FUTURE DIRECTIONS FOR SCIENTIFIC ADVICE IN EUROPE

Edited by James Wilsdon and Robert Doubleday

April 2015

CSaP
University of Sussex
SPRU – Science Policy Research Unit
STIFTUNG MERCATOR
European Commission
INGSA

Published by Centre for Science and Policy April 2015

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ACKNOWLEDGEMENTS

In May 2014, the Centre for Science and Policy (CSaP) and the European Commission co-hosted a Brussels workshop on 'New technologies and better evidence for EU policymaking'. One of its conclusions was the need to better connect the latest theory, policy and practice in this field. Building on our 2013 essay collection on *Future Directions for Scientific Advice in Whitehall*, we felt it would be useful to produce a similar collection exploring the future of scientific advice at the European level, during a period of transition to the new European Commission.

We knew this was a topical and important issue, but didn't anticipate quite how much debate it would provoke over recent months, linked in large part to the role of Chief Scientific Adviser, which **Anne Glover** occupied from 2012 to 2014. So it is through a combination of serendipity and design that this collection has emerged at an important juncture in these debates. We hope it makes a constructive contribution to discussions about the structures, processes and politics of scientific advice within the Commission and other European institutions, over the next year and beyond.

Several individuals and organisations have made this initiative possible. Huge thanks to all our authors, for their enthusiasm for the project, and for the quality and insight of their essays.

Special thanks to Stiftung Mercator and the European Commission, who funded the project, and we are particularly grateful to **Wolfgang Rohe** and **Jeannine Hausmann** at Stiftung Mercator; **Robert Madelin** and **Prabhat Agarwal** at DG Connect; **Vladimír Šucha**, **David Wilkinson**, **David Mair** and **Stephen Davies** at the Joint Research Centre; all of whom have provided advice, guidance and valuable support.

We are also delighted that this collection is associated with the new International Network for Government Science Advice (INGSA), which has been set up by **Sir Peter Gluckman**, Chief Science Advisor to the PM of New Zealand, with the aim of strengthening dialogue and exchange between science advisory systems worldwide.

Thanks to those who have assisted in the production process: **Simon Baugh** and **Lizzy Mace** for their copy-editing and proof-reading, and **Mike Green** at A3 Design for the design and printing. And finally, thanks to our colleagues at CSaP and SPRU – and most of all, to **James Hynard** at CSaP, who has done more than anyone to keep the collection, its authors (and its editors!) on track at every stage.

James Wilsdon and **Robert Doubleday**

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James Wilsdon, **Robert Doubleday** and **James Hynard**

Across Europe, science policy controversies – whether over climate, crops, fracking or food safety – regularly ripple across the headlines. But debates over the institutional arrangements for bringing scientific expertise into policy are more commonly confined to bureaucratic corridors, think tanks and seminar rooms. So it has been fascinating (and no doubt, for some inside the Berlaymont, rather surprising) to observe the intensity of discussion that has been generated over the past year about the structures and procedures for scientific advice within the European Commission.

The decision by President Juncker not to renew the post of chief scientific adviser (CSA) – a role created by his predecessor in 2012 and occupied for three years by the molecular biologist Anne Glover – was criticised by some as a backwards step, out of line with the broader march in many EU member states towards modern, evidence-informed policymaking. Others saw the move as a welcome admission that the diversity of political and decision-making cultures – what Sheila Jasanoff calls *"civic epistemologies"*[1] – across Europe were ill-served by the addition of a UK or US-style science adviser to the delicately-balanced Brussels mix.

The decision followed a public 'war of letters' over the future of the CSA role. In July 2014, a coalition of non-governmental organisations (NGOs), including Greenpeace, wrote to Juncker, arguing that: *"The post of CSA is fundamentally problematic as it concentrates too much influence in one person…"*.[2] Soon afterwards, a letter in support of the CSA role was sent to Juncker, signed by 40 scientific organisations and 773 individuals, which said *"we cannot stress strongly enough our objection to any attempt to undermine the integrity and independence of scientific advice received at the highest level of the European Commission."*[3] Further letters of support were sent by several scientific, business and civil society organisations, while a second, larger coalition of NGOs elaborated their opposition.[4]

The Moedas review

It initially appeared that President Juncker would renew the mandate of the CSA. Quizzed on the topic in July 2014 by British MEP Julie Girling, he indicated as much.[5] And in his mission letter to Carlos Moedas, the incoming Commissioner for Research, Innovation and Science, Juncker emphasized the need to *"make sure that Commission proposals and activities are based on sound scientific evidence"*.[6] But when the Barroso Commission left office at the end of October, Anne Glover's formal mandate ended, and the CSA role was placed in limbo.[7] This sparked fresh coverage of the issue, particularly in the British media, where there was limited engagement with the substance of the issue, but (viewed through the lenses of euroscepticism and/or anti-environmentalism) some took it as an opportunity to attack the European Commission, Greenpeace, or preferably both.[8]

Speaking in November 2014 to *Science* magazine, a Commission spokesperson emphasized that *"President Juncker believes in independent scientific advice"*, but had not yet decided how to 'institutionalize' the function.[9] Previously, the CSA was based within the Bureau of European Policy Advisers, and its successor body, the European Political Strategy Centre (EPSC), appears unlikely to include a scientific adviser.

Beyond that, options – officially at least – remain open. In January 2015, Juncker handed responsibility for the issue to Carlos Moedas, asking his Commissioner for Research, Innovation and Science *"to reflect and present options to me before the summer on how to better institutionalise future scientific advice to the Commission, based on the experience made in all Member States."*[10] The results of this review are expected shortly. Interviewed by Nature in March 2015, Moedas confirmed that the review is making progress:

> *I can promise you that there will be a system of scientific advice and it will be in place by the summer. President Juncker has asked me to look for the most appropriate system for the commission — as opposed to the system that works best in the UK, or in any other particular country. I will be proposing a system that allows timely advice to be gathered for all of the commissioners when it is needed — such as when new legislation is being prepared, or when there is an issue of urgency. The former chief scientific adviser, Anne Glover, has helped me understand what does and doesn't work in the context of the commission."* [11]

Beneath headline disagreements over the CSA role, there are legitimate debates to be had about the most effective arrangements for scientific advice in the Commission. And it is important to place the CSA in context: numerous advisory mechanisms and bodies like the Joint Research Centre existed within the Commission long before the creation of the CSA role, and continue to exist today. So the Moedas review does not start with a blank sheet of paper. Instead, it needs to suggest a better way of joining up these various structures, drawing on the best of what is available across the Member States while respecting their diversity, and learning from the controversy over the CSA role while building on the progress that Anne Glover made in key areas during her three-year tenure.

At the time of writing, the initial signals are that an option that the Moedas review is considering is a panel, rather than an individual CSA, as the new mechanism for scientific advice; that this panel will have a semi-autonomous secretariat based in the Commission, for example in DG Research and Innovation (rather like the Economic Policy Committee's relationship to ECOFIN); and that the panel is likely to have a more formal relationship with Europe's national academies of science, as a source of further input and advice on certain topics.

There are potential strengths to such a model, but as with any option for independent scientific advice many details will need to be resolved, including:

- How will advisors or panel members be selected to ensure a broad cross-section of national, disciplinary and sectoral perspectives?
- How openly will advisors or panel members be recruited and appointed? And how can the ongoing transparency and accountability of their work be ensured?
- How much time will advisors or panel members be expected to devote to their work, and will this be compensated, to enable proper engagement?
- How will a panel and secretariat based in DG Research and Innovation operate in practice? Will there be clear dividing lines between 'science for policy' and 'policy for science'?

- How will this independent science advice link to other advisory structures, including the Joint Research Centre?
- How will efforts be balanced between short-term emergencies and urgent issues, and longer-term foresight and horizon scanning?
- How will links to the national academies operate? How can these ensure expert input beyond the natural sciences, to include engineering, social sciences and the humanities?

The purpose of this collection

At this important juncture for scientific advice within the Commission, and across Europe more broadly, the Centre for Science and Policy, its partners and the authors of these essays offer these contributions to debates that will inevitably continue after the Moedas review itself is published.

Robert Madelin begins the collection by reminding us that *"our current and future challenges will only ever involve more science, not less"*. He argues that there must be a commitment to embed science into the democratic process through the framework of Responsible Research and Innovation: to promote *"early upstream public engagement aimed at bringing science more actively into the public debate on options and values from which any decision-making must derive its legitimacy."* Anne Glover and Jan Marco Müller echo this point, noting that digital technologies can enable greater citizen engagement. The Commission's reliance on formalised committees has contributed to a disconnect with its constituents. They call for the creation of *"fora in which citizens can discuss political choices based on the evidence"*, and highlight the leadership that Europe's science museums can offer in this regard.

The contribution from the Joint Research Centre calls for learning from science and technology studies; the creation of EU and global communities of practice; and Policy Labs which incorporate different disciplines and provides a space for experimenting with the latest policy innovations.

Switching focus to the European Parliament, Paul Rübig describes how the Science and Technology Options Assessment Unit (STOA) has recently

committed to *"an increased emphasis on foresight and informing the agenda-setting phase of the policy cycle, supported by more effective and timely communication and the strengthening of political and scientific networks"*. There is a real appetite to promote evidence-informed policy through innovative techniques, foresight, and engagement with the democratic process.

In her second essay, Anne Glover reflects with admirable openness and honesty on her time as CSA. A picture emerges of an under-resourced office with a poorly-defined remit. Glover acknowledges that *"the CSA model is, of course, only one option to provide direct scientific advice to the President"* and suggests that President Barroso *"felt more comfortable with a committee-oriented approach to science advice"*.

Doug Parr argues that a CSA role is flawed even in the best of circumstances. The concentration of the advisory function in one person risks a lack of accountability and transparency, when *"society needs broad based, open evidence gathering to act as a bulwark against a policy stitch-up in favour of vested interests"*. Kari Raivio, on the other hand, describes how he has recommended the creation of a CSA role in Finland in order to build *"trust between the different cultures of government and science [through] patience and diplomacy"*.

Jos van der Meer focuses instead on the role of national academies of science, whose *"potential contributions … to the policy making process are not always maximised."* The European Academies Science Advisory Council (EASAC) tries to remedy this by *"facilitating the sharing of expertise and resources between the science academies of the EU, Norway, and Switzerland."*

Savouring the mix

In their essay, Wolfgang Rohe and Jeannine Hausmann describe how private foundations, as financially and politically independent actors, *"can trigger social processes of change that transcend party boundaries, contribute to the pluralization of debates, and provide evidence-based arguments that drive the agenda"*. Ottmar Edenhofer and Martin Kowarsch liken this role to one of cartography, *"explor(ing) the political solution space*

through mapping out different pathways and their trade-offs or overlaps". Crucially, final decisions must still be taken by policymakers.

The social sciences have a key role to play in framing and informing policy decisions. Ulrike Felt argues that Europe is inclined to overly technocratic ways of thinking which elevate the *"Innovation Union"* without making full use of the contribution of the social sciences, whose *"integration will allow policymakers to profit from the added complexity in analysis and in the identification of potential solutions to problems."* Similarly, Andy Stirling argues that often only lip service is paid to the social sciences, illustrated by his personal experience of working on issues such as GMOs.

Holger Strassheim and Rebecca-Lea Korinek point out that policymakers must avoid thinking that behavioural governance, often known as 'nudging', is an easy short cut to good policy outcomes. However, the effort *"might be worthwhile if it helps to redesign public policy beyond rational choice models, by cautiously taking into account the human factor."*

Claire Craig and Mike Edbury argue that improving understandings of risk is also worth the effort despite the frequent assumption amongst decision makers that *"acknowledging uncertainties and the breadth of opinion and debate on an issue will inevitably lead to delay and complexity"*. Finally, Jörg Hacker and Stefan Artmann focus on the biosciences in order to elucidate the role that science advice should occupy. It can *"raise the probability of achieving a compromise"* between stakeholders in a policy by acting as an *"impartially sympathetic referee"*.

