SYMPOSIUM REPORT

Building a Scientific Narrative on Impact and Societal Value of Science

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SYMPOSIUM ORGANISED BY THE SCIENCE EUROPE SCIENTIFIC ADVISORY COMMITTEE

Introduction

The Symposium 'Building a Scientific Narrative on Impact and Societal Value of Science' was the first public initiative of the Science Europe Scientific Advisory Committee (SAC). It was organised to bring the results of a multidisciplinary reflection by the SAC on the societal impact of research to the attention of a science policy audience.

In order to convey the richness and diversity of science, the SAC approached the topic of research impact from the viewpoint of a range of scientific disciplines. It highlighted the importance of mutual trust between science and society and of balancing needs, expectations, and behaviours of both parties.

The SAC also made the case for a qualitative narrative through a story-telling approach, in which scientists emphasised the importance of presenting case studies and examples of research that created societal impact. In doing so, the Symposium facilitated a better understanding of the broad value that research brings to society through its many forms.

This event was also an opportunity for Science Europe to foster dialogue on the topic of research impact on society between its Member Organisations, members of its SAC, scientists, European Commission and European Parliament representatives, and other European research organisations. The format and structure of the Symposium addressed two sides of the same coin:

- The ways in which research can transform society
- The dynamic interactions that occur between society and researchers, which influence the evolution of the research ecosystem

Structure of the Symposium and Key Messages

The Symposium started with an opening session that launched the structuring ideas and the foundations for the SAC's narrative. It continued with three main sessions:

Session 1 Fundamental research: intrinsic value and long-term societal impact

Session 2 Translational research and co-creation of knowledge

Session 3 How to assess the societal value of science

The key messages that were explored during these sessions were:

- **Unexpected impact**: curiosity-driven and fundamental research bring long-term changes and transformative contributions to society.
- **Communicating science**: it is essential to convey the value of breakthrough research for its potential for long-term change and progress, beyond the short-term tangible results.
- **Dynamic impact**: co-creation of knowledge, innovation processes, societal challenges and use-oriented impact derive from translational processes in research, within a two-way interaction between researchers and society.
- **Trust**: the enhancement of dialogue and mutual exchange between societal actors and the scientific eco-system is key to societal impact, and needs increased co-design of research questions that are relevant to society.
- **Impact assessment**: research organisations should develop meaningful impact assessment policies and practises to give justice to the broad value of research to society.

Interaction with participants after each session helped focus on both the needs of the scientific community and the interests coming from the policy audience.

A final round-table discussion, chaired by Science Europe President Michael Matlosz, enriched the event and featured concluding remarks and possible common paths for action and future collaboration.

Opening Session
Laying the Foundations for a Narrative

Bonnie Wolff-Boenisch, Head of Research Affairs at Science Europe, chaired the opening session, and welcomed the participants to the very first SAC Symposium. She mentioned the importance of the SAC as the internal scientific advice mechanism of Science Europe, and how its work contributes to shaping a scientific narrative for what is an important topic to the association's members.

Introduction

Amanda Crowfoot, Director of Science Europe, stressed the political dimension of the value of science and the important expertise that the SAC's advice on the topic can bring to Science Europe members. She emphasised that curiosity-driven research is often expected to produce quick gains, but that there is a need to make the case for fundamental science, the impact of which is often only visible in the long term. She made a strong case for building trust between the wider public and research

actors, so that they can mutually understand and support each other. In this context, communicating science has to be a priority for policy-makers to help build and maintain trust in research.

Keynote

Julie Ward, Member of the European Parliament (MEP), stated in her keynote speech that science is an important tool to understand and shape the society we live in. She emphasised the importance of bringing science closer to people through innovative solutions. To tackle societal challenges, science should not be seen as a separate entity, but as an integral part of society. Citizens and politicians must be able to rely on the value of science thanks to a strong, common narrative. She also advocated for the interplay between fundamental and applied research, in order to nurture a research ecosystem that is able to facilitate an 'out of the box' way of thinking.

Her approach emphasised the importance of the arts (including the humanities), which she considered as crucial disciplines that should be added to STEM fields, advocating instead for STEAM (Science, Technology, Engineering, Arts, and Mathematics).

Welcome

Igor Emri, Director of the Centre for Experimental Mechanics at the University of Ljubljana and Vice-Chair of the SAC, echoed the importance of strengthening the role of science in society by using the example of translational research. The goal of translational research is to combine disciplines, resources, expertise, and techniques in order to empower people, enrich them culturally, and to build a sustainable knowledge-based society. Translational research requires cross-disciplinary, cross-sectoral, and cross-border co-operation. All products and technologies are forms of clever integration of the existing knowledge acquired through basic research.

Setting the Scence

Ola Erstad, Professor and Head of the Department of Education at Oslo University and Chair of the SAC, described how the impact of science has become a very important topic in many European countries for funding agencies, public and private organisations, and policy makers, due to their involvement in the debate about the return on investment in science. He explained that there are different conceptions of societal impact and value of science, and he stressed the importance that excellent fundamental research has for society.

These considerations were put forward to introduce the issue of the different approaches that exist to measure the impact of research on society. Quantitative indicators have been used for a long time already and new qualitative approaches have emerged in recent years. The differences across scientific disciplines play a crucial role in the understanding of the nature of impact itself and help figure out, according to Erstad, that the interpretation of impact as a linear process is too often erroneous. On the contrary, impact is much more dynamic and is often the result of productive interactions between research and society, explained Erstad. The political discourse needs to promote, therefore, a broader concept of impact reflecting this complex relationship.

Symposium Overview and Objectives

Mariachiara Esposito, Senior Scientific Officer at Science Europe, gave an overview of the concept, format, and expectations of the Symposium. She stressed that a narrative is something to build over time and thus the event was the starting point for an evolving debate. The Symposium's objective was, as a matter of fact, to clarify what are the most important factors that shape the relationship between research, policy, and society and how they influence the context in which research impact occurs or develops over time.

Esposito explained that looking into this is key to understanding the challenges and responsibilities shared by the different actors involved in impact policies and practises. She referred to excellence as a principle that needs to be promoted and supported in research at all levels, being driven by values, as well as by curiosity and imagination. Challenge-oriented research cannot be disconnected from curiosity-driven research, as much as fundamental and applied research interact alongside a continuum.

