan Nica (S&D, RO).

3.3 STOA workshop | Towards full digital language equality in a multilingual European Union

Lead Panel Member: Jordi Solé (Greens/EFA, ES)

Date: 8 November 2022

Relevant to European Parliament committees: ITRE, IMCO, CULT

Relevant European Parliament files: Language equality in the digital age

At least 21 European languages are in danger of digital extinction due to a severe lack of technological support, concluded the META-NET 2012 reports prepared by a group of more than 230 experts from all over Europe. For the past decade, the introduction of neural technologies in automatic translation has

precipi tated a revolution in digital language services, allowing for ever faster and more accurate automatic speech recognition (ASR) and machine translation (MT) results. Yet, a stark imbalance persists in technology support between the five most spoken EU languages (English, French, German, Spanish and Italian), and the remaining 19 official ones. This digital inequality further increases when regional and minority languages are considered, leading to a dearth of online technological support, both in spoken (audio, video) and written (text) form. As digital services become an ever more integral part of our lives, such digital language inequalities could eventually threaten the digital survival of EU languages.

This STOA event explored the research and development environment of language technologies in the context of EU multilingualism. It presented the results of the EU project European Language Equality (ELE), which proposes a roadmap towards achieving full digital language equality by 2030. A panel discussion ensued between MEPs Jordi Solé (Greens/EFA, Spain) and Yana Toom (Renew, Estonia), and experts from academia and industry, exploring challenges and opportunities for digital language equality in the EU. This event was the third in a series of STOA events on language technologies in the EU (the first, in 2013 and the second in 2017). It builds on a STOA study on 'Language equality in the digital age', which led to a European Parliament resolution on the same subject.

3.4 STOA workshop | Artificial intelligence public perspectives

Lead Panel Member: Eva Kaili (NA, EL)

Date: 14 November 2022

Relevant to European Parliament committees: ITRE, IMCO, AIDA, JURI, LIBE, CULT

Relevant European Parliament files: Artificial Intelligence Act

AI is a regular topic of discussion among politicians, scientists and entrepreneurs. Whereas in many areas, AI helps to empower citizens, its uptake depends strongly on people's perceptions. But how do citizens perceive AI? Are mentalities evolving in line with the technological revolution in motion? What stories are told about AI? According to the historian Yuval Noah Harari, storytelling is the essence of human survival and prosperity. It is because of the tales we told, that we came to believe in nations, justice, money, books and laws. It seems that the AI narrative largely depends on stories and images offered by culture and the arts.

The conference proposed to reflect on the importance of culture and artistic expression shaping the public perception of AI. Understanding what shapes people's relationship with and emotions around AI is important for policy makers in order to respond to public concerns and expectations. The artistic short film 'The Best Option', produced for STOA for this purpose, was presented to the public for the first time at the conference, serving as an introduction to the debate. Experts from different disciplines together with policy makers and artists discussed how to promote a lively public debate involving civil society, cultural organisations, academic networks, social media communities and other stakeholders.

3.5 STOA study | Privacy and security aspects of 5G technology

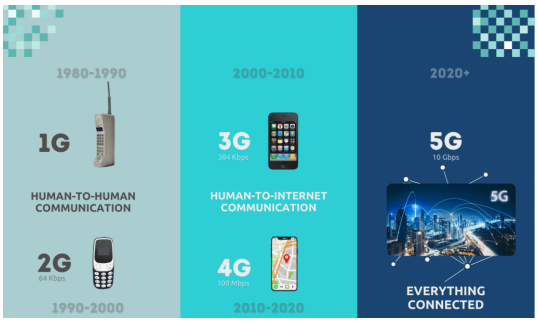
Lead Panel Members: Michèle Rivasi (Greens/EFA, France) and Ivo Hristov (S&D, BG)

Project duration: Started in June 2021, published in March 2022; presented to the STOA Panel on 25 November 2021

Relevant to European Parliament committees: ITRE, IMCO, AIDA, JURI, LIBE, CULT

Relevant European Parliament files: Revision of Directive on the Security of Network and Information Systems (NIS2), Critical Entities Resilience Directive, Joint cyber unit recommendation of the EU Commission, Cybersecurity Resilience Act

This study describes two main dimensions of 5G technology: privacy and security. It focuses on the analysis of cybersecurity risks and threats, privacy challenges and 5G technology opportunities at EU level and worldwide, as well as the relationship between cybersecurity risks and privacy issues. The methodological framework for this assessment of the impact of 5G technology is built on three pillars: (i) a document-based analysis; (ii) a parallel analysis with stakeholder involvement; and (iii) a selection of relevant case studies. The complexity of the 5G ecosystem, where new use cases are constantly emerging, also led the authors to assess the prospects of using new 5G-enabled technologies, such as the internet of things, robotics and AI. Moreover, policy options are defined and put forward for consideration by the European Parliament's Committees on Legal Affairs, Internal Market and Consumer Protection, Civil Liberties, Justice and Home Affairs, and the Subcommittee on Security and Defence, as well as by other EU institutions and the Member States.