The scientific states we're in

Debates in Brussels and across Europe about the politics and practices of scientific advice form part of a broader and intensifying international discussion of these issues. At the end of August 2014, scientists and policymakers from forty-eight countries gathered in Auckland, New Zealand to debate the science and art of scientific advice.[12] Jointly hosted by Sir Peter Gluckman, Chief Science Advisor to the Prime Minister of New Zealand, and the International Council for Science (ICSU), the Auckland summit was the largest ever meeting of its kind, attracting science advisers, advisory bodies and academic experts from Albania to Zimbabwe, and

a host of countries in between. Over two days of intense discussion, participants debated structures and methods for the provision of scientific advice in emergency situations, across national and disciplinary boundaries, and on contested topics, where science, values and politics collide. The meeting ended with a call to strengthen collaboration between advisory systems, an agreement to formalize the network, and a commitment to meet again in 2016.

The Auckland process has now resulted in the creation of a new International Network for Government Science Advice (INGSA).[13] This will provides a forum for policymakers, practitioners, academies, and academics to share experience, build capacity and develop theoretical and practical approaches to the use of scientific evidence in informing policy at all levels of government. INGSA is committed to diversity, recognizing the multiple cultures and structures of governance and policy development and does not seek to endorse any particular form or structure of science advice. It will operate under the general aegis of ICSU, with the Office of the Chief Science Advisor to the Prime Minister of New Zealand hosting its secretariat.

Ecosystems of expertise

Alongside the umbrella provided by INGSA, the OECD's Global Science Forum will soon be publishing a review of scientific advice across its member countries; national governments including Finland and Japan are reviewing the organization of their systems;[14] at an international level, fresh expert assessments are underway, such as IPBES (the Intergovernmental Platform on Biodiversity and Ecosystem Services);[15] and new advisory committees have been established, for example a Scientific Advisory Board to the United Nations.[16]

Within this diversity, four structures stand out as commonly used, often in combination, across particular systems:

- **Advisory councils:** many countries have a high-level council for science (or science and innovation) policy. Members typically include senior scientists, alongside representatives of industry, higher education and civil society. Examples include Japan's Council for Science,

Technology and Innovation (CSTI), the UK's Council on Science and Technology, and the US President's Council of Advisors on Science and Technology (PCAST). In Australia, chief scientist Ian Chubb recently established a new science council to advise government on policy.[17]

- **Advisory committees:** most governments also rely on an array of specialized scientific and expert committees, which can address detailed technical and regulatory issues in areas such as health, environment and food safety. For example, the US and Japan have hundreds of such committees; the UK has over seventy.

- **National academies, learned societies and networks:** A growing number of national academies are active in science policy, and in countries such as Canada, China, Germany, Netherlands, South Africa, US and UK, academies are an important source of scientific advice. Furthermore, networks of national academies such as the International Council for Science, with a membership of 121 national bodies, representing 141 economies, and 31 International Scientific Unions,[18] and the InterAcademy Panel, the global network of science academies from 107 economies[19] are actively involved in science for policy processes at the international level.

- **Chief scientific advisers:** the US appointed its first presidential science adviser in 1957, followed seven years later by the appointment of the first cross-government chief scientific adviser (CSA) in the UK. CSAs have also been appointed in Australia, Cuba, Czech Republic, India, Ireland, Malaysia, New Zealand and (until recently) at the European Commission. In the UK, additional roles have been added gradually since 2002, and there is now an adviser in every government department (DSAs). New Zealand is also adopting a DSA model.

None of these structures is perfect, and governments typically rely on two or more of them in combination to create a broad ecosystem of expertise around policy processes. Despite the diversity that we see, common challenges persist across all systems: how to protect the independence of advice while ensuring that it is listened to; how to develop a trusted relationship with policymakers, while maintaining transparency and accountability in the eyes of the public and the science community alike; and how to undertake appropriate quality assurance.

The science of scientific advice

How far can we go towards defining and codifying a 'science of scientific advice'? This question was debated at the Auckland meeting, and several common challenges were identified which will be relevant to discussions in the European Commission as the results of the Moedas review are made public, debated and implemented over the coming months:

i) How to meet the demands and rhythms of the policy process

Debates about scientific advice often focus on the 'supply-side' of the science-policy interface. But the 'demand-side' is equally important: advisory bodies need a sophisticated understanding of how policymaking processes work, and the pressures and constraints under which politicians, officials and decision makers operate.

Policy challenges arise across different time horizons, requiring very different responses. Modes of scientific advice that are most useful in emergency situations will rarely be the same as those required for long-term foresight or horizon scanning. Over the past decade, advisory bodies have had to navigate a number of crises with scientific dimensions. Examples include SARS, bird flu, the Great East Japan earthquake and tsunami, the Christchurch earthquake, hurricanes, flooding and the volcanic ash cloud over Europe. As a result, countries such as Japan, New Zealand and the UK now have improved protocols for scientific advice in emergencies. A key part of this involves communicating to the wider public, where providing clear advice while acknowledging areas of scientific uncertainty, is the hallmark of mature crisis management.

Some structures, such as national academies, are better suited to providing formal advice against a longer time horizon, typically by convening expert panels and producing detailed reports. Others, such as chief scientific advisers, may find it easier to provide rapid, informal advice in emergencies,[20] by gathering inputs from a range of sources or forming ad hoc working groups. Responding to the different rhythms of policymaking, and striking the right balance between formal and informal inputs, are crucial aspects of effective scientific advice.

ii) The need to distinguish between 'science for policy' and 'policy for science'

In many systems, advisers or advisory bodies combine a responsibility for the use of scientific evidence in policymaking ('science for policy') with a role in determining the budgets and structure of the research and innovation system ('policy for science'). The lines between these can easily become blurred, not least because areas of 'science for policy' will have implications for particular research priorities or the funding structure. However, where possible, it is often useful to keep the two roles distinct, to avoid limiting the advisory remit by being seen primarily as a lobbyist for resources for science.

Given their proximity to the scientific community, it can be a challenge for scientific advisers to extend the same commitment to impartial evidence to the management of the research system that they bring to other areas of policy. But it can be done: former US presidential science adviser John Marburger won plaudits for his willingness to ask tough questions about the evidence base for research funding in a 2006 speech, which led to the creation of the National Science Foundation's programme on the *"science of science and innovation policy"*.[21] Such efforts should focus not only on the economic case for research funding, but also on its social and public value, and on opening up debates about research priorities to more diverse perspectives.[22]

iii) The need for advisers to act as intermediaries, brokers and communicators

Scientists are typically appointed as advisers or expert committee members because of their deep expertise and standing in a particular field of research, but (except in technical committees) they may only rarely be asked to provide advice which draws on their narrow area of expertise. More often, their role is to act as intermediaries, able to translate, aggregate and synthesize varied perspectives and sources of evidence.[23]

Roger Pielke Jr. identifies several roles that scientists can play in policymaking, and suggests that the most crucial of these is the 'honest broker', who is able to help decision makers to choose wisely between the available options on a given topic.[24] It is important for advisers to be clear when they are moving from 'honest broker' mode into more explicit advocacy of a particular policy position (as inevitably happens from time to time), as a failure to do so can undermine trust.

Another aspect of the intermediary role is to look beyond the scientific content of a particular issue and communicate the broader methodological principles and concepts that underpin scientific evidence. William Sutherland and colleagues suggest twenty key points (such as *"no measurement is exact"*, *"correlation does not imply causation"* and *"randomization avoids bias"*) that policymakers and the wider public should bear in mind when interpreting scientific claims.[25]

iv) The difficulty of resolving conflicts of values through appeals to facts

Advisers and advisory bodies spend a lot of their time engaged in debates that reflect what some have dubbed 'post-normal science': where facts are uncertain, values are in dispute, stakes are high and decisions are urgent.[26] Arguments over climate change and GM crops are two obvious examples, but there are many others.

Any issue where science is an important factor, but where values, ethics and politics are also in tension, is unlikely to be resolved through a simple statement of the scientific evidence.[27] To assume a linear relationship between evidence and policymaking is often a mistake, and advisers need to recognize the many ways in which evidence, values and political judgments combine to produce decisions. As Sir Peter Gluckman argues, this is not to deny that science *"should hold a privileged place"* among the types of knowledge that may be meaningful to policymakers, but this privilege is fragile and depends on not overstating what is known, and on acknowledging scientific limits and uncertainties.[28]

v) An increased reliance on multidisciplinary & interdisciplinary expertise

There is a growing recognition across advisory systems that identifying solutions to cross-cutting policy problems will require input not only from natural scientists, but also from engineers, social scientists and other experts. Some argue for 'chief social scientists' or 'chief historians' to be appointed alongside chief scientists, but creating separate structures ducks the more important challenge of how to integrate an appropriate mix of advice and evidence from a wide range of disciplines.[29]

In this context, it is helpful to distinguish between multidisciplinarity, which is usually about building better links between different disciplines, each of

which continues to rely on its usual methods and modes of enquiry, and genuine interdisciplinarity which encourages various disciplines to cross subject boundaries, thus enabling, as Andy Stirling argues, *"more radical interactions between different styles of knowledge, fostering potentially transformative solutions."*[30]

Similarly, effective advisory systems now draw their evidence from a wide range of methods, including scientific studies, randomized controlled trials, statistical data, socioeconomic models and forecasts, opinion polls, observational studies, and more qualitative modes of social analysis and public engagement. The growing availability of online 'big data' also has the potential to supplement and enrich existing methods.

Approaches to scientific advice that draw on a more diverse range of disciplinary and methodological inputs may in turn lead to less emphasis on reaching a 'consensus', which may obscure legitimate scientific disagreements and uncertainties, in favour of more 'plural and conditional' modes of advice.

vi) The need to link scientific advice to wider developments in evidence-informed policymaking

In a number of countries, governments are showing a renewed enthusiasm for evidence-based policy and more 'experimental' approaches to policymaking, in which scientific methods, such as randomised control trials, are used to inform policy options.[31] Examples include a new program on evidence and policy in the Chinese Academy of Sciences, a new behavioural sciences unit in the US Office of Science and Technology Policy, expanded work on behavioural sciences in the Joint Research Centre and a UK government network of 'What Works' evidence centres.[32] A resurgence in the field of intervention research has seen it move beyond health and human services into new areas of policy testing as well.

These efforts are often being driven from the demand side by policymakers and civil servants, and may operate separately from structures for scientific advice. But the synergies between these agendas are obvious, and scientific advisory bodies should position themselves at the forefront of this agenda.

vii) Opportunities to link science policy research more closely to practice

Advisers and advisory panels need to draw more systematically on research in political science, social psychology, behavioural economics, and science policy which investigates *"why certain kinds of knowledge are acted upon, and others are not."*[33] This requires concerted efforts from both sides – academics and practitioners – to connect the latest scholarship to advisory processes and practices.