Session 1

Fundamental Research: Intrinsic Value and Long-term Societal Impact

The ideas explored in the first session focused on the intrinsic value of research and its inner capacity of advancing discoveries, progress, and the understanding of the world. Discussions focused on the assumption that scientific research may not produce immediate 'useful' results (the risk of 'short-termism'), and that pushing scientific frontiers for the 'unknown unknowns' to emerge helps society answer future questions and unforeseen problems.

Presentations

Susanne Siebentritt, Physics Professor and Head of the Laboratory for Photovoltaics at the University of Luxembourg and Vice-Chair of the SAC, chaired this session and opened the debate by stressing that research has an intrinsic value due to its capacity to generate new knowledge. She emphasised how much easier is to understand the notion of economic impact that is more directly connected to applied science, than it is to make the case for fundamental science and its overall value. She focused on the link between some of the biggest evolutions in society and the scientific endeavours that originated them, mentioning examples such as the discovery of gravitational waves and the Higgs particle.

She also recalled some of the skills learnt by students who carry out research, including how to think critically, pose questions, solve problems, use creativity, and use their knowledge for a purpose that could benefit society. Science does not only have such impact through the process of training a skilled workforce; it has a long-term impact in changing the ways in which society advances its understanding of the world. She mentioned a few findings driven from fundamental research which helped societal progress: Hertz's electromagnetic waves; Einstein's general theory of relativity; Drude's investigation of the reflexion of metals; and Bardeen, Brattain, and Shockley's work on semiconductor contacts. Without this fundamental research there would be no radio communication, no transparent touchscreen, no integrated circuits, processors or memory chips, and no GPS.

Long-term impacts led to unexpected effects such as the discovery of DNA in fundamental biology; the number theory and the laser, which was initially thought of as 'a solution without a problem'. "We do not even know the questions of tomorrow", stressed Siebentritt. "To allow answers to future problems, we need to do research beyond today's challenges."

Keynote

Liviu Stirbat, Deputy Head of Unit Evaluation at the Directorate-General for Research and Innovation of the European Commission (EC), explained in his keynote that a general objective of the EC is to contribute to building a society and an economy that is both based on knowledge and innovation. To do so, the implementation of the Horizon 2020 strategy and the development of the European Research Area are crucial.

The overall objectives of Horizon 2020 and the strategy adopted by the EC are to assess impact, look at different types of impact notions and indicators, including socio-economic and innovative approaches to job creation, structuring, network or leverage effects, as well as at promoting scientific and technological excellence. He emphasised the following aspects and figures:

- The European Research Council (ERC) is a good example of the impact of research in Europe. Seven percent of ERC publications are in the top one percent of most highly cited publications. More than 70% of projects evaluated make scientific breakthroughs of major advances, and 30% have a very positive impact on the careers of researchers. Experts estimate that at least 75% of ERC research outputs will have an impact on the economy or society in the medium and long term.

- In the context of the impact assessment of Horizon 2020, the EC takes into account: the difficulty of measuring impact (problem of attribution, intended/unintended effects, effects dispersed throughout economy, and so on); the fact that research takes time to produce results, outcomes, and impacts, and that it is difficult to assess (potential) impact from recently started and ongoing projects; and the fact that EU Framework Programmes accounted for less than 10% of total public research and development expenditures in Europe and that there is no comparable benchmark for them. For the future, the need to work with stakeholders to define impact categories and the respective timespan for evaluating research projects should be better taken into account.

Stirbat ended by quoting Einstein: “Everything that can be counted does not necessarily count; everything that counts cannot necessarily be counted.”

Case studies on Fundamental Research

Unexpected Impact of Acoustics on European Cultural Identity

Marc Leman, Professor in Systematic Musicology at Ghent University, presented the case study ‘Unexpected Impact of Acoustics on European Cultural Identity’.

He explained how 3D audio systems were derived from a mathematical curiosity in the 1980s, which helped develop and bring new applications into the arts and creative industries (music, multimedia, and sound design). 3D audio has been gradually embedded in a European tradition of art-tech innovation emerging from what he called the ‘playground’, fostered by electro-acoustic music, such as spatialisation with loudspeaker orchestras in the 1960s; computer music digital sound synthesis in the 1980s; musical content technologies and e-commerce; up to today’s scientific interests like in the field of embodied interactions with music (motion capture, body area networks, Internet of Things technology[1]). All this emerged from the context of people ‘playing around’, wanting to have fun, and experiment.

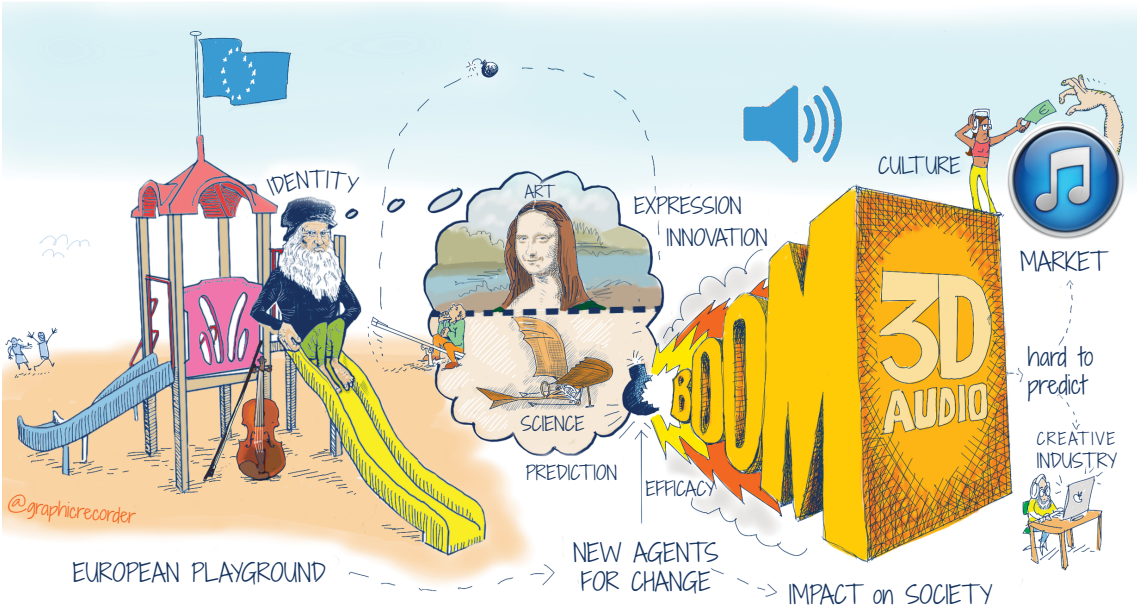

Figure 1 Illustration of case study ‘Unexpected Impact of Acoustics on European Cultural Identity’