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3.6 STOA study | AI and digital tools in workplace management and evaluation: An assessment of the EU's legal framework

Lead Panel Member: Lina Gálvez Muñoz (S&D, ES)

Project duration: Started in July 2021; published in May 2022; presented to the STOA Panel on 5 May 2022

Relevant to European Parliament committees: ITRE, IMCO, JURI, EMPL, LIBE

Relevant European Parliament files: e-Privacy Regulation, Digital Markets Act, Digital Services Act, Data Governance Act, Data Act, AI Act, Digital Resilience Act

This study focuses on options for regulating the use of AI-enabled and algorithmic management systems in the world of work under EU law. The first part describes how these technologies are already being deployed, particularly in recruitment, staff appraisal, task distribution and disciplinary procedures. It discusses some short-term potential development prospects and presents an impact assessment, highlighting some of these technologies' most significant implications. The second part addresses the regulatory field. It examines the various EU regulations and directives that are already relevant to regulating the use of AI in employment. Subsequently, it analyses the potential labour and employment implications of the European Commission's proposal for a regulation laying down harmonised rules on artificial

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intelligence (AI act). Finally, it summarises the other ongoing EU policy debates relevant to the regulation of AI at work. The third and final part of this study reflects in detail upon the AI act and its potential impact on the existing EU social *acquis*. On this basis, it advances potential policy options across different EU legislative files, including but not limited to the AI act, to ensure that regulation keeps pace with technological development. It also argues that the AI act should 'serve' and complement – rather than over-ride – other regulatory standards that may already govern the introduction and use of AI-enabled and algorithmic-management systems at work.

3.7 STOA study | Regulatory divergences in the draft AI act: Differences in public and private sector obligations

Lead Panel Member: Maria-Manuel Leitão-Marques (S&D, PT)

Project duration: Started in November 2021; published in May 2022; presented to the STOA Panel on 10 March 2022

Relevant to European Parliament committees: ITRE, AIDA, JURI, LIBE, CULT, IMCO

Relevant European Parliament files: Digital Markets Act, Digital Services Act, Data Governance Act, Data Act, AI Act, Digital Resilience Act

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This study identifies and examines sources of regulatory divergence within the AI act regarding the obligations and limitations upon public and private sector actors when using certain AI systems. A reflection upon possible impacts and consequences is provided, and a range of policy options is suggested for the European Parliament that could respond to the identified sources of divergence. The study focuses specifically on three AI application areas: manipulative AI, social scoring and biometric AI systems. Questions regarding how and when those systems are designated as prohibited or high-risk and the potentially diverging obligations towards public versus private sector actors and the rationale behind it, are described.

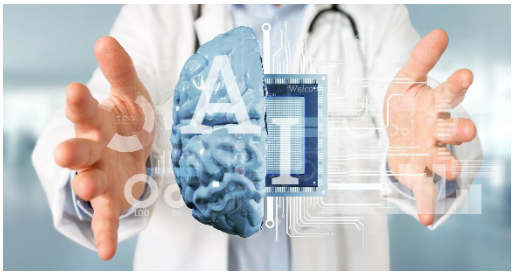
3.8 STOA study | Artificial intelligence in healthcare: Applications, risks, and ethical and societal impacts

Lead Panel Member: Eva Kaili (NA, EL)

Project duration: Started in November 2020; published in June 2022; presented at a STOA workshop on 11 February 2022

Relevant to European Parliament committees: ITRE, IMCO

Relevant European Parliament files: Artificial Intelligence Act, Data Governance Act, Data Act



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In recent years, the use of artificial intelligence (AI) in medicine and healthcare has been praised for the great promise it offers, but has also been at the centre of heated controversy. This study offers an overview of how AI can benefit future healthcare, in particular increasing clinicians' efficiency, improving medical diagnosis and treatment, and optimising the allocation of human and technical resources. The report identifies and clarifies the main clinical, social and ethical risks posed by AI in healthcare, more specifically: potential errors and patient

harm; risk of bias and increased health inequalities; lack of transparency and trust; and vulnerability to hacking and data privacy breaches. The study proposes mitigation measures and policy options to minimise these risks and maximise the benefits of medical AI, including multi-stakeholder engagement through the AI production lifetime, increased transparency and traceability, in-depth clinical validation of AI tools, and AI training and education for both clinicians and citizens.

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3.9 STOA study | 'Splinternets': Addressing the renewed debate on internet fragmentation

Lead Panel Member: Patrizia Toia (S&D, IT)

Project duration: Started in July 2021; published in July 2022; presented to the STOA Panel on 9 June 2022

Relevant to European Parliament committees: ITRE, JURI, IMCO

Relevant European Parliament files: Digital Markets Act, Digital Services Act, Data Governance Act, Data Act, AI Act, Digital Resilience Act

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Recent events have multiplied concerns about potential fragmentation of the internet into a multitude of non-interoperable and disconnected 'splinternets'. Composed of thousands of compatible autonomous systems, the internet is by definition technically divided; but it was also designed to be an open and global technical infrastructure. The unity and openness of the internet appear to be under great pressure from political, commercial and technological developments. This report explores the implications of the EU's recent policies in this field as well as the opportunities and challenges for EU Member States and institutions in addressing internet fragmentation. It underlines how recent EU legislative proposals – on the digital services act, digital markets act, artificial intelligence act, and NIS 2 Directive – could help to address patterns of fragmentation, but also have limitations and potentially unintended consequences. Four possible strategies emerge: stay with the status quo, embrace fragmentation, resist patterns of divergence, or frame discussions as a matter of fundamental rights.