In a recent essay, Sheila Jasanoff distils insights that can be drawn from three decades of research in the field of science and technology studies (STS). She acknowledges that the questions raised by STS sometimes can be *"associated with unproductive wheel-spinning and relativism"*, but insists that *"the wheels, in my view, can spin with traction."* In democracies, no institutions should place themselves beyond critique: *"If judges may not presume to stand above the law, still less should science advisers seek to insulate themselves from the critical gaze of the science of science advice."*[34]

viii) The need to strengthen exchange and learning across different systems

The INGSA network is a response to calls for a more open and inclusive global forum for such discussions.[35] There are links here to wider agendas around 'science diplomacy' and collaboration in pursuit of shared science policy goals. Follow-up summits on scientific advice are already planned in Brussels in 2016 and in Japan in 2018. Every system can benefit from a process that brings together advisers, policymakers, practitioners, experts and others on a regular basis to reflect on progress, share ideas and chart future agendas. This is an area where Anne Glover made tangible progress during her tenure as CSA, and the network of Member State science advisers and equivalents that she established should be maintained and expanded by whatever advisory structure now follows.[36]

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EVIDENCE AND INSTITUTIONS

SCIENCE AS THE FUEL OF THE PUBLIC POLICY MACHINE

Robert Madelin

As a historian working in public policy, I have been consistently surprised by the way in which science gets ignored so easily, and often so routinely, in the actual practice of public policymaking. Over my own career almost all of my work has involved complex trade-offs that most frequently involve some kind of scientific knowledge in one way or another. While few would disagree that our current and future challenges will only ever involve more science, not less, in practice scientific advice frequently falls by the wayside when actual decisions are taken. The challenge of giving science its right place in public policymaking must be looked at again now, perhaps more urgently than ever.

Current calls for a major modernisation of the state, sometimes called the Fourth Revolution, offer an opportunity to improve the way we make public policy, as part of an urgent agenda of active reform and reinvention.[1] Yet many scientific claims are not always fully, nor indeed easily, reconciled with a democratic, values-based society. The question is thus how to reposition science not just so that it is more powerful, but – perhaps more crucially – so that it is more trusted. I will argue here that a modern and efficient policy machine should have scientific knowledge as a central component of decision-making, but with due consideration of society's value preferences and democratic political judgment.

In science we trust?

One does not need to look far into history to see why science might not be trusted. In the area of GM organisms, the science says that there is no specific scientific evidence of risks to human and animal health or the environment, yet most European parliaments have voted against the introduction of such organisms. Another example worth citing is the effect of electromagnetic radiation. Although several major studies have found that the use of mobile phones does not increase the risk of brain tumours, concern about radiation from masts and high-voltage cables continues to be widespread.

Other factors that add to a lack of trust are disagreements about methodologies that are not easy for the layman to follow, and what some see as the disproportionate importance given to outliers in the scientific literature. Also, perceptions that there is insufficient transparency about clinical trials, together with the asymmetry in financial means between those who might benefit commercially and those who are meant to oversee scientific evidence, only further add to public mistrust.

Inside government institutions, the position of a chief scientific adviser is also instructive. In one EU member state it took more than 50 years to establish such a role and have it supported with a network of senior scientists inside government. As I write, the usefulness and future of such a position at the EU level, and possible alternatives, are subject to intense debate. As Sir Peter Gluckman, Chief Science Advisor to the PM of New Zealand, so accurately notes, public trust in such a position can be very easily granted or withdrawn.[2]

Acknowledging uncertainty

In order to build public trust in the capacity of science to inform policymaking and reposition science more effectively within public bodies, a new approach to using science as evidence is needed. Such an approach must break away from the common reductionist notion that scientific evidence can simply be linearly translated into public policies. Instead, scientific evidence must be correctly embedded into the democratic processes by which accountable public policy is made. A recent report by the National Research Councils of the US National Academies offers key elements of a new vision in which scientific evidence sits alongside both society's value preferences and political judgment when it comes to policy decisions.[3]

What does this mean in practice? First, the use of objective evidence must be significantly strengthened. This requires the more systematic production and uptake of high-quality scientific evidence, in all its varieties, on issues that society cares about. This must be accompanied by clear communication, not only of the results but also of the associated uncertainties and unknowns. The ability to speak openly and clearly on such issues is a vital skill that is not sufficiently developed across the board, not least because participants in the conversation speak to each other too rarely.

The sometimes radically different timescales involved in establishing evidence and making policy decisions must be designed into any effective system of advice. This also requires a much closer symbiosis between those who need and those who give advice; scientists can rarely reach consensus on new questions over a weekend, and policymakers often cannot wait for long periods for an academic consensus to be formed. Harold Macmillan famously noted that politics is almost always a response to events; to anticipate what evidence might be needed long periods in advance is seldom possible. These problems can be mitigated to some degree by using foresight systematically as a tool to think ahead, as well as having a well-functioning 'always-on' system of scientific advisory networks.

Second, the training of civil servants must be overhauled to equip officials not only with the ability to understand and engage with scientific evidence and uncertainty, but also with a deeper understanding of the many cognitive biases we all face when reasoning. Daniel Kahneman's insights – now more than 30 years old – help us to understand the shortcuts we take when faced with unintuitive evidence.[4] Better basic training in science together with a deeper understanding of the limits and biases of cognition can help to develop new reflexes of critical analysis in policymaking, especially when faced with the all-too-common pressure of urgent decisions.

Beyond evidence-based policymaking

But more objective evidence and more training will not be enough. It is important to situate scientific evidence in the context of society's value preferences and political judgments in a democracy. Science should sit neither above nor below, but alongside values and politics. This is tricky to achieve in practice – and not only in Europe. But the 'evidence change agenda' has been hijacked at EU level by an over-simplistic debate between those arguing that 'values trump evidence' and those using the reductionist mantra of 'evidence-based policy' to advance a merely deregulatory goal.

As a society we are not good enough at having a calm debate about the role of science in policymaking. How do we get away from a sound-bite-driven discourse on science in times of ever-increasing attention scarcity?

To begin with, we need to gather evidence more broadly from all sources – including from citizens – and then discuss more openly how to weigh and balance the different aspects. A credible, robust and open policymaking approach, using citizen-friendly digital tools, will play an important role in enabling the kind of high-quality debate that is needed to find trusted and sustainable solutions. While inconvenient scientific truths will inevitably form an important element of a sober debate, politics remains the art of the possible, and political decisions are seldom wholly divorced from a debate around values. It must be conceivable that even if science points in one direction, society might decide to go in another – provided this is done on the basis of a quality debate around values, and not by discrediting or distorting the scientific evidence.

Recent history has provided examples of such decisions. The German government's decisions to phase out nuclear power, or the setting of minimum retail prices for alcohol, provide some examples of values-based political decision-making.

At the European level, some structures exist that can facilitate the necessary debates. In the domain of research ethics, there is the European Group on Ethics in Science and New Technologies (EGE), and also numerous ethical committees for research projects. The new paradigm around Responsible Research and Innovation (RRI) offers another route to the indispensable notion of see-through science.[5] RRI effectively involves anyone with an interest early on in a dialogue. Rather than being the mere communication of science, it is early upstream public engagement aimed at bringing science more actively into the public debate on options and values from which any decision-making must derive its legitimacy.

Four types of risk

A conflict around science as evidence can sometimes arise because scientists are ultimately also people, and in the end none of us is truly objective. However, by virtue of their training, scientists may well have a deeper understanding of what pitfalls there are when drawing conclusions from a given set of facts. Scientists also have a culture of peer review that is largely absent from other spheres of public life, and on which much of the trustworthiness of the scientific system relies. Yet despite these assets

there are four types of risk that can, and often do, limit the public's trust in science.

1. Science without RRI – This is research in the proverbial ivory tower, which cuts itself off from the public discourse around society's values that might underlie the research, and the debate on future options and the moral and ethical consequences which the research might imply. RRI is research which is built around robust mechanisms and a genuine desire for open engagement with a broad range of stakeholders.

2. Scientists without respect for the public – Some fall into the trap of arrogance or, worse, denigrating, anti-democratic behaviour by treating the general public as ignorant, and unworthy or incapable of any meaningful debate. Many politicians have understood that treating their electorate with respect is a prerequisite for democratic legitimacy. Using science as evidence in policymaking similarly requires that those who seek to understand the future consequences of policies are not intellectually bullied into blind-faith acceptance of the science. While it is clear that a scientifically literate society will be better able to debate evidence and choices, trust can easily be destroyed if the public is disparaged or patronised.

3. 'Truth twisted by knaves to make a trap for fools' – A third risk arises when businesses or interest groups interpret scientific facts beyond the truth they contain. Trust requires not just transparency but, perhaps more importantly, the absence of deception. Where such deception is not accidental, but is used to support ulterior motives, trust in both the science and its use for public policy can be eroded – perhaps irreversibly.

4. Scientists themselves behaving badly, or being thought to do bad science – Science is, of course, not entirely free from rotten apples in the form of practitioners guilty of professional misconduct. Perhaps worse than the distortion of science, fraudulent science is another type of deception which affects trust in the entire discipline. Here, in particular, the media – including the scientific media – need more diligence. It is in relation to this threat to the credibility of the scientific enterprise that there is a benefit to having scientists inside the machine, including inside the media machine.

But even honest science may be mistrusted, often because of where it gets its money from – a form of guilt by association. Clear rules for conflicts of interest exist and must, of course, be applied, together with all the necessary elements of transparency and independent peer review that lie at the heart of science. But in a model where we expect the private sector to contribute significantly to investments in research, privately funded research will inevitably generate some of the knowledge which will inform policies. To be trustworthy, this research must be subject to the highest standards of scientific practice.

Towards trusted science

With all these risks to the trust placed in science what, then, makes for trusted science? Ultimately, countries and institutions that allow free speech for scientists form the bedrock of trusted science. It is only in settings where scientists are free to discuss openly that the necessary conditions for open, democratically legitimate scientific discourse can take place. Free speech also means that scientists should be able to admit to errors, to allow us to distinguish honest mistakes from systematic deception; even in countries where free speech is the norm, institutions are not always as open to dissenting voices as necessary.

In conclusion, science needs help from everybody to become stronger and more trusted. Greater scientific literacy in society at large, but also inside institutions, is essential. Systematic access to independent scientific opinions is needed inside institutions, including policymaking institutions as well as the media. RRI must be thoroughly mainstreamed throughout the scientific enterprise.

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EVIDENCE AND POLICY IN THE EUROPEAN COMMISSION: TOWARDS A RADICAL TRANSFORMATION

Anne Glover and **Jan Marco Müller**

As the world around us becomes increasingly complex, the task of developing a new policy can easily spread across the portfolio of five, ten or even more Directorates-General (DGs) within the European Commission; policy on biofuels is a perfect example. As a consequence, the time has passed where each DG could gather and consider scientific evidence in isolation. At the same time, disruptive technologies and social innovations are changing our way of life at an accelerating speed, and policymaking is not immune to this.

As a consequence, decision-making increasingly depends on advice given by science and technology in order to deliver the most innovative and effective policies. However, there is also an increasing uneasiness among both citizens and politicians that policies are becoming too technocratic, with solutions being 'dictated' by experts rather than taking into account the beliefs of the wider public. This is not a problem with the evidence per se – this remains the same regardless of ideologies and public opinion – but a problem with how evidence is used and communicated.

Thanks to modern information technologies, evidence can now be delivered in real time and from a multitude of sources, including big data gathered by citizens on their smart phones. This creates new opportunities for the involvement of citizens in policymaking (so-called 'open policymaking'). At the same time, this has increased the need to differentiate 'junk' science from trustworthy science, while also increasing the pressure on the Commission to be as transparent and interactive as possible.

Stuck in the past

The policymaking procedures of European institutions (and in fact, of most political bodies around the world) are still rooted in the 20th century, relying as they do on formalised committees, stakeholder consultations and expert groups. In EU policymaking this process is known as 'comitology' – a word that in itself symbolises why citizens have fallen out of love with Europe. At most, there are web-based 'public consultations', which sometimes gather embarrassingly few comments from across the EU. Take for example a consultation carried out in autumn 2014 on the review of the Commission's impact assessment procedure, one of the key elements in its policymaking. This gathered just 162 responses from the 508 million citizens of the EU. Despite these processes being public, citizens are largely disconnected from them, and this disconnection feeds the populist narrative of 'Brussels' meddling with everybody's lives without asking what citizens want.