This technique created an impact on society that was not possible to predict and that could only deploy its potential once different aspects merged. As, in order to make sense of 3D audio, one needs art and artistic content. There is no point in developing a CD player if artists do not record their music on CDs. 3D audio has made it possible, over time and in an unpredicted manner, to innovate the way in which artists spatialise their expression with sound and popularise it to attract large audiences.

This has had a sizeable impact on society and the economy, influencing the development of creative industries and the market linked to new concert halls, new home audio installations, sounds for electronic cars, and so on. The spatial sounds became a natural part of the habits of people in society and became part of new cultural traditions and identities, linked to the new forms of artistic expressions, allowing continuous exploration of the human interaction with multimedia machines.

Early Research on Privacy Made the Internet of Things Possible: the Case of Smart Meters

Simone Fischer-Hübner, Professor in Computer Science at Karlstad University, presented the case study 'Early Research on Privacy Made the Internet of Things Possible – the Case of Smart Meters.'

Fischer-Hübner illustrated the route from 1979 to the present day, from curiosity-driven research on privacy to societal impact. She informed the audience about the importance of the influence of Privacy Enhancing Technologies (PETs) research on 'Privacy by Design' (PbD) and the General Data Protection Regulation (GDPR).

She explained that PETs allow for systems that enforce privacy. One approach is 'Data Minimisation', which can for instance facilitate useful information being obtained from data without access to that data or without knowledge of its origin. It is based on the concept of collecting and/or sharing a minimal amount of data 'by design', including being able to forget data upon request. Another important application of the technology is the capability for transparency while ensuring privacy-friendly approaches and services.

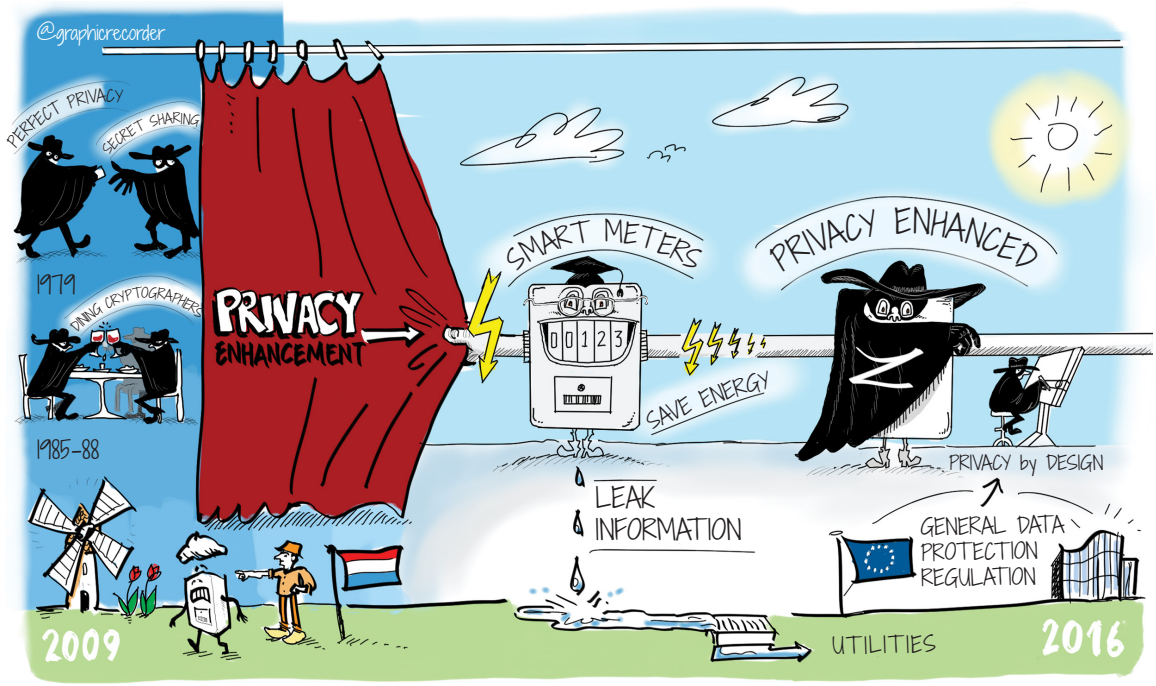

Figure 2 Illustration of case study 'Early Research on Privacy Made the Internet of Things Possible – the Case of Smart Meters'

So-called smart metering is a good example of the technology that also makes it possible to save energy, in line with EU goals to reduce emissions. Smart meters optimise energy use in reaction to a household's energy use patterns. However, issues of privacy have arisen because smart meters 'leak' information about individual households' habits and life-style to utility companies. New smart meter projects balance privacy and energy saving by requiring PETs.

Research on privacy, its findings, and derived technologies have also had a strong influence on different aspects of EU regulations related to data protection rights, consent, trust and accountability.[2]

Discussion

Key messages guiding the debate during this session:

- **Unexpected impact**: curiosity-driven and fundamental research bring long-term changes and transformative contributions to society.
- **Communicating science**: it is essential to convey the value of breakthrough research for its potential of long-term change and progress, beyond the short-term tangible results.