3.10 STOA study | Governing data and artificial intelligence for all: Models for sustainable and just data governance

Lead Panel Member: Eva Kaili (NA, EL)

Project duration: Started in July 2021; published in July 2022; presented to the STOA Panel on 15 September 2022

Relevant to European Parliament committees: ITRE, JURI, AIDA, IMCO

Relevant European Parliament files: Artificial Intelligence Act, Digital Markets Act, Digital Services Act, Data Governance Act, Data Act, Digital Resilience Act

With a particular focus on artificial intelligence (AI), this study identifies and examines policy options for the EU's data governance framework that align with a data justice perspective. A data justice approach is one that centres on equity, recognition and representation of plural interests, and the creation and preservation of public goods as its principal goals. The analysis offers both an assessment

of the EU data governance strategy overall and specific policy options for the AI act, the data governance act and the data act. Four benchmarks for good data governance are proposed, in line with the principles of justice: preserving and strengthening public infrastructure and public goods, inclusiveness, contestability and accountability, and global responsibility. Exploring examples of different governance models, we examine how these models and options intersect, and what lessons they offer for the EU case.

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3.11 STOA study | Ethical and societal challenges of the approaching technological storm

Lead Panel Member: Eva Kaili (NA, EL)

Project duration: Started in July 2021; published in July 2022; presented to the STOA Panel on 20 January 2022

Relevant to European Parliament committees: ITRE, JURI, AIDA, IMCO

Relevant European Parliament files: Digital Markets Act, Digital Services Act, Data Governance Act, Data Act, AI Act, Digital Resilience Act

Supported by the arrival of 5G and, soon 6G, digital technologies are evolving towards an artificial intelligence-driven internet of robotic and bionano things. The merging of artificial intelligence (AI) with other technologies such as the internet of things (IoT) gives rise to acronyms such as 'AIoT', 'IoRT' (IoT and robotics) and 'IoBNT' (IoT and bionano technology). Blockchain, augmented reality and virtual reality add even more technological options to the mix. Smart bodies, smart homes, smart industries, smart cities and smart governments lie ahead, with the promise of many benefits and opportunities. However, unprecedented amounts of personal data will be collected, and digital technologies will affect the most intimate aspects of our life more than ever, including in the realms of love and friendship. This study offers a bird's eye view of the key societal and ethical challenges we can expect as a result of this convergence, and policy options that can be considered to address them effectively.

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3.12 STOA study | Auditing the quality of datasets used in algorithmic decision-making systems

Lead Panel Member: Eva Kaili (NA, EL)

Project duration: Started in November 2021; published in July 2022; presented to the STOA Panel on 7 July 2022

Relevant to European Parliament committees: ITRE, JURI, AIDA, IMCO

Relevant European Parliament files: : Digital Markets Act, Digital Services Act, Data Governance Act, Data Act, AI Act, Digital Resilience Act

Bias is commonly considered one of the most detrimental effects of artificial intelligence (AI) use. The EU is therefore committed to reducing its incidence as much as possible. However, the existence of bias pre-dates the creation of AI tools. All human societies are biased – AI only reproduces what we are. Therefore, opposing this technology for this reason would simply hide discrimination and not prevent

it. It is up to human supervision to use all available means – which are many – to mitigate bias. It is likely that at some point in the future, recommendations made by an AI mechanism will contain less bias than those made by human beings.

Unlike humans, AI can be reviewed and its flaws corrected on a consistent basis. Ultimately, AI could serve to build fairer, less biased societies. This study begins by providing an overview of bias in the context of artificial intelligence, and more specifically of machine-learning applications. The second part is devoted to the analysis of bias from a legal point of view. The analysis shows that shortcomings in this area call for the implementation of additional regulatory tools to adequately address the issue of bias. Finally, this study puts forward several policy options in response to the challenges identified.

4. STOA activities in relation to the European Green Deal

With the potential to play a key role addressing long-term climate change threats and other environmental challenges, the European Green Deal (EGD) remained one of the priority thematic areas of the STOA Panel in 2022. Ranging across eight policy areas – biodiversity, eliminating pollution, climate action, sustainable food systems, sustainable agriculture, clean energy, sustainable industry, building and renovating and sustainable mobility – the deal represents an unprecedented effort to review more than 50 European laws and redesign public policies.

The events and publications described below have made a substantial contribution to policy debates on the European Greed Deal in the European Parliament and beyond.

4.1 STOA-STS forum High-level conference 'From a European to a Global Green Deal'

Lead Panel Member: Christian Ehler (EPP, DE)

Date: 12 May 2022

Relevant to European Parliament committees: ITRE, ENVI

Relevant European Parliament files: The European Green Deal

Fighting climate change is a global challenge. Even as Europe is leading the way on the green transition, other countries are working on their own paths to reach the Paris climate goals. On this topic, STOA hosted a conference on 12 May 2022 entitled 'From a European to a Global Green Deal' in cooperation with one of STOA's partner organisations, the Japan-based Science and Technology in Society (STS) forum.

The first panel brought academics and industrial leaders together to discuss how to achieve the goals of the European Green Deal. Some highlighted the role of fundamental research and science in accelerating the transition, while others focused more on the political and economic resources that will have to be mobilised to build sufficient renewable energy capacities and physical infrastructure. The second panel explored possibilities to leverage European insights to achieve a 'Global Green Deal'. The participants underlined the need for international dialogue at all levels of society.