Despite the demand from society to be more transparent and interactive, the evidence-gathering process of the Commission is largely opaque to citizens. Currently there is no harmonised procedure for the gathering, use and communication of scientific evidence, and legislative documents emanating from the different DGs do not necessarily describe all their sources of evidence – and if they do, there is often no justification of how the choices made relate to the evidence.

Each DG has its own sources of evidence, which may include the Joint Research Centre (JRC), various EU agencies, standing scientific committees, ad hoc expert groups, as well as contract work done by third parties. There is, however, little guidance on which of these to use, when and how. Moreover, DGs have a tendency to use the resource they are familiar with: for example, making effective use of 'their' agency only, even when other EU agencies could make important contributions. Working methods also vary considerably, which decreases transparency and makes scrutiny difficult. In many cases, desk officers rely on costly third-party contractors to collect and analyse data, ignoring the fact that there is an in-house science service, the JRC, with 3000 staff and an annual budget exceeding €300 million.

There are Commission guidelines,[1] published in 2002, on how to collect and use expertise. These lay out in an elaborate way the principles of good evidence gathering. However, these principles are not always respected in practice, and the fact that these guidelines have not been revised in the last 12 years might suggest a lack of interest in improving the processes of evidence gathering. The ongoing revision of the guidelines for impact assessment does, however, provide an opportunity for change.

Inefficient evidence

The lack of standard procedures around evidence gathering and analysis leads to decreased efficiency and increased cost. Moreover, it makes the evidence gathering prone to political intervention, in that evidence is more likely to be gathered in a biased manner with the aim of suiting a particular political view – 'policy-biased evidence' rather than 'evidence-based policy'.

One of the consequences is that the impact assessments prepared to accompany policy proposals may be deliberately limited in the options they consider, with the aim of achieving a desired outcome. Although the Impact Assessment Board provides some form of peer review, it mainly focuses on the overall process of the impact assessment, the methods used and the reporting. It does not carry out a scientific review of the data and evidence used, the sources of these data, or the choices made in the selection of evidence. This increases the risk of regulatory failure and public criticism. The lack of openness in evidence gathering has also resulted in impact assessments being focused far more on risks than on opportunities, leading to a rather stringent interpretation of the precautionary principle (which, in itself, remains valid but can be misused to block progress rather than allowing us to innovate by managing associated risks).

Like many public bodies, the Commission struggles to be forward-looking and is often caught by surprise by technological and societal innovations. Few DGs are able to define their needs for evidence beyond a two-year time frame. Historically, foresight activities have been carried out in various corners of the Commission, but not in a coherent and shared manner.

Even when Commission proposals are based on the best possible evidence, the evidence often gets diluted in Parliament and Council. While politicians must have discretion as to whether they want to follow the evidence or not, it is worrying that the European Council has no science service, and the majority of Member States do not have a formally appointed government science adviser. Moreover, the Research Service of the European Parliament was only established in October 2013 and is still in its infancy. All this increases the risk that politicians will make decisions on very technical EU legislation without access to the necessary expertise.

An evidence structure unfit for purpose

In the JRC, the Commission has an enormous in-house resource at hand. The JRC is not only the second-largest DG, but is probably the only governmental science service in the world which has the rank of a ministry (i.e. a DG in Commission terms). The JRC produces internationally-recognised, high-quality science based on first-class infrastructures, and delivers scientific-technical support to the policy DGs of the Commission in a manner that is independent of national or commercial interests. Although the JRC can publish without restrictions, it is not entirely free of political pressure, being subject to a Policy Commissioner and operating in a 'customer relationship' with other DGs. However, the JRC is widely unknown outside the Commission (except in some scientific circles) and internally there is still a lack of awareness of what it can do. The fact that more than 90 per cent of JRC staff are located outside Brussels does not help to foster interaction.

Some DGs (such as DG Health and Consumers, and DG Research and Innovation) have scientific advisory committees, while others do not. With a few exceptions (e.g. the Chief Economist in DG Economic and Financial Affairs), DGs do not have science advisers. The existence and mandate of advisory committees seems to be ad hoc and a result of historical developments. For instance, it is unclear why the mandate of the European Group on Ethics covers only science and new technologies, but not business ethics.

The strong scientific expertise existing in EU agencies such as the European Medicines Agency, the European Environment Agency or the European Food Safety Authority is not fully exploited. The EU agencies

themselves feel that they could do much more to support the European Commission with evidence – if they were asked. However, interaction is not straightforward because the agencies are very diverse in their mandates and setups, and each agency has its own rules and membership. In addition, the proliferation of EU agencies has led to a certain duplication of competence and activity, and has perhaps justifiably triggered criticism from Member States.

The Chief Scientific Adviser (CSA) established by President Barroso in 2012 and then discontinued by President Juncker in 2014 gained high public visibility and quickly developed into a champion for the use of scientific evidence by the Commission, both as a 'voice of science' at the political level and as a 'scientific ombudsman' for third parties. The CSA was instrumental in establishing for the first time a network of government science advisers across the Member States (the European Science Advisers Forum) and supporting the new EU Agencies Network of Science Advisers, which aimed at better coordination.

The CSA also established a formal Foresight Network in the Commission, which currently involves 21 different DGs and more than 200 participating staff. The fact that it was possible to put in place such a network of foresight experts, without adding any structural or administrative burden, is proof that transversal initiatives are possible in the Commission. The will and interest to cooperate exists at working level; it just needs to be unleashed through a top-level mandate.

Radical transformation is possible

As a matter of principle, evidence needs to be procured from the widest possible range of sources and used and communicated in an unbiased manner. There must be complete transparency on what questions are used to request evidence, where the evidence comes from, how it is analysed, how it is prioritised and what the conclusions are. The same standards must apply across all Commission services. At the end of any process there will always be a democratic political decision – which may or may not go against the evidence – but the evidence-gathering process itself must not be compromised by a politically desired outcome, as this reduces options and exposes an Achilles heel to potential critics.

A restructured and prioritised JRC could play a more central role in the policymaking process. As the Commission's 'evidence service', the use or at least the consultation of the JRC should be compulsory for all Commission departments. This would increase coherence and reduce the costs of external advice. In order to fulfil this role, the JRC would carry out research and coordinate wider scientific networks across Europe and worldwide, as well as having direct access to the results of research projects funded by Horizon 2020. To achieve this, the JRC needs to retain its current flexibility to operate as a scientific body within the Commission framework.

At the same time, the JRC itself must become better aligned with the needs of the Commission and the demand for a fit-for-purpose regulatory environment. The JRC must be proactive, rather than reactive, when providing inputs into the policy agenda. Inevitably, the JRC and its political masters will have to prioritise strategically what support it can provide within its given resource envelope. As the ultimate goal of the JRC is to support better regulation, a strong link to the Commission's First Vice-President in charge of regulatory fitness should be established. In that sense, the evidence service (JRC) should be treated in the same way as the legal service (SJ) and the procedural service (the Secretariat-General), as all three serve a Commission-wide purpose.

A strengthened role for science advisers

While the new Commission has decided to discontinue both the function of the CSA and the President's Science and Technology Advisory Council (STAC), it is evident that only having a technical science service like the JRC is not enough. A good level of scientific literacy is required in the policymaking parts of the Commission, in order to be able to frame evidence needs. Such expertise exists in many DGs, but not in a coherent manner. In our view, each DG with a political mandate should have a science adviser, ideally attached directly to the respective DG. The task of the science adviser would be to identify the needs for scientific evidence within the DG, formulate the related questions and serve as liaison with the JRC and external evidence providers. Such science advisers could initially be introduced in a budget-neutral manner, e.g. by seconding staff from the JRC or by identifying suitable individuals among DG staff.

The science advisers from the different DGs would form an internal network which would allow quick identification of policy files with a cross-DG dimension, and enable a coherent framing and handling of the relevant evidence. Likewise, there is a need for a scientific expert on the Impact Assessment Board who would have the task of carrying out a sanity check on whether proposals are based on sound and timely evidence, and whether they have the potential to unleash innovation rather than hamper it.

There is still an open question as to how the President or other Commissioners can quickly access scientific advice when required, and how to ensure that the voice of science is 'in the room' when political decisions are taken. The experience of the CSA role in the Barroso Commission demonstrated the need to have some sort of 'scientific ombudsman', i.e. a port of call when citizens or interest groups think that the Commission is ignoring the scientific evidence. As this might imply complaints about the work of the JRC, it would be healthy to keep this role separate from the JRC.

Finally, the Commission should continue to play a leading role in the emerging network of government science advisers in Europe (the European Science Advisers Forum), with the aim of fostering consensus-building around the scientific evidence underpinning European policies, and aligning science advice to the Commission with that given to Member States. This would ensure better-informed debate in the European Council, and would allow politicians to focus debate on political choices, rather than on how to interpret the evidence.

Making the gathering and use of evidence transparent

In line with President Juncker's call for more transparency of the Commission, we suggest establishing a Commission-wide 'evidence portal'. Every DG which requires scientific evidence for the development of a policy would publish on this portal open 'calls for evidence', with the support of the science adviser within that DG. All evidence providers – which could be national academies, universities, businesses or NGOs listed in the Commission's registry of expert groups, as well as the JRC itself – could then submit their evidence via the portal. All evidence submitted (with the

possible exception of commercially sensitive information), as well as its sources, would be open and transparent to everyone.

The JRC could then review the evidence and make a quality-based analysis using its expert knowledge, which would then be submitted to the relevant DG and made public. The DG would then develop policy options and take a political decision about which evidence to take into consideration, and which not, the decision being made transparent on the portal. The DG would need to explain why certain evidence has or has not been taken into consideration, thus making it transparent to citizens why a political choice has been made. This would also ensure feedback to the evidence providers themselves, as most of them currently have the impression that their evidence disappears into a 'black hole', which makes it difficult to design scientific evaluation systems that provide an incentive for policy-support work.

Empowering citizens to take part in the political debate

These measures would enable a much more open and informed debate with citizens – preventing the Commission from hiding behind a technocratic approach to evidence. It would also be fully transparent to citizens when economic, social, ethical or political imperatives override the scientific evidence. This would bring much more honesty into debates, and avoid the impression that science and technology 'dictate' a particular outcome, or are being given more weight than democratically elected governments and parliaments. Similarly, it would avoid evidence being used to justify certain decisions which are in reality being taken for a political reason.

Public debate would focus on the political choices to be made, while taking the evidence base into consideration. To foster societal debate, the Commission should support web-based platforms that inform citizens, in an unbiased manner, about the risks and opportunities of new technologies, and empower them to make up their minds. Also, there is a need to stimulate initiatives such as an EU Science Media Centre, to help scientists to communicate more effectively with the media. Last but not least, there is

a need to create forums in which citizens can discuss political choices based on the evidence. Europe's largest science museums – which are among the most highly trusted institutions in Europe – have already offered the Commission the use of their facilities to organise such debates, physically and online.

The start of the new Commission is an ideal moment to transform the scientific advisory and evidence-gathering system, with the aim of enhancing regulatory fitness and transparency, reconnecting citizens with the European project and restoring confidence in the EU's institutions. The new Commission has the opportunity to set the gold standard for 21st century public administration.