Sven Stafström, Director General of the Swedish Research Council and rapporteur for this session, started by commenting on the contribution from Liviu Stirbat and expressing some concern about the approach and indicators so far used by the EC to deal with impact. He mentioned the importance of using case studies as a good way to assess impact and urged the EC to work together with stakeholders on a better understanding of impact. He reinforced the connection between impact, excellence, and openness in terms of the importance of explaining societal value of research through a wider notion where impact, excellence, and quality of research are linked together.

He highlighted two important variables: timescale and level of involvement. Regarding the timescale, he reminded the audience that impact is far from a linear process. Ideas become knowledge and can eventually have an impact as a result of many different factors interacting with each other. In reference to the level of involvement, impact requires much more than the scientific community. The involvement of other stakeholders, within a more open environment to business and societal actors, is fundamental in order to create a dynamic impact between research and society.

The following debate with participants highlighted a number of points:

- The use of patents to measure impact risks to entail a too simplistic notion of impact.
- Ideas and experiments whose future effects cannot be predicted, are a fundamental part of the research process.
- The importance of wider teams of experts coming together in a common environment shows how the distinction between fundamental and applied research is much less relevant than before.

Session 2
Translational Research and Co-creation of Knowledge: Shaping Mutual Trust between Scientists and Society

The second session explored the changing landscape in research practises, where researchers are increasingly experiencing the realities of working in teams, and co-operating with more diversified groups involving different disciplines and/or members of society, such as citizens, businesses, and other societal groups who contribute to identifying research questions and problems.

Presentations

Igor Emri, Chair of this session, introduced the concept of translational research, explaining that it has gradually become synonymous with cross-disciplinary and cross-sectoral exchange, and co-creation of new knowledge. He then gave an overview of the implications of translational research on academic practices and ways of working, highlighting that it requires the reorganisation of scientific teams, as well as stronger cross-border co-operation in academia.

Emri also emphasised the notion of perpetual and circular knowledge exchange, which can only happen thanks to the creation of platforms where researchers and socio-economic stakeholders can meet and work together. Connected to this, he gave his perspective on the notion of innovation communities where the potential of translational research can be fully deployed across environments where the best existing knowledge is nurtured and integrated, and where new practises of knowledge exchange help the application and use of the new knowledge and its related values.

Keynote

In his keynote, **Mark Ferguson**, Chief Scientific Adviser to the Government of Ireland and Director General of Science Foundation Ireland, addressed the issue of new trends in science. He explained how science has been democratised over the past decade, and is now accessible to more and more people. Basic and applied research, as well as curiosity-driven and use-inspired research, are subject to complex interactions. He also emphasised that people tend to describe science in the way they think it is important and that "there has never been more money for science than now, but with that comes accountability. It is a time of change, excitement and innovative collaboration."

In Ireland, the Applied and Basic Combined (ABC) scholarship model invites people from different domains to work together on a problem from the beginning. The aim is to develop a set of world-leading, large-scale research centres that will provide major economic impact for the country.

To give an example of how research needs to be funded in order to fuel the economy, he mentioned that in 2016, Google invested more money in model computing than all other funders in the world. In his view, this shows how the company aims to achieve, maintain, and enhance research excellence, as to foster a culture of leadership and industrial competitiveness.

Impact, in his view, is a "demonstrable contribution that excellent research makes to the economy and society." The criteria to review impact are quality, credibility, and relevance of the impact statement, including the likelihood, scale, and value of societal and economic effects as a result of the proposed research.[3]

Ferguson highlighted that the journey from input to impact is not necessarily linear. It usually goes from inputs through activities, outputs and outcomes to achieve an impact. Based on this vision, peer review is considered successful for identifying what is excellent but it is not sufficient to determine if excellent research may bring about actual societal impact.

He also gave a precise overview on how impact is assessed at Science Foundation Ireland in ex-ante evaluation. Scientifically excellent projects are shortlisted as a first step in the evaluation process. A separate impact panel then assesses the shortlisted projects. The impact panel does not only consist of members of academia, but also of representatives from industry and business. Funding agencies need to be as entrepreneurial and as fast-moving as the communities they serve, he concluded.

The iWater Project: Research and Society Co-designing a Monitoring System for Cities' Water Supply

Georgia Destouni, Professor of Hydrology at Stockholm University, presented the example of the iWater Project, a pilot case of Stockholm's cloud-based water sensor system that allows massive real-time water quality monitoring.[4] The narrative behind this project shows a collaborative effort between society and researchers that aligns curiosity-driven research with a specific societal challenge. Focusing on the quality of the water supply through the entire water life cycle helped mobilising research actors engaged with the study of hydrological systems and environmental factors, as well as companies with advanced intelligent monitoring technologies, sensors, and indicators.