4.2 STOA workshop | New European Bauhaus: The way forward

Lead Panel Member: Christian Ehler (EPP, DE)

Date: 13 June 2022

Relevant to European Parliament committees: ITRE, CULT, ENVI, IMCO

Relevant European Parliament files: Report on the New European Bauhaus, European Parliament resolution of 14 September 2022 on the new European Bauhaus (2021/2255(INI))

Combining technology with cultural heritage and creativity is the way forward for the New European Bauhaus project.

The workshop presented the main results of the STOA study, 'The Green Deal ambition: Technology, creativity and arts for environmental sustainability'. In the context of the New European Bauhaus (NEB) project run by the European Commission, the STOA workshop brought forward some of the policy options and suggestions provided by the study.

Christian Ehler, (EPP, Germany) STOA Chair, and Pernille Weiss (EPP, Denmark), attended the workshop. According to Ehler, 'The NEB should look at the consumer market, and efforts should be made to integrate marketing strategies because citizens are used to them'. Sustainability needs to meet aesthetics, which brings us to what was at the core of the old Bauhaus, where form followed function. 'For the NEB to work, it has to be attractive for citizens. Most of the time citizens are addressed as consumers, not as citizens. And as consumers, people are addressed in a very modern and versatile way, with their attention attracted by visuals and art support'.

4.3 STOA study | The Green Deal ambition: Technology, creativity and the arts for environmental sustainability

Lead Panel Member: Christian Ehler (EPP, DE)

Project duration: Started in July 2021; published in June 2022; presented to the STOA Panel on 9 June 2022

Relevant to European Parliament committees: ITRE, CULT, ENVI, IMCO

Relevant European Parliament files: Report on the New European Bauhaus, European Parliament resolution of 14 September 2022 on the new European Bauhaus (2021/2255(INI))

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Responding to the challenge of rebuilding a resilient, sustainable, beautiful and more socially inclusive Europe, while facing a climate crisis and a pandemic, the New European Bauhaus has been launched as a comprehensive programme to break down silos and go beyond innovation within specific sectors. In its efforts to foster collaboration between arts, technology, science, social and cultural enterprises, citizens and institutions, the New European Bauhaus wishes to be open to insights, ideas and constructive criticism. This study combines knowledge gleaned from a literature review of the most up to date publications dealing with innovation in the technology and arts sectors with understanding gained from interviews with players from a diverse range of industries, professional sectors, institutions and societal groups.

5. STOA activities in relation to quality of life

Quality of life has become an important overall objective in healthcare and also in a general political context. It is one of three STOA priority thematic areas for the ninth parliamentary term (2019-2024). As a broad concept, it is firmly established at an individual level as an indicator of physical health and material well-being, but it is also strongly influenced by interactions with psychological, spiritual and social variables.

In 2022, STOA organised a large number of events and studies in this field, as described below. These events and publications represent a considerable contribution to policy debates on several aspects of quality of life, in the European Parliament and beyond.

5.1 STOA workshop | Ethical issues in the COVID-19 pandemic: The case of digital health applications

Lead Panel Member: Anna-Michelle Asimakopoulou (EPP/EL)

Date: 11 February 2022

Relevant to European Parliament committees: IMCO, ENVI, LIBE, JURI

Relevant European Parliament files: European Health Data Space

Artificial intelligence (AI) was at the core of the response to the COVID-19 pandemic. In turn, the pandemic accelerated the development of AI technologies in the field of healthcare, with immediate implications in the improvement of clinical diagnoses and the enhanced precision of medical interventions.

The revolutionary advent of AI in healthcare has the potential for both disruptive advances and extraordinary benefits, with many unknowns and sensitive ethical and social issues. As with other technological advances, AI has its own set of benefits, risks, ethical issues and societal implications. Relevant questions include how to balance such benefits against the risk of unintended harms, how to govern the use of these technologies, and how to incorporate societal values into salient clinical and policy considerations.

This STOA workshop presented a STOA study on AI health-related applications and their potential to transform healthcare in the EU and worldwide. A discussion panel on the application of digital health applications in the context of COVID-19 followed. Experts discussed outstanding ethical, regulatory and policy challenges, and address possible policy options targeted at enhancing AI governance.

5.2 STOA workshop | The use of animals for scientific research in Europe

Lead Panel Member: Christian Ehler (EPP, DE)

Date: 28 June 2022

Relevant to European Parliament committees: ITRE, ENVI

Relevant European Parliament files: Revision of EU legislation on animal welfare

In September 2021 the European Parliament adopted a resolution on plans and actions to accelerate the transition to innovation without the use of animals in research, regulatory testing and education. This resolution calls upon the Commission, together with stakeholders and Member States, to draw up an EU-wide action plan, with the aim to drive the active phase-out by reducing, refining and replacing procedures using live animals for scientific and regulatory purposes; as soon as scientifically possible and without lowering the level of protection for human health and the environment. The resolution of the European Parliament calls for a science-based discussion to both foster animal welfare and drive technological innovation, and about potential risks of jeopardising Europe's top position in science and development in medical and biomedical research.

The event brought together scientific experts and stakeholders to provide insights on the state of play, areas for improvement and future perspectives. STOA Chair Christian Ehler (EPP, Germany) set the scene regarding EU legislation. President of the European Research Council (ERC) Maria Leptin, highlighted that animal suffering must be minimised and balanced against human suffering stemming from disease. In her opening speech, Laura Gribaldo from the European Union Reference Laboratory for Alternatives to Animal Testing (EURL-ECVAM, JRC) insisted on the principle of the 'three Rs', i.e. replacement, reduction and refinement of animal use in basic, applied and translational research. An open discussion followed, starting with statements from a panel of experts in the different areas concerned.