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Endnote

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THE IN-HOUSE SCIENCE SERVICE: THE EVOLVING ROLE OF THE JOINT RESEARCH CENTRE

Vladimír Šucha, **David Wilkinson**, **David Mair**, **Martin Ahbe** and **Stephen Davies**

The European Commission's Joint Research Centre (the JRC) operates daily in the so-called 'post-normal science' environment, where facts are uncertain, values are in dispute, stakes are high and decisions are urgent, across several policy areas, such as biofuels, shale gas, endocrine disruptors, nanomaterials, GMOs and banking structural reform.[1]

The JRC is a boundary-crossing organisation at the interface between science and policy, having a foot in both the scientific community and, as one of the departments of the Commission, the policy community. Its work programme is developed with the other departments and formally adopted by the Commission each year. the JRC therefore produces much of the knowledge needed to develop and implement EU policy.

What is the JRC?

As the Commission's in-house science service, the JRC has a key role in putting evidence at the centre of EU policymaking, by producing evidence for policy in an impartial, transparent manner. We do this with around 2000 scientific and technical staff, in six locations across Europe, across a broad range of disciplines. Our research capacity includes, for example, around 40 large-scale research facilities (such as the Vehicle Emissions Laboratory); online databases (such as the Emission Database for Global Atmospheric Research); knowledge centres (such as the one for energy efficiency) and observatories (such as the Bioeconomy Observatory); as well as more than 100 economic, bio-physical and nuclear models. In order to maintain our scientific excellence and to serve as a science hub, we are actively involved, not only in Europe but worldwide, in more than 100 networks and cooperate with over 1000 research organisations.[2]

The JRC is embedded within the Commission and thus, for example, we are fully involved in the policymaking process, providing knowledge both informally (e.g. in discussions with policy colleagues formulating a new proposal) and in a formal manner (e.g. responding to an inter-Commission consultation). Our integrity is crucial, as well as our independence from national, commercial or civil society interests, and our recognised status as an unbiased and policy-neutral science service. This is particularly important in complex policy issues where the science is contested, or where policy decisions will have significant economic consequences. Other Commission departments which are responsible for a particular policy field need the JRC to take a policy-neutral position, to provide ongoing support and to be transparent in the analysis, data and models we provide.

Our expertise is used in a number of ways across the range of EU policies (including agriculture, economics, industry, energy, climate, environment, transport, consumer protection and security):

1. Direct support to a policy department, e.g. for an ex-ante impact assessment accompanying a policy proposal or for the implementation of a Directive.[3]

2. Reporting directly to Commissioner Tibor Navracsics, who is one of the voices of science for policy at, for example, debates between all the Commissioners.

3. Providing support to EU Member States and fulfilling international legal obligations, also on behalf of the EU, to international organisations.[4]

Our activities cover:

- **Policy anticipation**: via horizon scanning and foresight studies to identify emerging issues, anticipate future policy needs and contribute to the agenda setting of the Commission and beyond.

- **Policy formulation**: providing the evidence that enables the Commission to assess the impacts of various policy options. For example, policy initiatives published by the Commission are accompanied by an impact assessment evaluating the potential economic, social and environmental consequences of the initiative. This

impact assessment gives decision-makers (scientific) evidence on the need for EU action and the advantages and disadvantages of alternative policy choices. These policy initiatives are then scrutinised by and negotiated with the other EU institutions.[5]

- **Policy implementation**: following adoption of any legislation by the European Council and Parliament, and transposition into national law by EU Member States, the JRC supports the monitoring of its implementation, for example through the development of indicators; remote satellite sensing; maintenance of databases and information systems; development of reference materials, measurements and standards; and running of EU Reference Laboratories, observatories and networks.

- **Ex-post policy evaluation**: where the JRC undertakes assessments of the effectiveness, efficiency and added value of EU policies.[6]

In 2013, we produced 1244 policy-support deliverables, 311 tangible policy-support impacts and 634 articles in peer-reviewed journals.[7]

Science in EU policymaking

EU policymakers are increasingly confronted with a wide array of intractable problems such as climate change, economic inequality, ageing populations, energy and food security, and water scarcity. They need their decisions to be informed by the best available science from across multiple disciplines, as these challenges no longer arrive in neat discipline-shaped or department-shaped boxes. This is crucial because the wrong policy can result in grave economic and social costs, and erode trust in governing institutions. The good news is that never before in human history has so much scientific knowledge been produced, and never has it been so easily accessible. We now have a better understanding of our planet, our economy, our society and of ourselves than at any other time in history.

We know that policy is not developed on the basis of science alone. Indeed, this should never be the case; in a democracy, science is only one part of policy development, which is ultimately decided by the values of society as a whole. Science can, however, help to put policy decisions on a sound factual basis and to focus political debate on the values at stake rather than

on disputing the facts. Since science has a cultural and political authority, it also has a responsibility to examine the impacts of policy decisions. In addition, science can help to mitigate the risks in policymaking; identify innovative policy alternatives; provide early warnings of new challenges thrown up by the latest science and technology; deploy systems thinking to help policy escape from 'silo thinking'; and help to combat short-termism in policymaking. Science can thus support the proper functioning of the political decision-making process mediated through democratic institutions.

As an illustration, consider the challenge of developing a coherent policy balancing competitiveness with environment and safety, requiring trade-offs to be made. For example, reducing car emissions makes engines more expensive, and there is a balance to be struck by choosing the point where the costs start to rise very steeply for relatively little improvement in the level of emissions. This point can only be identified though a proper scientific analysis of the issues.

Challenges for effective science advice

Clearly the link between science and policy is not straightforward, and there is a vigorous debate on how policymakers use, or do not use, scientific evidence. Whilst there is extensive literature on the supply-side, there is less known from the demand-side perspective, i.e. on what policymakers actually need and how they use scientific evidence, especially in EU Member States.[8] DG JRC, as part of the Commission, is well placed to contribute to both the supply and demand sides of this debate.

From our own analysis, we have identified three main challenges facing the JRC and policy development more generally, namely timing (of research and policy cycles), the role of the JRC (honest broker rather than advocate or pure scientist) and communication (between scientists and policymakers).[9] It matters a lot when our advice is given, how and by whom it is given, and where it is given. To be effective, the JRC has to provide its input at the right time and in the right way, since there is no value for the Commission in providing an excellent scientific report if it comes too late to inform policy development and is too long and complicated for policymakers to quickly grasp. Scientific evidence is also effectively provided via both formal and informal channels.

Scientists also need insight into human behaviour, empathy with policymakers, an understanding of the role of emotion and values in policy decisions, and a grasp of the policy context.[10] Insights of this type can be provided by the discipline of Science and Technology Studies. For example, in addition to having a good understanding of the policy context, the most successful scientists informing policy do this by developing a good dialogue with policymakers; empathising with the constraints they are subject to; recognising that policymakers, flooded with a myriad of other scientific, lobby-group and think-tank papers and postings on social media (Twitter, blogs, etc.), rarely read academic journals nor a lengthy report; accepting that policymakers' decisions are not solely based on scientific evidence; and tailoring their advice within the policy context. Scientists must also recognise that the vast majority of policymakers do not have a scientific background.[11]

A particular challenge is the use and misuse of science in policy debates. We know that scientific viewpoints are given to policymakers by many stakeholders, giving rise to a flood of inputs which can sometimes create conflict or confusion. This can also lead to the facts and science itself being questioned, and to 'cherry-picking' – i.e. selecting evidence that supports a pre-determined policy viewpoint (also known as 'policy-based evidence'). Since stakeholders tend to want a high degree of certainty, they may use the uncertainties that are part and parcel of scientific evidence to question the validity of the science. Such questioning, or interpreting the scientific evidence in different ways, may dilute consideration of the values at stake and lead to a general distrust of science.

The JRC's evolving role in EU policymaking

The JRC has the ambition to become one of the world's leading organisations in the practice of transforming scientific knowledge into evidence to support policymaking. We aim to be at the heart of policymaking in the European Commission by providing relevant knowledge and science-based tools and methods that can be used to develop, roll out and assess policies, as well as to anticipate emerging societal challenges. To this end, we are currently considering how to better support this evidence-based policy culture, as outlined below.

In the EU there is no standard approach to science advice to policy – nor should there be one. The myriad ways in which science is used to inform policy across Europe can only benefit from having a debate on what works. Broadly there are five different models in the EU:

- Collegial and hierarchical bodies such as various forms of councils, committees, etc.
- Research-based organisations, ranging from policy-oriented think tanks to intermediary agencies
- Networks such as those of universities and research institutes
- Scientific academies and foundations
- (Chief Scientific) Advisers attached to a Prime Minister's or President's office.

A distinction can also be made on whether consultation of a scientific advice body is compulsory as part of the parliamentary process (as in Estonia and France, for example) or not (e.g. Austria and Belgium). If not, scientific advice may, in some instances, be requested by individual parliamentarians or committees (e.g. in Germany). Europe can thus be characterised by the sheer diversity of models for scientific advice: Ireland and the United Kingdom have a government chief scientist; Croatia has advisers attached to both the President's and Prime Minister's offices; in some Member States (e.g. Denmark, Poland and Hungary) this role is fulfilled by the President of the National Academy of Sciences; others (e.g. Germany) have one or more scientific advisory boards; while Spain and Sweden use senior ministry representatives. It is not uncommon for a combination of these different approaches to be used in the same Member State. A further level of science advice occurs in those Member States with a federal structure (e.g. Austria, Germany and Belgium), where decisions are taken at both regional (e.g. Länder) and federal level.

Consider, for example, the practice within the Commission, where in addition to the JRC there are projects funded via the Horizon 2020 programme which are required to bring out more the policy relevance of their work; external consultants undertaking studies for a specific

Directorate-General; various (scientific) committees; EU agencies (e.g. European Food Standards Agency, Fundamental Rights Agency); and Directorates-Generals having some research capability (e.g. DG Economic and Financial Affairs), or directly managing entities or networks (e.g. European Migration Network for Home Affairs) or having direct links with research institutes (e.g. European University Institute for Climate Action and for Energy). On top of this, there are numerous external think tanks, lobbyists, associations (e.g. within specific industries), NGOs, international organisations, etc. who also provide their insights to inform EU policymaking.

Developing a community of practice across the EU (and globally) would strengthen cooperation and exchange of best practice at all levels of decision-making in the EU (within cities, regions, Member States and EU-wide). This could then lead to more effective policies with smarter and more efficient spending of taxpayers' money, in a way that brings fairness and promotes growth and jobs. As a complementary activity, organising summer schools on science advice to policy, in collaboration with other leading organisations, would provide an opportunity to both discuss and provide training in the latest state-of-the-art analysis and thinking on science advice to policy.

Improving the use of evidence to inform policy development

The Commission, like many other organisations, is faced with an increasingly vast amount of knowledge obtained from various sources. In order to improve our knowledge management practices, the JRC is creating European Knowledge Centres whose purpose is to be the reference for all stakeholders (policymakers, industry and academia) in a given policy field, with state-of-the-art knowledge and information to help policymakers establish what works. Such centres would provide a comprehensive, quality-checked, accessible repository for data, knowledge, methodologies and tools, and would also offer a qualitative and quantitative, forward-looking perspective via modelling and foresight studies. Examples of such knowledge centres would be for Disaster Management, Energy Efficiency, Financial Aspects and Food Authenticity. As a complementary, related development, the systemic change in the modus operandi of research via Science 2.0 provides possibilities to have the best scientific evidence available to inform policy.[12]

Another important area where the JRC is ideally placed is in the promotion of policy coherence, such as inter alia concerning the environmental dimension in economic and competition policies. As outlined previously, policy challenges are now increasingly interdependent and systemic, and cannot be addressed by a single policy field only. Indeed the structure of the current Commission specifically aims to break down 'silo thinking' and to promote collaborative working in order to achieve more consistent and coordinated policy development.[13] The JRC has a clearly identified role as a service providing support across the Commission through its knowledge and expertise.[14] Because the JRC does not have a policy-development mandate it can, for example, provide the broader perspective for the development of a comprehensive policy, identifying and incorporating the linkages between different policy fields.