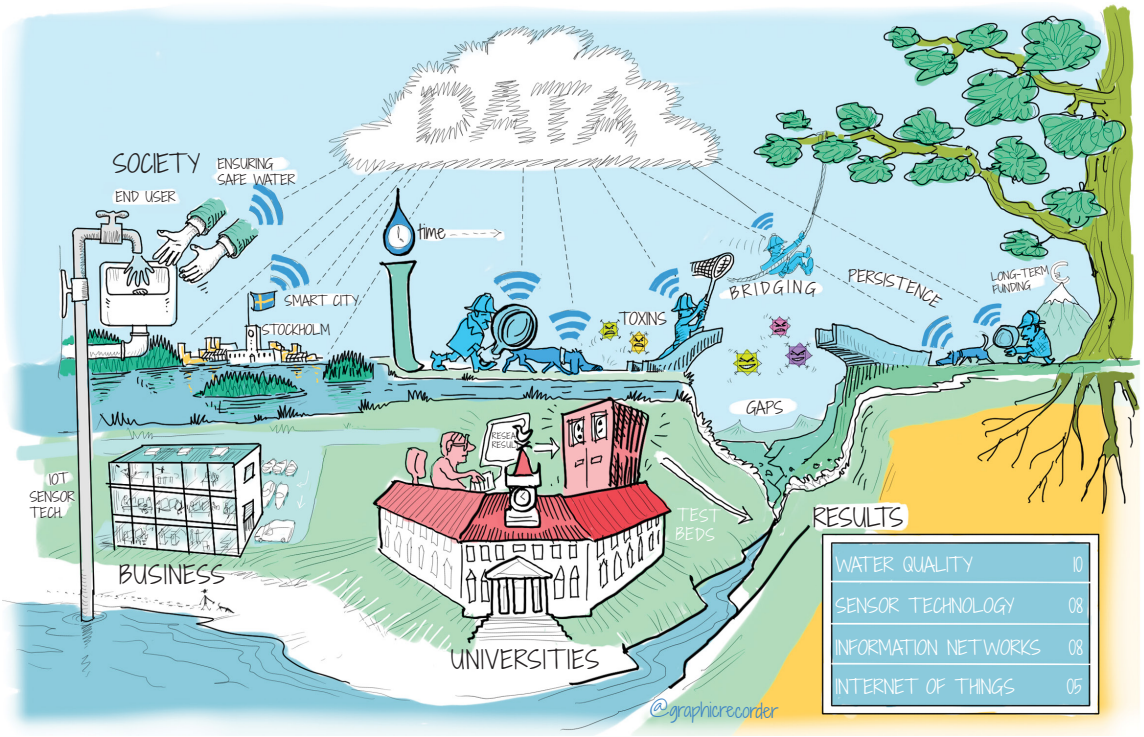

Figure 3 Illustration of case study 'The iWater Project: Research and Society Co-designing a Monitoring System for Cities' Water Supply'

The community of relevant actors, including universities, stakeholders, companies, and local authorities co-designed a new water supply system aimed to increase sustainability in the long run. To do so, the collaboration was crucial even during difficult phases, characterised by delays in result and low-funding periods. The result was a successful new system for Stockholm that improved the control over the quality of the water supply in the city and that was easy to scale up in other cities thanks to the project's emphasis on mutual learning and exchanging of different results.

Nano-encapsulation: a Method for Maximising Health Benefits from Medicinal Plants and Agro-food By-products

Eduardo Rosa, Professor of Agronomy at the University of Trás-os-Montes and Alto Douro in Portugal, then described the case of 'nano-encapsulation',[5] a method for maximising health benefits from medicinal plants and agro-food by-products.

He explained that medicinal plants, and most agro-food by-products, are valuable sources of biologically active molecules (for example polyphenols, phenolic acids, and terpenes), which could be used as nutraceuticals. However, most of their proven *in vitro* effects are not achieved *in vivo* because of these molecules' low *in vivo* bio-availability. A number of their characteristics constitute limitations to their nutraceutical and pharmaceutical exploitation. The potential benefits of nano-encapsulation to address these limitations were identified through knowledge sharing amongst scientists and users

in industry and the agro-food system. Nano-encapsulation, for example, protects products from oxidation. It increases bioactive resistance under acidic and bile-salt conditions and improves bio-availability and biological activity. The exploitation of these research results have proven to be very promising in helping the reduction of cancer mortality as well as the decrease in costs for healthcare and the social system.

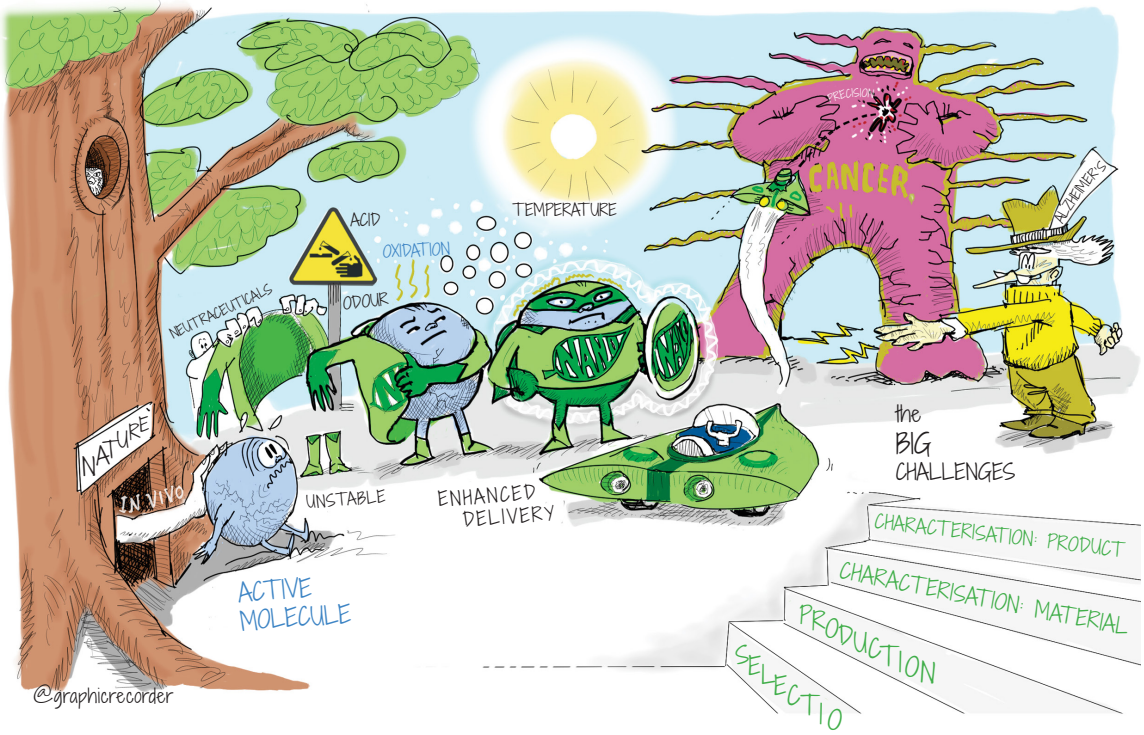

Figure 4 Illustration of case study 'Nano-encapsulation: a Method for Maximising Health Benefits from Medicinal Plants and Agro-food By-products'

Discussion

Key messages guiding the debate during this session:

- **Dynamic impact**: co-creation of knowledge, innovation processes, societal challenges, and use-oriented impact derive from translational processes in research, within a two-way interaction between researchers and society.
- **Trust**: enhancing a dialogue and mutual exchange between societal actors and the scientific ecosystem is key for societal impact. The co-design of research questions that are relevant to society is a key part of this process.