5.3 STOA workshop | Creation of a public EU pharma R&D infrastructure: Purpose and feasibility

Lead Panel Member: Patrizia Toia (S&D, IT)

Date: 28 September 2022

Relevant to European Parliament committees: ITRE, ENVI, IMCO

Relevant European Parliament files: Pharmaceutical strategy for Europe

While great progress has been made in recent years in the development of public health within the EU, the COVID-19 pandemic brought to light existing vulnerabilities in the European health response mechanism, from a lack of coordination between Member States and difficulties in manufacturing and accessing medicines, to EU research fragmentation and differences between corporate research and development (R&D) choices and public health priorities.

On 2 June 2020, the European Commission published its roadmap for a pharmaceutical strategy for Europe, fostering access to affordable high-quality, effective and safe medicines and supporting innovation in the EU pharmaceutical industry. With its resolution of 17 September 2020 on shortages of medicines, the European Parliament called on the Commission and Member States to 'examine the possibility of creating one or more European non-profit pharmaceutical undertakings which operate in the public interest to manufacture medicinal products'. The December 2021 Council conclusions suggested examining Parliament's resolution to ensure the supply of medicinal products affected by market failures.

With these objectives in mind, a recent STOA study investigated the feasibility of creating a large-scale European public infrastructure aimed at addressing vulnerabilities linked to the research, development, production and distribution of medicines. This workshop brought together experts from biomedical research, representatives of the pharmaceutical industry, and EU and international public health experts to discuss the state-of-play of the EU's current pharmaceutical strategy and explore policy options for strengthening EU preparedness and response, including the feasibility of creating an advanced EU pharmaceutical infrastructure for the research and development of novel medicines and treatments.

5.4 STOA study | How are we coping with the pandemic? Mental health and resilience amid the COVID-19 pandemic in the EU

Lead Panel Member: Eva Kaili (NA, EL)

Project duration: Started in December 2020; published in March 2022; presented when STOA met experts on 25 January 2022

Relevant to European Parliament committees: ENVI, COVI

Relevant European Parliament files: COVID-19 pandemic: Lessons learned and recommendations for the future

This report reviews the existing scientific evidence regarding the mental health of different population groups amid the COVID-19 pandemic in the EU and influential factors. Since the beginning of the pandemic, there has been extensive research on the psychosocial and mental health consequences, showing negative effects in the general population compared to before. There is also evidence of resilient responses as the pandemic progressed – that is, the maintenance or recovery of mental health.

However, these findings are limited to the first wave or shortly thereafter. No reliable conclusions regarding the mental health impact of COVID-19 policy responses – containment and support measures – are possible. The report identifies several risk factors, with a need for more research on protective factors. Finally, the study outlines a set of relevant policy options to address the mental health challenges during the COVID-19 pandemic and similar future situations.

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5.5 STOA study | Genome editing in humans: A survey of law, regulation and governance principles

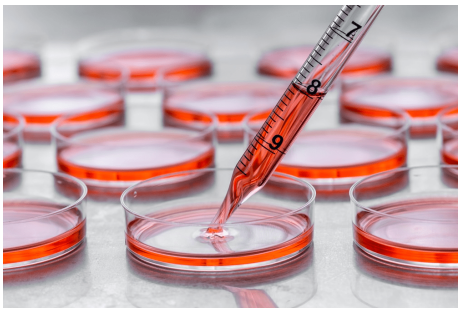
Lead Panel Member: Lina Gálvez Muñoz (S&D, ES)

Project duration: Started in November 2020; published in June 2022; presented to the STOA Panel on 7 April 2022

Relevant to European Parliament committees: ITRE, ENVI, JURI

Relevant European Parliament files: EU4HEALTH, European Health Data Space, Artificial Intelligence Act

Genome editing is a powerful new tool allowing precise additions, deletions and substitutions in the genome. The development of new approaches has made editing of the genome much more precise, efficient, flexible, and less expensive, relative to previous strategies. As with other medical advances, each such application comes with its own set of benefits, risks, ethical issues and societal implications, which may require new regulatory frameworks. Important questions raised with respect to genome editing include how to balance potential benefits against the risk of unintended harms; how to govern the use of these technologies, and how to incorporate societal values into salient clinical and policy considerations. This STOA study provides an overview of human genome editing applications and a review of the principles that guide the governance of genome editing in humans, at EU level and worldwide. The study also formulates a series of policy options targeted at basic research and to clinical applications, both somatic and germline.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5.6 STOA study | Genome-edited crops and 21st century food system challenges

Lead Panel Member: Lina Gálvez Muñoz (S&D, ES)

Project duration: Started in Feb 2020; published in July 2022; presented to the STOA Panel on 20 October 2022

Relevant to European Parliament committees: AGRI, ENVI, ITRE, IMCO, JURI

Relevant European Parliament files: New genomic techniques

Genome editing is the targeted alteration of a few DNA letters within the existing genetic blueprint of an organism. Genome-editing technology can be applied in a number of different ways. While the technology is highly accurate, off-targets can occur. Views on this new technology differ widely, and there is a clear need to discuss which type of regulatory governance is warranted for genome-edited crops.