Fresh insights into the way we develop policy might be learnt from a Policy Lab which integrates different disciplines, including horizon scanning, foresight and behavioural sciences, and uses the latest policy-innovation techniques to tackle complex systemic problems. Currently there are such labs in Denmark, Finland and the United Kingdom, as well as in the USA and the World Bank.[15] They provide a forum for policymakers to develop innovative, integrated solutions; use foresight studies to tackle complex problems and identify forward-looking solutions; and address behavioural change that can help to focus on policy impacts for EU citizens in a practical way.

The way ahead

The JRC has made progress in its understanding, and in developing its capacity to improve how it provides scientific evidence to inform policy. This has also included developing good contacts with some of the leading experts and institutes in this field, not only in Europe but worldwide. Indeed, even though institutionally the JRC lies within the Commission, still we face the same or similar challenges as other policy-informing entities which are external to policymaking bodies. There is thus a need to mutually share all our experiences.

We consider that practitioners who provide science advice to policy require different skills from those of a pure scientist. Indeed the role may not be suited, or indeed relevant, to all scientists. Owing to the JRC's institutional

setup, we have skill sets ranging from pure scientists to those who bridge the science–policy interface.

But to enhance still further the capacity of science to inform better policy, there is a need for a broader, cross-disciplinary understanding of the policymaking process and the role of scientific evidence in this. Clearly there is no deficit in the amount of knowledge that can be supplied, but we require more understanding of the need for scientific evidence, how it is actually used, plus the constraints from the demand side (i.e. by policymakers). Likewise, policymakers themselves could benefit from understanding better how knowledge is produced and how it can be used to inform policy development.

Whilst there are challenges to more effective use of science to inform policymaking, nevertheless it becomes more and more a necessity for our societies. The scientific expertise and competence of the JRC mean that we can provide the best available evidence to inform policy development and apply scientific rigour when analysing research conducted elsewhere.

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Endnotes

1. 'Post-normal science' is a concept developed by Silvio Funtowicz, a former the JRC scientist, and Jerome Ravetz. See S. Funtowicz and J. Ravetz, 'Post-Normal Science', International Society for Ecological Economics, February 2003.
2. Further details, including outputs, are available from the the JRC Science Hub at https://ec.europa.eu/jrc/
3. Re the former, for example, to support the revision of a Directive on Deposit Guarantee Schemes in the banking sector. See http://ec.europa.eu/finance/bank/guarantee/index_en.htm. Re the latter, such as developing Best Available Techniques Reference Documents (BREFs). See http://eippcb.jrc.ec.europa.eu/reference/
4. Such as for crisis monitoring and provision of information (e.g. regarding forest fires and floods) and in the nuclear sector, and the Euratom Treaty Chap. III Art. 36 and 39, Recommendation 2000/473/Euratom and Council Decisions 87/600 and 05/14929, including for the International Atomic Energy Authority.
5. Notably the Council of the European Union and the European Parliament. Further details on the EU's decision-making process may be found at http://europa.eu/eu-law/decision-making/procedures/
6. As part of the Commission's Regulatory Fitness and Performance programme (REFIT), which aims to make EU law simpler and reduce regulatory costs, thereby contributing to a clear, stable and predictable regulatory framework supporting growth and jobs. See http://ec.europa.eu/smart-regulation/refit/
7. DG JRC Annual Activity Report 2013, available at http://ec.europa.eu/atwork/synthesis/aar/doc/jrc_aar_2013.pdf
8. See, for example, the outcomes of the Science Advice to Governments conference in August 2014, available at http://www.globalscienceadvice.org/ and Doubleday, R. and Wilsdon, J. (2013) 'Future Directions for Scientific Advice in Whitehall' for a perspective from the United Kingdom, available at http://www.csap.cam.ac.uk/events/future-directions-scientific-advice-whitehall/
9. These terms (honest broker, advocate, pure scientist) for science advice to policy were coined by Roger Pielke; see http://rogerpielkejr.blogspot.be/. 'Knowledge broker' is also a term commonly used: see, for example, Peter Gluckman in Nature 507, 163–165 (13 March 2014). A trusted honest (or knowledge) broker can play a crucial role in informing and providing clarity to policymakers, in a transparent, tailored and independent manner, about the status and findings of the latest scientific evidence, including the uncertainties, consensus and minority views. 'Pull' communication techniques (i.e. providing the means to proactively access information) rather than 'push' (i.e. sending information directly) are deemed to be more effective.
10. Recently the JRC has established a unit looking at behavioural insights, which will also consider the aspect of science advice to policy. We also have good relations with many institutes looking at science advice to policy from several angles.
11. For example, of the 736 MEPs in the last European Parliament up to April 2014, just 6 trained as scientists.
12. http://www.science20.com/
13. European Commission Press Release IP/14/984 of 10 September 2014.
14. Mission letter to Commissioner for Education, Culture, Youth and Sport, 10 September 2014.
15. They are also being developed by France, New Zealand and Canada.

SCIENTIFIC FORESIGHT AT THE EUROPEAN PARLIAMENT

Paul Rübig

The Science and Technology Options Assessment unit (STOA) exists to provide members and committees of the European Parliament (EP) with independent expert assessments of scientific and technological options for particular policy areas. STOA was officially launched in March 1987 as an 18-month pilot project; it was subsequently authorised to continue its work on a permanent basis and the STOA Panel was created.

In the years that followed, STOA's development went through a founding period, in which the practice of parliamentary technology assessment, and its associated methodology and tools, were established at the EU level. Following a restructuring of STOA in 1994, a new framework for project work was established. Finally, after further reforms in 2003–2004, a third period ensued with a better focus on strategic science and technology issues, and an emphasis on ensuring relevance to parliamentary work. During this latter period, STOA multiplied and diversified its products and activities, while paying increasing attention to communication and visibility.

The structure of STOA

Political oversight of STOA's work is ensured by a panel of 15 Members of the European Parliament (MEPs), which decides on STOA's research priorities and approves studies. The panel comprises the EP Vice-President responsible for STOA, four MEPs appointed by the Committee on Industry, Research and Energy (ITRE) and two MEPs from each of five other committees, namely Employment and Social Affairs; Environment, Public Health and Food Safety; Internal Market and Consumer Protection; Transport and Tourism; and Agriculture and Rural Development. The STOA Panel constitutes itself at the beginning and the middle of each parliamentary term.

Panel meetings are prepared by the STOA Bureau, which comprises four members: the EP Vice-President responsible for STOA, the STOA Chair

and two Vice-Chairs. The STOA Bureau and Panel are assisted in their work by the STOA Secretariat, which belongs to the European Parliament's Directorate-General for Parliamentary Research Services (DG EPRS).

STOA's mission, products and activities

STOA's mission is firstly to provide the EP's parliamentary bodies with independent, high-quality and scientifically impartial studies for the assessment of the impact of new technologies, and identify the options for the best courses of action to take. A second element of its mission is to *"organise forums in which politicians and representatives of (science) and of society as a whole shall discuss and compare scientific and technological developments of political relevance"*.[1]

In fulfilling the first part of its mission, STOA assigns great importance to identifying and assessing a comprehensive range of options for policy action in relation to the introduction of new and emerging technologies. It also provides MEPs with state-of-the-art information about the current status and deployment prospects of these technologies. In recent years, STOA's studies have included scenarios for an eco-efficient energy and transport future; the sustainable management of natural resources; developments in ICT; future prospects in healthcare and new technologies in the life sciences; and science, technology and innovation policy.

STOA works with external experts in a number of policy areas in order to produce these studies. These experts include universities, research institutes, consultancies and individual scientists. STOA's studies are publicly available so that the wider public can profit from the information and insights they contain, and engage in a dialogue on their implications. Without compromising scientific robustness and accuracy, the studies are written in a language accessible to the layperson.[2] One or more Panel members oversee the execution of each study to ensure the relevance of the outcome for parliamentary work. Interim and final results of studies are regularly presented by experts during meetings of parliamentary committees and the STOA Panel.

STOA fulfils the second part of its mission by organising workshops, both in relation to the studies and as ad hoc events. The latter are often co-

organised with external organisations, including the European Commission's Joint Research Centre (JRC), European and international organisations, and professional scientific associations. STOA workshops are open to the public and are advertised via STOA's website, so that people from outside the Parliament can also participate. Workshops are attended by MEPs, their assistants and other EP staff, as well as representatives from other European institutions, scientists, stakeholders and the wider public, in numbers ranging from several dozen to the hundreds, depending on the subject.

Material from these workshops, including background papers, presentations and conclusions, are posted on STOA's website. The events are routinely webstreamed, and video footage is posted on the website for those who cannot physically attend but want to follow them. More recently, STOA has been extensively using the social media possibilities offered by DG EPRS (Twitter, blogs, etc.) to advertise the events it organises, communicate with the public during the events, and disseminate their outcomes.

Since its first edition in 2003, the STOA Annual Lecture has constituted the high point of STOA's annual activities. It features eminent scientists – often Nobel laureates – speaking about subjects of political relevance, ranging from climate change and sustainability to the challenges of the Information Society and path-breaking advances in the life sciences. The Annual Lecture is attended by numerous scientists and stakeholders, MEPs and staff, and hundreds of ordinary citizens. The use of webstreaming and social media ensures much wider accessibility and public participation.

Inspired by similar initiatives in some national parliaments, STOA has also organised three rounds of an MEP–scientist pairing scheme, to enhance mutual understanding between scientists and policymakers and help them establish lasting, mutually beneficial links. The scheme, whose fourth round will be launched in the first months of 2015, is intended to help policymakers better understand the working methods of scientists and the real-life aspects of the process by which scientific knowledge is obtained. On the other side, the scheme helps scientists to comprehend the intricacies of the policymaking process, the way scientific advances are perceived by policymakers and how scientists can more effectively influence policymaking.

During the seventh term of the EP (2009–2014), STOA carried out 24 projects and organised more than 60 events, namely 21 project-linked workshops, 36 ad hoc workshops and 5 Annual Lectures. STOA welcomed more than 6,000 participants to these events. In addition, 13 pairs of MEPs and scientists were involved in the third round of the pairing scheme.

Looking to the future

Taking advantage of the long-term, strategic character of its work, and putting it in the context of the current political discourse, the outgoing STOA Panel recently endorsed an 'Action Plan for the Future'.[3] This calls for the recognition of STOA as the *"permanent structure of the European Parliament with an explicit foresight role in the area of science and technology (...) firmly anchored (...) in the agenda-setting phase of the policy cycle"*. This is particularly important at a time when the Parliament is vigorously claiming a more active role in applying scrutiny to the full policy cycle, including the early, agenda-setting phase.

In line with this political decision, the former Science and Technology Options Assessment unit, which served as the STOA Secretariat, was renamed the Scientific Foresight (STOA) Unit. This comprises two services, namely the STOA Secretariat and the newly created Scientific Foresight Service. Although there had been a number of ad hoc forward-looking exercises within the EP in recent years, notably the ongoing participation in the European Strategy and Policy Analysis System (ESPAS) process, the creation of the new service demonstrates the EP's strategic intention to strengthen its capacity for scientific foresight.

The Action Plan is the instrument for implementing a forward-looking strategy that takes into account the evolving reality in which STOA operates. In particular, the STOA Panel sees that it has to remain proactive and its products and working methods have to keep pace with the unprecedented speed of technological advances and parallel economic and political developments. These include the role of innovation in the creation of growth and jobs; the difficulties posed by an enduring economic and financial crisis; wide recognition of the pervasive role of impact assessment; and the need to apply parliamentary scrutiny throughout the policy cycle.