Wolfgang Ertmer, Vice-President of the German Research Foundation and rapporteur for this session, used the two case studies to emphasise the importance of diversity and excellence in science. He stressed that these examples of societal driven research showed that, when high quality is the criterion pursued by scientists, this can be exploited by society at many levels.

He also stressed that different kinds of research are needed, from curiosity-driven to more applied research, and can co-exist with excellence as the primary objective for the research system. He closed by stating that, from fundamental research to applied research and industrial research, science has a tremendous impact on society. Everything used in everyday life comes from science, which is also key for culture, education, wellbeing, the economy, and other aspects of life.

The subsequent debate with participants focused on the following points:

- The impact of applied research is often self-evident. In fields where there is no direct implication for society, there is a stronger need to rely on excellence.
- Excellence is evaluated through the peer review of scientists and this continues to be a crucial dimension for funding agencies who rely on this process.
- There is a need to continue funding various types of research that are all needed by society.
- A key question is to anticipate what is not known and support efforts towards the creation of future new knowledge.
- A crucial challenge for politicians is to look at fundamental research as, often, the preliminary step to challenge-oriented research and impact.

Session 3
How to Assess the Societal Value of Science?

The key question addressed by the speakers throughout the third session was: can the impact and value of science be captured and measured accurately, and if so, how? The main narrative, derived from the session's presentations, referred to the many constraints related to policies and practises of impact assessment. It aimed to facilitate the understanding of the pressures and variables that influence the environments in which impact assessment takes place. In so doing, it tackled the need to recognise, in the context of such complexity, that impact assessment criteria and methods should not solely determine funding decisions. Additionally, they should always be based on a careful analysis of the timescale of societal impact.

Presentations

Mireille Chiroleu-Assouline, Professor in Economics at the University of Paris 1 Panthéon-Sorbonne, chaired this session. She opened by stating that, when trying to look at the best mix of indicators and methods for impact assessment, there is a need to account for externalities. Externalities, in this context, represent the costs or benefits (affecting a party who did not choose to incur those costs or benefits) that arise when trying to capture the whole value of the research under evaluation. She explained that there can be different kinds of external effects which were neither predicted nor expected before the research was undertaken. Some of these external and unexpected effects can be embodied in the additional knowledge produced by the research and they become useful and valuable at a later stage or for a purpose which was not necessarily foreseen.

Chiroleu-Assouline highlighted that externalities lead to what economists call the 'option value': the value that is given to the fact that potential benefits could appear in the future. The crucial attribute of these potential results is that nobody knows what they will be, how large they will be, and when they will appear. But these results could well be lost if a project or another research activity is not funded. Maximising the 'option value' of funded research, and minimising the value loss of non-funded research, requires a deep understanding of how the process of generating value works.

For these reasons, it is important to develop models that take into account knowledge propagation and percolation, considering that any short-term approach would miss these important aspects. Qualitative

and multi-dimensional approaches are then necessary to counterbalance the more controversial quantitative assessments merely focused on the monetary value of science.

Position Statement on the Societal Value of Science by the Science Europe Working Group on Research Policy and Programme Evaluation

Jordi Molas-Gallart, representing the Spanish National Research Council and Chair of the Science Europe Working Group (WG) on Research Policy and Programme Evaluation, explained that the interest of the Working Group on the impact topic emerged from the increasing concern expressed by Science Europe Member Organisations to have a discussion on impact practises and policies, to better understand researchers' and funders' needs and challenges.

He summarised the key points, identified by the WG, that are to be taken into account when dealing with impact assessment:

- The need to be alert about concepts and definitions: they circumscribe what matters and how you look at it. The notion of impact and its dominant narratives in policy environments are still very much influenced by linear thinking. Research is a collaborative system that generates a variety of effects. Societal outcomes are the effect of collaboration and the combination of research results with many other inputs. They take time. Impact assessment is about understanding those pathways and processes that bring about societal impact, rather than the monetary value of science, and it accordingly needs a non-linear approach.

- The need to be more explicit about the normative value judgments in evaluation: the word 'value' carries implication. There is a need to think about value when discussing impact, in order to realise that it is about the contributions of science to society: inducing the value that science and knowledge generate for future generations. The point is to consider how research can broaden the options available to society. Therefore the question to explore becomes: How do we value options that will open up in the future but are not recognisable today? This question determined the core concept of the Position Statement on impact that Science Europe has developed: value will be deemed to accrue when research has a direct or indirect effect. This notion of value, which includes societal impact, takes into account that there are different understandings of what is valuable in each society.

- The need to recognise that not everything that is valuable is directly observable: in the practice of assessing the impact or value of research we should not be driven by the availability of indicators. Methodological diversity is essential to capture the complexity of the issues and avoid narrow descriptions of the contribution of science to society.

A final word of caution from Molas-Gallart was directed to research managers and staff who deal with impact assessment practises, as well as to research policy makers: he advised them to be careful about the result of any assessment. Impact assessments should not be the only determinant of research funding decisions. Any assessment of the value and impact of science on society has to be used with care because it can also generate unintended effects on research activities and practises.

These ideas have inspired the key principles emphasised in the Science Europe Position Statement, 'On a New Vision for More Meaningful Research Impact Assessment'. This paper identifies a number of key actions for policy makers and research organisations to improve impact assessment policies and practises, and advocates for the notion of value of research.

Tracing the Generation of Value: the Case of ASIRPA

Pierre-Benoit Joly from the French National Institute for Agricultural Research (INRA), presented the ASIRPA[6] evaluation tool, which proposes a methodology for ex-post impact assessment that is based on case studies and pays attention to the diversity of values generated by research.

The objectives of this tool are to provide an account for the impact of the research carried out at INRA, and to learn about impact generation mechanisms. The first key aspect of ASIRPA is to try to understand the pathways from knowledge to impact. These are complex pathways with many interactions. ASIRPA carries out an analysis of the processes and the context in which research organisations operate to identify the different groups and actors those involved in research processes and their productive interactions. The second key pillar of ASIRPA is the choice of indicators for the different dimensions of impact (for example on health and on the economy). Each indicator needs to allow comparability and take into account different values of research. In that way it is possible to produce qualitative standardised measures of impact. Joly explained that among the lessons learnt when developing ASIRPA, was the one that impact can have a highly skewed distribution. A very small set of cases is responsible for a large part of the impact. This means that funders and evaluators need to be careful with decisions based on ex-ante evaluation of impact. ASIRPA found that the average time lag for impact that comes from applied research was 19.9 years. For fundamental research, much longer time lags are needed.