5.7 STOA study | Fostering coherence in EU health research: Strengthening EU research for better health

Lead Panel Member: Lina Gálvez Muñoz (S&D, ES)

Project duration: Started in July 2021; published in October 2022; presented to the STOA Panel on 24 November 2022

Relevant to European Parliament committees: ITRE, ENVI

Relevant European Parliament files: EU4HEALTH, Pharmaceutical strategy for Europe, European Health Data Space, Horizon Europe

This study analyses the structure and organisation of public funding for EU health research, through literature review and consultations with experts. It identifies several systemic weaknesses. Funding instruments have increased in diversity and complexity over the last decade, with a shift in priority towards more application and implementation. However, clinical therapeutic studies lack continuity, and there are stark inequalities in infrastructure and workforce investment between Member States. The EU lags behind global leaders, due to a lack of coherent investment, long-term strategy, competitiveness and leadership in biomedical innovation.

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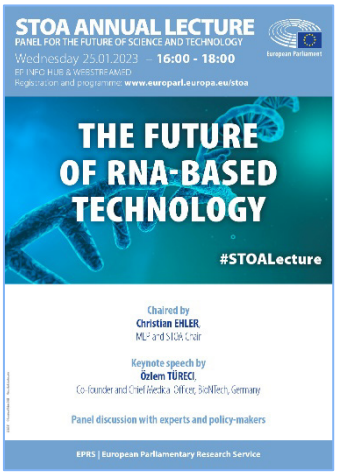
The report proposes a set of seven policy options to achieve increased coherence and translational throughput, from basic research to implementation, while considering environmental and economic challenges. These include strengthening cross-border collaboration, increasing programme synergies, and building stronger EU leadership, among other things through the appointment of an EU health adviser and the creation of an EU health institute for research coordination.

6. STOA annual lecture | The future of RNA-based technology



The STOA annual lecture traditionally looks at a major scientific topic of current relevance. This 20th edition was dedicated to exploring RNA-based technology, its achievements, its future promises, and what it means for Europe. STOA was honoured to have as its keynote lecturer Professor Özlem Türeci, co-founder and Chief Medical Officer of BioNTech.

From an acronym that some may remember having heard at school, RNA was recently catapulted to the status of **household** term by the COVID-19 pandemic. RNA-based COVID-19 vaccines have shown the efficacy and versatility of this technology, allowing not just for targeted development and fast production turnover, but also quick adaptability in the face of viral mutations. These vaccines are also in part an EU-success story, as one of the major COVID-19 vaccines was developed in Europe at BioNTech, whose basic research was assisted by EU funding. Applications of RNA-based technology are not limited to vaccines against viral infections. Earlier work on this technology was motivated in particular by the fight against cancer, an area in which it still holds much promise. Furthermore, continued developments, beyond what is currently done with vaccines, may see it having wider application, for example in the treatment of rare diseases.

In her keynote lecture, Professor Türeci covered the development of mRNA technology and the various challenges it faced, not just in terms of research and development but also in scaling up the industrial production of COVID-19 vaccines. She also discussed future prospects for the technology, highlighting how Europe is a leader in this field. This was followed by a panel discussion that included other experts, covering a wide range of topics ranging from the use of mRNA technology for vaccines against other diseases or in other therapeutic approaches, to barriers faced by innovative research, as was the case with mRNA, and issues surrounding clinical trials and funding and evaluation of research. The event also featured a lively question and answer session involving several MEPs and other audience members. The event closed with remarks by STOA Vice-Chair Ivars Ijabs (Renew, LV) and STOA Chair Christian Ehler (EPP, DE).

7. Presentations to the STOA Panel

During their meetings in Strasbourg plenary weeks, or in an online or hybrid format under the extraordinary measures adopted as a consequence of the global pandemic, the members of the STOA Panel usually hear presentations of the results of ongoing STOA projects and provide feedback and further guidance for completing the reports. STOA continued this activity undiminished under the emergency measures.

The following projects were presented to the STOA Panel during its meetings in 2022:

- The challenges of the upcoming technological storm: Blending AI, the internet of things, blockchain and 5G technologies
- Pollution and the spread of COVID-19 (study published in 2021)
- Regulatory divergences of the AI Act: Differences in public and private actors' obligations when using AI systems
- Genome editing in humans: A survey of law, regulation and governance principles
- Artificial intelligence and digital tools in workplace management and evaluation
- Splinternet: Managing the divergence and convergence of online content and services
- Auditing the quality of datasets used in algorithmic decision-making systems
- Governing data and AI for all: Models for sustainable and just data governance
- Genome edited crops and 21st century food systems challenges
- Fostering coherence in EU health research
- Social approach to the transition to smart cities (study published in 2023).

8. Networks and collaborations

8.1 STOA attendance at EPTA meetings

As a founding member of the European Parliamentary Technology Assessment network (EPTA), established in 1990, STOA plays an active part in its work, including the annual directors' and EPTA Council meetings.

EPTA Directors' Meeting, 9-10 May 2022, Karlsruhe, Germany

At the 2022 annual EPTA directors' meeting each EPTA member organisation presented a report of their activities, including information on new projects, milestones and plans for the future, as well as recent developments in technology assessment (TA). They also decided on the topic for the annual EPTA conference.

EPTA conference, 17 October 2022, Berlin, German Bundestag

The topic of 2022 EPTA conference was: Disruption in society – TA to the rescue?

What do leapfrog innovations, 9/11, a possible collapse of the Gulf Stream, and the COVID-19 pandemic have in common? The answer is: disruption. Using three case studies 'Critical infrastructures', 'Autonomous weapon systems' and 'Forests', the conference highlighted some of the many facets of disruption and explored the question of what contribution TA has made and can continue to make to the political and social handling of disruption.