Effectively, STOA already played a foresight role though the strategic, forward-looking character of its work – all that remained was to embed its mission in the political discourse. Interestingly, the Panel also considered that STOA *"can experiment with novel concepts and tools, such as open innovation and crowdsourcing, to leverage collective intelligence and tap the cognitive surplus of the scientific community and the wider public for the fulfilment of its mission"*. Simultaneously, STOA should *"continue to act as a beacon for science and technology within the European Parliament and towards the scientific community and the public at large, especially with respect to young people"*.

The Action Plan also suggests an increased emphasis on timely and effective communication of policy options to committees and MEPs, based on a solid understanding of the long-term policy framework. It is essential for STOA to ensure the relevance of its output for the work of committees and individual MEPs if it is to maintain its legitimacy within the EP in its role as co-legislator. STOA has to keep pace with developments, in terms of both its analyses and its working methods, with a special emphasis on the effective and timely communication of its results, and an enhanced effort to increase awareness of its activities among MEPs. While maintaining its capacity to shape the political agenda through sound scientific work, STOA has to keep track of the long-term, evolving policy framework at the European level, so as to ensure the relevance and usefulness of its interventions for European policymaking.

In addition, STOA should further develop close relations with parliamentary committees, supporting their work and providing personalised advice to MEPs on demand. STOA's agenda-setting role has to be made clear to MEPs, and all legitimate communication channels to the parliamentary committees have to be exploited for this purpose. The MEPs appointed to the STOA Panel by the six committees represented on the Panel are expected to act as STOA ambassadors to their committees, raising awareness among their colleagues about the ways in which STOA's expertise can inform their parliamentary work. This may include urging their committees to present proposals for STOA projects, and then having interim and final results of these projects presented during prime time in committee meetings.

Depending on the availability of human resources, STOA administrators could make themselves available upon demand to inform committees about STOA projects or provide personalised advice to MEPs, as required.

STOA has to make sure its products are well adapted to MEPs' needs and expectations. In particular, long-term products should be re-balanced in favour of shorter timelines. STOA has already acknowledged that studies do not need to be lengthy or extend over a long time to be recognised as authoritative and convincing. All the studies launched in 2014 have an expected duration of less than nine months, with most being planned to last six months or less. STOA may further decide to produce concise informative products, such as state-of-play briefings, state-of-the-art technology reports, or policy options briefs for the benefit of interested committees and Members.

STOA will set up clear criteria for the selection of topics, format and content for workshops. As highlighted above, STOA organises numerous workshops and other events as a way of promoting dialogue with the scientific community and society at large. Most of these events are well attended and produce very useful outcomes. Nevertheless, STOA has to adapt the topics and format of its workshops to the evolving communication paradigm. Rapid and concise communication is entirely compatible with long-term planning; the latter has to rely on clear criteria for appropriate workshop topics and formats, compatible with STOA's priorities and the needs of the EP.

Finally, STOA must develop its relations with the scientific and science policy communities. STOA intends to actively pursue the enhancement of existing links and the creation of new links with key European policymaking, research-funding and academic institutions (e.g. ERC, EIT, EUREKA, CoE/PACE and ENA) as well as the scientific EU agencies, with the aim of building a science cluster based on technology options for 2050. This is achieved through mutual invitations to each other's meetings, and can proceed all the way to the conclusion of establishing cooperation agreements.

A new STOA Panel for the eighth parliamentary term

On 22 October 2014, at the constituent meeting convened by Mairéad McGuinness (MEP and EP Vice-President responsible for STOA), the STOA Panel elected Paul Rübig (MEP) as Chairman, Eva Kaili (MEP) as First Vice-Chair and Evžen Tošenovský (MEP) as Second Vice-Chair for the next two-and-a-half years.

The new STOA Panel endorsed the further implementation of the 'Action Plan for the Future' and at the same time started a discussion about STOA's research priorities for the first half of the eighth parliamentary term. The demands of STOA's function have changed since its inception in 1987, but STOA now stands well equipped to deal with the current rapidity of technological change. An increased emphasis on foresight and informing the agenda-setting phase of the policy cycle, supported by more effective and timely communication and the strengthening of political and scientific networks, will ensure that the EP is better able to anticipate and deal with the issues raised by scientific and technological developments. STOA looks forward to informing the work of the new Parliament, drawing upon its previous experience and the Action Plan in order to continue to provide the EP with excellent scientific advice.

Paul Rübig **has been an MEP for the Austrian People's Party since 1996 and is Chairman of the STOA Panel (@PaulRuebig).**

Endnotes

1. According to Article 1(2) of the STOA Rules adopted by the EP Bureau in May 2009 and subsequently modified.
2. Reports can be downloaded from the STOA website (http://www.europarl.europa.eu/stoa).
3. See minutes of the STOA Panel meeting of 17 April 2014, available at http://www.europarl.europa.eu/stoa/webdav/site/cms/shared/3_activities/panels/2014/STOA%20Panel%2017%20April%202014.pdf
4. ERC: European Research Council; EIT: European Institute of Innovation and Technology; CoE/PACE: Council of Europe/Parliamentary Assembly of the Council of Europe; ENA: École Nationale d'Administration.
5. At the ordinary STOA Panel meetings of 27 November and 18 December 2014.

2
SOME ADVICE ON ADVISERS

A MOMENT OF MAGIC REALISM IN THE EUROPEAN COMMISSION

Anne Glover

> *At that time Macondo was a village of twenty adobe houses, built on the bank of a river of clear water that ran along a bed of polished stones, which were white and enormous, like prehistoric eggs. The world was so recent that many things lacked names, and in order to indicate them it was necessary to point.*
>
> **Gabriel García Márquez, *One Hundred Years of Solitude***

I want to summarise the journey I made as Chief Scientific Adviser (CSA) to the President of the European Commission during an almost three-year tenure: a journey that was very rewarding, but also contained elements of Quixote, Kafka and Macondo. It all started with an announcement by President José Manuel Barroso when he stood for re-election in the European Parliament on 15 September 2009:[1]

> *"We also need a fundamental review of the way European institutions access and use scientific advice. In the next Commission, I want to set up a Chief Scientific Adviser who has the power to deliver proactive, scientific advice throughout all stages of policy development and delivery. This will reflect the central importance I attach to research and innovation."*

Although there had been voices demanding a CSA in the past,[2] this announcement came as a surprise to many, not least to the Commission's own in-house science service, the Joint Research Centre (JRC).

As this was the first time the Commission would have a CSA, the announcement raised many questions, notably how the role would be implemented, what mandate it would have and how its relationship with the JRC would work. Soon after the announcement, the then Director-General of the JRC submitted a paper to the President's Cabinet outlining different options to implement the idea. The paper recommended having the CSA as a senior adviser attached to the President, in order to deliver credibility, independence, ease of implementation and proximity to decision-making.

Six months later, on 9 March 2010, the post was formally created by a Commission Decision, at Director-General-equivalent level. The CSA, with the long-winded title 'Chief Scientific Adviser to the President of the European Commission', was attached directly to the President, without any intermediaries (except de facto the Head of the President's Cabinet and the Member of the Cabinet in charge of science). The title and the reporting line made it clear that the main task of the CSA was to provide science advice to the President himself, not to the Commission, nor to the College of Commissioners, nor to individual Commissioners or Directors-General.

There was an unexplained gap of two years between the announcement of the role in September 2009, and my appointment in November 2011. The recruitment procedure was not transparent (the post was never advertised), but it is understood that the President interviewed various candidates and in the end offered the position – based on a temporary contract – to me, at the time working as the CSA for Scotland. On 5 December 2011 the European Commission issued a press release announcing the appointment, which also specified the new role as follows:[3]

> *The functions of the Chief Scientific Adviser[4] will be as follows:*
>
> - *To provide independent expert advice on any aspect of science, technology and innovation as requested by the President;*
> - *Upon a request by the President, to provide analysis and opinion on major policy proposals being submitted to the College touching upon issues of science, technology and innovation; in particular the Chief Scientific Adviser will provide authoritative guidance on interpretation of scientific evidence in presence of uncertainty, and will be involved in strategic emergency planning;*
> - *To build relationships with high-level advisory groups (e.g. European Research Area Board), the scientific committees of the Commission, the EU agencies (European Medicine Agency, European Food Safety Authority, the European Chemicals Agency and the European Centre for Disease Prevention and Control), the European Group on Ethics in Science and New Technologies;*
> - *To build relationships with similar structures in Member States and other countries;*

- *To advise on novel science, technology and innovation issues arising both in the context of the EU and internationally; to serve as an early warning conduct point on issues that might arise when scientific progress entails either opportunity or threat for the EU;*
- *To communicate the scientific values on which specific Commission proposals are based in order to enhance public confidence in science and technology, and in general to promote European culture of science and technology widely within Europe and abroad."*

It was clear from this mandate that the remit of the CSA was to address science for policy, and not policy for science, so I was not to be involved in the development of research policies such as Horizon 2020, but would advise on the use of scientific evidence in other policy areas. At the same time, the mandate was clearly designed with both an inward-facing and an outward-facing aspect. The last point in particular (*"to communicate scientific values (…) and in general to promote European culture of science and technology"*) overlapped with the mandate of the Commissioner for Research, Innovation and Science and the remit of DG Research and Innovation (DG RTD).

There was also an obvious overlap with the JRC, which also has a science for policy role.[5] In particular, point 2 (*"to provide analysis and opinion on major policy proposals"*) and point 5 (*"to advise on novel science, technology and innovation issues"*) clearly seemed to step on the JRC's toes. This was challenging to the established roles of the JRC and to the Commissioner for Research, Maire Geoghegan-Quinn, and highlights the need to give more thought to the establishment of a new function within an existing organisation to ensure that value is added rather than uncertainty being created.

Struggling to get off the ground

> *Melquíades had not put events in the order of a man's conventional time, but had concentrated a century of daily episodes in such a way that they coexisted in one instant.*
>
> **Gabriel García Márquez, *One Hundred Years of Solitude***

When I started work on 1 January 2012, my resources were minimal: I had an office, a secretary and the support of a seconded national expert from Portugal, who was already working for the Bureau of European Policy

Advisers (BEPA). I insisted that a permanent EC official should be seconded to my team who would know about the Commission's procedures, and in particular the JRC. I identified Dr. Jan Marco Müller as an optimal choice, as he had served as Assistant to the Director-General of the JRC (and had co-authored the paper on how to implement the CSA role), but also had experience with the science advisory systems in Germany and the UK. The secondment was not easy to arrange, but was eventually approved.

The limited staff available in 2012 significantly hindered my ability to implement the CSA's mandate in the first year. The large number of invitations and media requests put an enormous stress and workload on the small team, which handled all interview requests (within the typical short deadlines of the press), and regularly updated the website of the CSA in four different languages.[6] The lack of staff was mirrored by the lack of an adequate budget; it was particularly cumbersome to get travel – 'missions' in Commission jargon – approved.

Given the limited support for outreach activities, the DG for Communications, Networks, Content and Technology (DG CONNECT) created a CSA Twitter account,[7] which by the end of my mandate had more than 9400 followers. The choice of the Twitter handle 'EU_ScienceChief' raised some eyebrows in the JRC and DG RTD.