INRA sees impact assessment models (such as the ASIRPA case) as tools for strategic intelligence. But impact assessment also matters for accountability. Impact assessment can serve both strategic decision-making and accountability purposes only when multiple measures are taken into account, to fit the diverse goals and contributions of the research being evaluated. Impact assessment is not an easy endeavour, but when done right it can contribute to the improvement of public dialogue and mutual trust between science and society.

Discussion

Key message inspiring this session's discussion:

- **Impact assessment**: Research organisations should develop meaningful impact assessment policies and practises to give justice to the broad value that research brings to society.

Andres Koppel, Head of the Estonian Research Council and rapporteur for this session, commented on the two previous speakers' presentations. He stressed how, even for the Estonian Council, which is one of the smallest ones in Europe, there is a similar problem in answering the question 'why invest in research?'

For Koppel, when trying to answer this question in the framework of the debate about societal impact of research, the key element to think about is whether we have the right tools to interpret and evaluate impact. In his opinion, funders and policy makers need to develop more precise tools to assess impact, as well as to convey the right messages about the values carried by research and communicate them well. He also stressed that impact assessment policies need to bring in different players together. Revisiting instruments and strategies is crucial.

He strongly agreed with the idea that the use of ex-ante evaluations for allocating funds should be implemented very carefully. He expressed the importance of stimulating discussion on this topic and recognised a great value to Science Europe as an adequate and useful platform for this kind of exchange. For these reasons, he also emphasised the importance of a Science Europe Position Statement on this topic.[7]

Round-table Discussion

Understanding and Communicating the Value of Research: Building Trust and Sharing Responsibilities

The closing round-table discussion highlighted that both policy makers and research organisations have a role in building mutual trust. They should explore co-operative mechanisms to improve research ecosystems and help researchers and societal actors to work together effectively.

Michael Matlosz, President of Science Europe, highlighted that societal value and the impact of research have been key priorities for Science Europe over the past year. The narrative that the association is developing on the impact of research on society – which is supported by the case studies presented at the Symposium – needs to be translated into concrete policies, stressed Matlosz.

Understanding and Communicating the Value of Research: Building Trust and Sharing Responsibilities

Keith Sequeira, Senior Adviser at the Cabinet of Carlos Moedas, European Commissioner for Research, Science and Innovation, addressed the link between impact and data, which constitutes the framework context in which the EC is working to develop a new approach to impact. He recalled that Horizon 2020 is managed electronically; therefore, there is a large amount of data to deal with, but the question for them remains 'what to do with these data?'

When looking at the key values that have inspired Moedas' discourse on the Framework Programme's (FP) guiding principles – excellence, openness, and impact – Sequeira referred to the importance of translating these principles, as well as the expenditure foreseen in the FP, into three main stages that have defined the impact narrative:

- In stage 1, the EC had almost no data on impact and decisions on how resources should be spent were almost exclusively taken on a political basis.

- In stage 2, performance was considered in terms of Key Performance Indicators, such as on reputations of publications. But data were often not very timely, hence they could hardly influence decisions or help identify what kind of research was needed in order to drive excellence and tackle challenges.

- In stage 3, which concerns the future of the FP, the intention of the EC is to improve the use of big data for a broader strategy to capture, in real time, different sets of impact. He emphasised that the most important impacts are the unexpected ones. The Open Science agenda will play a key role in defining research priorities and needs and, in this context, the important support provided by Science Europe on the topic was welcomed.

Elena Celledoni, Professor of Mathematics at the Norwegian University of Science and Technology in Trondheim, stressed that funding agencies have a huge responsibility in rethinking the balance between the different practises of research, and that education has a crucial role to play. Education can help creating highly skilled researchers and scholars with increasingly better skills to communicate research to society and to engage with innovation processes and societal impact.

The rapporteurs from the previous three sessions – **Sven Stafström**, **Wolfgang Ertmer** and **Andres Koppel** – agreed entirely with this last remark about education and communication in science. They also emphasised the need to make a stronger case for the variety of societal impact of research, for its different forms, and for the responsibility, at national level, to recognise the implications of that

diversity for society. They called for the need to improve policies to make them capable of supporting quality research and excellence, as well as for the need to recognise the value of research as a public good that cannot be funded exclusively based on economic considerations or tangible benefits.

Final Remarks

Matlosz closed the Symposium by emphasising how essential it is to improve the interaction between science and policy makers, as far as decisions on the topic of research impact on society are concerned. He recalled that, while there is agreement that research is a universal public good, EU Member States still have to struggle with several boundaries that limit the deployment of science as an international activity. He closed by launching a call for increased commitment for a research environment without borders.

Conclusion

The Symposium proved to be a successful and useful opportunity for stakeholders from different organisations and backgrounds to interact and exchange views on the topic of societal impact of research. Participants agreed in particular on the need to further explore key messages and narratives that guided the discussions during the day, and to make more use of common platforms where science and policy perspectives interact towards common goals.

The Symposium highlighted that disciplinary diversity and scientific richness, in addition to the challenges faced by research funders in deciding on the right mix of fundamental and applied research, pose many questions to researchers, practitioners, and decision makers in different ways. A good balance to approach impact assessment policies needs to look at – and combine – excellence and impact in a holistic framework.

Based on discussions during the day, participants seemed to agree on three main objectives to orient the work towards further consolidating a common narrative on research impact and on its implications for the impact agenda of policy makers:

- Identify, communicate, and reward the impact produced by research, by taking into account the broader value that research activities bring to society.
- Embrace the notion of 'non-linearity' in order to better capture impact and using datasets in an intelligent way. This makes it possible to focus on impact pathways between research and the values that society attributes to scientific knowledge.
- Accept the impossibility of pre-determining unexpected impact and effects that will only occur after a long time span, and urge for the right balance to let both the predefined objectives of research and its actual outcomes emerge.