8.2 Visit to the Joint Research Centre in Seville

On 18–20 July, three STOA Panel members visited the JRC facilities in Seville following an invitation by Director Mikel Landabaso. They talked with experts about their work on topics such as digitisation, the green transition, and the JRC's Sevilla process. During the three days, they also met with the mayor of Seville and other local politicians to talk about the future of the Cartuja Science and Technology Park and the planned JRC building, which will embody the spirit of the new European Bauhaus in Seville.

8.3 Delegation to the ELLIS Unit in Milan

Three members of the STOA Panel participated in a STOA delegation to the European Laboratory for Learning and Intelligent Systems (ELLIS) Unit in Milan on 23 and 24 May 2022. They met with researchers working on various fields of artificial intelligence (AI) including technical development, assessment techniques, industry collaboration, ethics and policy.

8.4 Visit to Brilliant Minds conference in Stockholm

One of the main missions of the STOA Panel is to help policy makers understand the societal impacts of new and emerging technologies and how to best support technological innovation. In this context, on 16-17 June 2022, a STOA delegation attended the Brilliant Minds conference in Stockholm where Members had the opportunity to exchange with high-level leaders in the creative industry from Sweden and all around the world.

9. Communication

9.1 Publications

STOA publishes studies and briefings relating to individual projects. STOA studies report on project methodologies and findings, and assess a number of options for policymakers to consider. Short, concise and to-the-point 'options briefs' summarise the policy options assessed in four pages.

In addition, since 2015, the Scientific Foresight Unit (STOA) has regularly published two-page 'at-a-glance' notes as EPRS publications. These are intended as awareness-raising and thought-provoking overviews of current and relevant techno-scientific trends, always in the form of 'What if ...?' questions. Each of these 'What-ifs' (see next table) concerns one trend and consists of three sections: trend description, exploration of the potential impacts and developments, and anticipatory law-making.

Title	Publication date
What if xenotransplantation was the answer to the donor organ shortage?	January 2022
What if we killed all microorganisms in our bodies?	February 2022
What if machines made fairer decisions than humans?	March 2022
What if AI regulation promoted innovation?	April 2022
What if we built cities on water?	June 2022
What if we sequenced all human genomes?	June 2022
What if microbial protein could help reverse climate change?	July 2022
What if AI could make the agri-food sector more resilient?	September 2022
What if everyone spoke the same language?	October 2022
What if a 'Trojan horse' strategy could help address antimicrobial resistance?	November 2022
What if quantum technologies were to revolutionise healthcare?	December 2022
What if we grew plants vertically?	December 2022

9.2 Other dissemination channels

STOA is increasingly using social media and other channels to communicate its activities. This includes STOA's own Twitter account (@EP_ScienceTech), and blog posts on the EPRS blog, which report on news, projects and events in an accessible manner. STOA also continues to produce regular podcasts, often based on its short awareness-raising publications ('What if ...?' notes), and videos. STOA events are live webstreamed and often accompanied by live tweeting from @EP_ScienceTech, enabling simultaneous interaction with stakeholders, experts and citizens.

2022 in numbers:

38	**23**	**22**
Publications	**Blog posts**	**Videos and podcasts**
(46 in 2021)	**(29 in 2021)**	**(18 in 2021)**
>2 800	**>75 150**	**>3 900**
Participants at 15 STOA events	**Views on the blog and website**	**Twitter followers**
(>3 800 in 2021)	**(>233 640 in 2021)**	**(>3 000 in 2021)**

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10. European Science-Media Hub

Science-Media Days

In May 2022, the European Science-Media Hub (ESMH) organised the workshop **'Promoting trust in science to combat misinformation', part of the Science-Media Days, organised by the ESMH in the Member States**. Hosted by the European Parliament Liaison Office (EPLO) in Spain (Madrid), the seminar focused on the growing concern about the negative effects of false news and deceptive narratives on the public, notably on the level of trust which communities have in science, and on media reporting on scientific subjects. The seminar was opened by the MEP and STOA Member Lina Gálvez Muñoz (S&D, Spain), other speakers were Cary Funk, Director of science and society research at Pew Research Center, Sonia Contera, Professor of Biological Physics at the University of Oxford and Senior Fellow at the Oxford Martin School and Green Templeton College, Patricia Férnandez de Lis, Director of *Materia*, *ElPáis*, and Pampa García Molina, Editor-in-chief at Agencia SINC and Director of the Science Media Centre Spain.

The Summer School

After a couple of years of COVID-19 related restrictions, the ESMH organised its big annual event – **the summer school for young science journalists on 8-11 June 2022**. Four days, 6 thematic sessions, 1 festival, 26 renowned speakers and 50 science journalists are just some figures from the event, which focused on the increasing challenge of climate reporting, offering an open forum for journalists to look at possible solutions and to continue doing quality science-based story-telling.

The presence of the STOA Chair, Christian Ehler (EPP, Germany), underlined once again the European Parliament's engagement on the climate challenge.

He also emphasised the importance of EU institutions working with the media, especially on complex topics such as climate change and academic freedom. The event was held in a hybrid format, to adapt to the new working conditions imposed by the pandemic. The summer school participants joined the Festival of the New European Bauhaus, organised by the European Commission.