Next Steps

The topic remains of high importance to Science Europe and the SAC. The groundwork laid by the Symposium will be important for future activities, including collecting new scientific case studies.

The outcomes of the Symposium have already been used as input for the recently published Science Europe Position Statement on Impact Assessment (http://scieur.org/impact-pos), which demonstrates to policy makers the need to adopt a broad definition of impact and to include value of research as a key notion.

Notes and References

1. For more information on embodied music cognition and Marc Leman's field of study see: https://mitpress.mit.edu/books/embodied-music-cognition-and-mediation-technology
2. For more information, and a more comprehensive view, on the impact of PETs on European policies, challenges and opportunities, see the ENISA (European Union Agency for Network and Information Security) study: https://www.enisa.europa.eu/publications/pat-study
3. In the Irish model, all impact can be described along six pillars and three cross-cutting themes. The pillars are economy; health and wellbeing; natural capital and built environment; policy and public services; future capacity and skills; and societal and international aspects. The three cross-cutting themes are creating new products, processes, policies or behaviours; improving efficiency and efficacy of existing practice; and research to improve resilience or sustainability.
4. For further reading on water quality monitoring systems: http://www.wmo.int/pages/prog/hwrp/publications/Technical_report_series/TR-No3water_quality_monitoring_systems.pdf
5. Nano-encapsulation is the coating of various substances within another material at sizes on the nanoscale. Nano-encapsulation remains to be the one of the most promising technologies having the feasibility to entrap bioactive compounds. Nano-encapsulation of bioactive compounds has versatile advantages for targeted site-specific delivery and efficient absorption through cells. See https://link.springer.com/article/10.1007/s11947-012-0944-0
6. Analyse socio-économique des impacts de la recherche publique agronomique (Evaluating impact of public agricultural research): https://ideas.repec.org/p/gbl/wpaper/2015-04.html
7. The Science Europe Position Statement 'On a New Vision for More Meaningful Research Impact Assessment' was released in July 2017: http://scieur.org/impact-pos

Annex

Thursday 17 November 2016 // Metropole Hotel, Brussels

13.00–13.30 **Lunch-time Discussion with Scientists**

The Humand Mind, Graphene and Black Holes: What Do They Have in Common?

- **Silke Britzen**, Max Planck Institute for Radio Astronomy, Germany
- **Vincenzo Palermo**, National Research Council, Italy
- **Michael Wheeler**, Stirling University, United Kingdom

13.30–14.15 **Laying the Foundations for a Narrative**

Moderator **Bonnie Wolff-Boenisch**, Head of Research Affairs at Science Europe

Introduction
Amanda Crowfoot, Director of Science Europe

Keynote
Julie Ward, Member of the European Parliament

Welcome
Igor Emri, Interim Chair of the Science Europe Scientific Advisory Committee, University of Ljubljana, Slovenia

Setting the Scene
Ola Erstad, Member of the Science Europe Scientific Advisory Committee, Oslo University, Norway

Symposium Overview and Objectives
Mariachiara Esposito, Senior Scientific Officer at Science Europe

14.15–15.15 **Fundamental Research: Intrinsic Value and Long-term Societal Impact**

Moderator **Susanne Siebentritt**, Vice-Chair of the Science Europe Scientific Advisory Committee, University of Luxembourg

Keynote
Liviu Stirbat, DG Research and Innovation, European Commission

Unexpected Impact of Acoustics on European Cultural Identity
Marc Leman, Member of the Science Europe Scientific Advisory Committee, Ghent University, Belgium

Early Research on Privacy Made the Internet of Things Possible: the Case of Smart Meters
Simone Fischer-Hübner, Member of the Science Europe Scientific Advisory Committee, Karlstad University, Sweden

Questions & Answers

Rapporteur **Sven Stafström**, Director General of the Swedish Research Council

15.45–16.45 **Translational Research and Co-creation of Knowledge: Shaping Mutual Trust between Scientists and Society**

Moderator **Igor Emri**

Keynote
Mark Ferguson, Chief Scientific Adviser to the Government of Ireland and Director-General of the Science Foundation Ireland

The iWater Project: Research and Society Co-designing a Monitoring System for Cities' Water Supply
Georgia Destouni, Professor of Hydrology and Head of Department of Physical Geography at Stockholm University, Sweden

Nano-encapsulation: a Method for Maximising Health Benefits from Medicinal Plants and Agro-food By-products
Eduardo Rosa, Full Professor at the Department of Agronomy at the University of Trás-os-Montes and Alto Douro, Portugal

Questions & Answers

Rapporteur **Wolfgang Ertmer**, Vice-President of the German Research Foundation

16.45–17.30 **How to Assess the Societal Value of Science**

Moderator **Mireille Chiroleu-Assouline**, Professor at the University of Paris 1 Panthéon-Sorbonne, France

Position Statement on the Societal Value of Science by the Science Europe Working Group on Research Policy and Programme Evaluation
Jordi Molas-Gallart, Chair of the Science Europe Working Group on Research Policy and Programme Evaluation, Spanish National Research Council

Tracing the Generation of Value: the Case of ASIRPA
Pierre-Benoit Joly, French National Institute for Agricultural Research

Questions & Answers

Moderator **Andres Koppel**, Head of the Estonian Research Council

17.30–18.00 **Roundtable Discussion**

Moderator **Michael Matlosz**, President of Science Europe

Understanding and Communicating the Value of Research: Building Trust and Sharing Responsibilities

- **Keith Sequeira**, Senior Adviser at the Cabinet of Carlos Moedas, European Commissioner for Research, Science and Innovation
- **Elena Celledoni**, Member of the Science Europe Scientific Advisory Committee, Professor of Mathematics at the Norwegian University of Science and Technology in Trondheim
- **Sven Stafström, Wolfgang Ertmer, Andres Koppel**, Rapporteurs sessions 1–3

Science Europe is a non-profit organisation based in Brussels representing major Research Funding and Research Performing Organisations across Europe.

More information on its mission and activities is provided at www.scienceeurope.org.

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