Media monitoring

In Spring 2022, the European Science-Media Hub also launched a new project: the **'social media listening on selected scientific topics'**. The objective of the project is to follow the main narratives and discourse happening on social media on selected subjects of particular interest to ESMH/STOA. An external company is providing the ESMH with its expertise on social media listening, producing two kinds of reports: 1) horizon scanning/landscape analysis, providing an overview of how the selected topics are 'trending' on social media, and 2) in-depth analysis of selected topics/subtopics, offering a systematic quantitative and qualitative analysis of the main conversations on social media, including network and sentiment analysis, and other social media elements. These outputs provide valuable insights for the work of the European Parliament on topics including climate change, artificial intelligence, digital transition and EU research and data policy (for instance in relation to COVID-19).

While launching the new social media listening capacities, the ESMH continued with its regular media monitoring covering the traditional media. With the help of the EMM (the media monitor tool of JRC), the ESMH produced eight media reviews in 2022 – selecting and highlighting prominent science and technology news in its mainstream media and twitter feeds.

Communication and publications

The ESMH continued to publish weekly articles and interviews, featuring relevant topics relating to science, technology and communication. In order to raise awareness and promote STOA events more effectively, before each event an interview with the key speakers was conducted and promoted via social media.

In addition to this, a series of articles have been produced, in line with the STOA priorities, on the Green Deal, digitalisation and AI, and public health. A special focus has been the discussion about academic freedom, research integrity and public trust in science as well as different aspects of solid science communication.

All together, the ESMH published 21 articles and 18 interviews, among them an interview with Ukrainian mathematician **Professor Maryna Viazovska**, who in 2022 received the Fields Medal, a prestigious honour often described as the 'Nobel Prize of Mathematics', and an interview with **Professor Edvard Moser**, founding director of the Kavli Institute for Systems Neuroscience, who won the Nobel Prize in Physiology or Medicine in 2014.

In 2022 the ESMH started substantially and consistently upgrading its communication activities for STOA projects. The ideas is:

1. to plan a tailor-made communication concept for each STOA project from the outset;
2. to be more visual – to produce more audiovisual products that are easy to share on social media channels; and
3. to be more visible – to enhance internal (in the EP) and external dissemination of our communication products.

Ten videos were produced in 2022 promoting STOA events and studies. Cooperation with DG ITEC and DG COMM has been stepped up in order to improve the dissemination of the promotion materials internally and externally.

11. Implementation of the STOA budget

For the 2022 calendar year, the budget assigned by the European Parliament to the European Parliamentary Research Service (EPRS) earmarked up to €650 000 for use on STOA-related activities.

STOA's 2022 expertise budget was spent mainly on direct contracts, which require a simplified procedure and are quicker to implement. In total, 8 studies were launched with negotiated procedures with one candidate.

In 2022, STOA conducted 10 different projects, organised workshops and peer reviewed outsourced studies.

12. STOA administration

STOA is administered by the Scientific Foresight Unit (STOA) within the Directorate for Impact Assessment and Foresight, which itself forms part of the Directorate-General for Parliamentary Research Services (EPRS) of the Secretariat of the European Parliament. The STOA Unit consists of the STOA secretariat, the Scientific Foresight Service, and the European Science-Media Hub (ESMH). The STOA team members are listed below.

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Etienne Bassot (acting, from 1 July 2022 to 31 October 2022)
Anders Rasmussen (from 1 November 2022)

Director, Impact Assessment and Foresight
Wolfgang Hiller

Head of Scientific Foresight Unit (STOA)
Theo Karapiperis (until 30 April 2022)
Marcus Scheuren (from 1 May 2022)
Luisa Antunes
Philip Boucher (until 30 June 2022)
Andrés García Higuera
Nera Kuljanic
Jurgita Lekaviciute (from 16 August 2022)
Zsolt G. Pataki (until 15 July 2022)
António Vale
Vasco Guedes Ferreira (until 31 October 2022)

European Science-Media Hub (ESMH)
Svetla Tanova-Encke, Coordinator
Emilia Bandeira Morais
Vitalba Crivello
Carolien Nijenhuis

European Parliament Forum for Academic Freedom
Eszter Fay

Assistants
Michal Hubar
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STOA trainees

The STOA Unit actively uses the Schuman scholarship scheme to offer vocational training to high-potential recent university graduates. In addition, the unit accepts those seeking a traineeship as part of their studies or for the advancement of their careers. Each trainee works closely with an administrator and so becomes involved in most of the tasks and challenges they face: taking part in meetings with Members and other stakeholders, and organising workshops and studies on science and technology topics. They are also normally able to travel to the European Parliament in Strasbourg to attend one plenary part-session (not possible for most of 2020 or 2021). Trainees thus become acquainted with the whole EU policy-making process.

During 2022, the following trainees worked with STOA:

Laia Delgado Callico (Spain, October 2021 - February 2022)

Liliia Hrytsai (Poland, October 2021 - February 2022)

Evan McNamara (Ireland, October 2021 - February 2022)

Tobias Hoffmann (Germany, March 2022 - July 2022)

Michael Sicaud-Clyet (France, October 2022 - February 2023)

This Annual Report of the European Parliament's Panel for the Future of Science and Technology (STOA) for the year 2022 provides a comprehensive account of EP activity in promoting understanding of and research in the fields of science and technology assessment. The STOA Panel comprises 27 Members of the European Parliament (MEPs) representing 11 parliamentary committees.

This is a publication of the Scientific Foresight Unit (STOA)
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