A significant challenge was the fact that the CSA was not on the radar of any Commission procedures and was often cut off from vital information. With one exception, I was never invited to attend meetings of the College of Commissioners – unlike the DG of BEPA who sat in on a regular basis as a standing observer. Likewise, I was not invited to the weekly meetings of the Directors-General, except for one occasion when I reported on my experiences over the first year. Nor was I copied into messages sent by the Secretary-General to the Directors-General. This meant in practice that both the Commissioners and the Directors-General were always better informed than the CSA's office. Moreover, the Commission's internal information systems did not allow services to consult the CSA directly, nor did my office have direct access to some systems, such as the Argus system used for crisis management.

More than once, this state of affairs resulted in instances where internal information reached me accidentally (sometimes from external sources), occasionally leading to embarrassing situations that reflected poorly

on the Commission. This included the briefings and speeches of the President, on which the CSA was rarely asked for input. It took until 26 July 2012 for detailed terms of reference for the CSA role to be adopted and communicated to the relevant Commission services. The official note specified, inter alia, that:

- The CSA will cooperate closely with all relevant Commission services in order to gather the evidence necessary for her advice, and these services are invited to contact the CSA proactively to flag issues related to her remit.
- The formulation of research, science and innovation policies will remain the responsibility of the relevant portfolio Commissioner.
- The Impact Assessment Board will invite the CSA to examine proposals with a policy dimension that are controversial in nature.
- The CSA may establish a Working Group looking at how to enhance the scientific evidence gathering by the Commission.
- Commission services may consult the CSA on proposals with a scientific dimension that can be expected to be controversial in nature when establishing the Work Programme of the following year.
- The CSA will provide guidance to Commission services when setting up and managing scientific advisory bodies, and is to be consulted before taking any decision regarding new scientific advisory bodies.
- The CSA will explore the feasibility of setting up a high-level scientific advisory group for the President.
- The CSA may be invited to the weekly meetings of Directors-General when such meetings deal with matters falling within her remit.
- The CSA will liaise with bodies of other European institutions that provide science advice.
- The CSA will coordinate all Commission relations with other Chief Scientific Advisers, or similar functions, from the public and private sectors, whether national or international, and will represent the

Commission on networks of Chief Scientific Advisers as well as actively support the development of these at European and global level.

- The CSA will act as overall coordinator for scientific horizon scanning, anticipation and foresight activities in the Commission, and is to be consulted before embarking on any major exercises of this type.

- The CSA will be a proactive ambassador for European science, engineering and technology.

- The CSA will contribute to the President's speeches and briefings within the remit of the CSA's mandate, and will support high-level, science-related visits to the European Commission and visits of the President to scientific establishments.

- The CSA will promote science and technology and its take-up in society, and will actively engage in public debate about the opportunities and risks of new technologies.

- The Commission services will nominate 'CSA correspondents' to interact with the CSA.

I was never requested to provide advice on the evidence underpinning policy proposals submitted to the College of Commissioners, and was never involved in providing advice on files leading to College decisions. I was not given the authority to *"provide authoritative guidance on interpretation of scientific evidence in presence of uncertainty"*. I did get involved, however, in the management of emergencies; the DG Humanitarian Affairs (ECHO) engaged with me proactively, and the Secretariat-General invited me most recently to high-level meetings on the handling of the Ebola crisis.

Tilting at windmills

> *It was as if God had decided to put to the test every capacity for surprise and was keeping the inhabitants of Macondo in a permanent alternation between excitement and disappointment, doubt and revelation, to such an extreme that no one knew for certain where the limits of reality lay.*
>
> **Gabriel García Márquez, *One Hundred Years of Solitude***

Several Directors-General explicitly welcomed the CSA's role as an honest broker, in particular where dialogue with external stakeholders – but also within the Commission – had been characterised by polarised or entrenched positions. However, it is also true that the Commission administration as a whole did not embrace the CSA role, as it did not fit well into the existing Commission structure.

In particular, the interaction of the CSA with the public was an issue of concern for the administration. I gave a lot of interviews to the media – which had to be cleared by the Commission's Spokespersons' Service – and spoke frequently about scientific evidence at public events, including on politically (but not scientifically) controversial issues such as GM technology. In autumn 2012, one of these speeches triggered a question from a Member of the European Parliament asking about the Commission's position on the views I had expressed on GM technology. The answer given by the Commission – I was not consulted on the final text – was as follows:[8]

> *"The Commission wishes to use the opportunity to clarify to the Honourable Member the role of the Chief Scientific Adviser (CSA). The CSA reports directly to the President of the Commission and has the task to provide independent expert advice to the President on any aspect of science, technology and innovation and the potential opportunities and threats to the EU stemming from new scientific and technological developments. Likewise, the CSA has a role in enhancing public confidence in science and technology and to promote the European culture of science. In this context, the CSA has a role in stimulating societal debate on new technologies and to communicate the existing scientific evidence about such technologies. The CSA has a purely advisory function and no role in defining Commission policies. Therefore, her views do not necessarily represent the views of the Commission."*

The Commission was therefore dissociating itself in public from its own CSA. While the lack of buy-in from the Commission administration was not surprising – having an internal 'Chief Devil's Advocate' would be uncomfortable for any administration – there was also a lack of support from parties where one might have expected it. For instance, despite the President's genuine interest in science, our relationship was not as close as it could have been. While meetings with the President's Cabinet were scheduled once a month, those with the President himself were much less frequent (which can partly be explained by the President's busy diary

during the euro crisis). Most communication went via the President's Cabinet, and answers from the President to requests usually took some time. The advice I gave to the President – on matters as diverse as space weather, dengue fever and the Higgs boson – was mainly proactive rather than at his request, and feedback on briefings was rare. The weak link with the Commissioner for Research, Innovation and Science was another issue of concern and hampered making full use of the CSA role to everyone's advantage.

Also, the relationship with the JRC proved rather cumbersome, mainly because of the administrative distance between it and the CSA, which involved two intervening Cabinets. While this interaction was never a problem at the working level – JRC staff provided a great deal of support and were eager to engage with me during my visits to all JRC sites – at the DG level, support was rather lukewarm. There was a lack of information flow between the JRC and the CSA which hampered development of the CSA role. DG RTD took a more proactive role in engaging with the CSA, and supported me on several occasions, for example by funding a Eurobarometer Survey on foresight. With its ongoing transformation from a funding agency into a policymaking entity, DG RTD is also stepping increasingly into the science-for-policy business and saw the CSA as an ally for its cause, for example in creating linkages with science academies.

The most supportive DG was DG Connect. The Director-General of Connect supported me from day one, interacted with me on an almost weekly basis, invited me to many events – including a senior management meeting of the DG – and provided hands-on support for many tasks the CSA team could not carry out because of a lack of resources. He proactively used the CSA as an ambassador for the digital society, brokered speaking engagements and served as a critical friend, being fully committed to evidence-informed policymaking. Had such support been Commission-wide, the impact of the CSA role would have been greatly enhanced.

On 8 March 2013, the journal Science published an article entitled *Europe's Science Superwoman Struggles to Get Off the Ground*[9] which was written by a journalist who had shadowed me for a full day. The article, which can be considered as a kind of unofficial mid-term evaluation of the role, concluded: *"Glover's influence is hard to discern so far. […] With less than 2 years left until Barroso's term expires, Glover is pressing hard to raise the profile of science and evidence in European politics."*

Given that with such a small team the scope for me to act was very limited, innovative ideas to enlarge the team had to be developed. At the end of 2012, the Director-General of the European Space Agency (ESA) generously offered, at no cost, to second the French foresight expert Dr. Didier Schmitt to the CSA team. This enabled me to implement the foresight part of my mandate.

Further, following the end of the contract of the Seconded National Expert (SNE), Professor Ana Maria Costa Freitas, in autumn 2013, I was able to recruit another SNE as a replacement, namely Xameerah Malik, who previously advised the Science and Technology Select Committee of the UK's House of Commons. Malik managed the President's Science and Technology Advisory Council, and played a crucial role in enhancing its potential. In addition, through a short trainee programme, in mid-2014 the CSA team was enlarged by another secondment from the Belgian Academies, Sofie Vanthournout, who provided a direct and welcome link with the European Academies' Science Advisory Council (EASAC).

Making an impact

> *José Arcadio Buendía would spend the day walking through the house. "Incredible things are happening in the world," he said to Úrsula. "Right there across the river there are all kinds of magical instruments while we keep on living like donkeys."*
>
> **Gabriel García Márquez, *One Hundred Years of Solitude***

Despite the lack of resources, the CSA role had a substantial impact. Looking back on three years, the highlights for me include the following:

I established and chaired the President's Science and Technology Advisory Council (STAC), which had eight formal meetings following its launch in February 2013 – all of which were attended by the President himself. STAC was made up of 16 eminent scientists from across the European Research Area (including members from Switzerland and Israel) who covered a wide range of scientific disciplines.[10] The Council was not designed as a technical advisory board, but had the aim of thinking about the 'big picture' role of science, such as its relationship with society, and its role in a future vision for Europe. In autumn 2013, I published a Berlaymont Paper *Science and society: Time for a new deal*, which included the first opinions of STAC,

entitled *Science for an informed, sustainable and inclusive knowledge society.*[11] At a conference in Lisbon in October 2014 – the first and only time the President appeared in public with me – STAC delivered a paper on science and technology foresight called *The future of Europe is science*[12] which highlighted how Europe can make the most of science, engineering and technology opportunities over the next 15 years.

In June 2014, I also set up the European Science Advisers Forum (ESAF), a network of government science advisers, currently drawn from 15 Member States. I launched this forum in December 2012 when speaking at the Competitiveness Council (the Council meeting of European Science Ministers), where it received great support. However, failing to get the direct backing of the Secretary-General or the President, I embarked on a programme to convince Member State governments, one by one, of the advantages of having a government science adviser or at least of nominating a person to represent the country in the new European network. Identifying these individuals was not an easy task given the diversity of cultural approaches to science advice in Europe (some Member States opt for the CSA model, some for the academy model, some for an advisory board model). Still, the efforts have paid off as more and more Member States have been thinking about establishing such roles. ESAF will allow European and national science advisers to discuss the scientific evidence around topics of pan-European relevance ahead of political decisions, to share best practice and to promote evidence-informed policymaking in the EU. The platform will also allow quick sharing of scientific information in cross-border emergencies. This will ideally enable politicians to focus their meetings in Brussels on the political choices, rather than losing time with discussions on how to interpret the evidence.

I was a member of the organising committee of the first global meeting of government science advisers which took place on 28–29 August 2014 in New Zealand, attended by science advisers from all continents, including many G20 nations, who discussed how to enhance science advice in the global context.[13] This activity is now developing into an ongoing global network of government science advisers.

I contributed actively to the establishment of the EU Agencies' Network of Science Advisers (EU-ANSA), a network of the Chief Scientists of the various EU agencies which pushes for greater coherence in the scientific advice delivered by these agencies to European policymakers. The terms of

reference of this network made the CSA the Commission's representative on the network, providing a link to other science advisory bodies of the Commission. On repeated occasions, I also spoke at meetings of the European Research and Innovation Area Board (ERIAB), and of the European Group on Ethics in Science and New Technologies (EGE).

For evidence providers such as science academies and other learned societies, the CSA formed an easy interface with the Commission. In collaboration with DG RTD and the JRC, I set up a strategic partnership between the Commission and the European umbrella organisation of the national academies of sciences (EASAC), the national academies of applied sciences and engineering (Euro-CASE) and the academies of sciences and humanities (ALLEA). This has enabled the scientific community to deliver advice in a much more targeted and timely manner to European policymakers. For instance, following the temporary ban of certain pesticides (neonicotinoids) by the Commission in 2013, I brokered an independent report by EASAC on the state of knowledge regarding the impact of these pesticides on the health of pollinators, which was delivered in time for the revision of the two-year ban.

Without being specified in my mandate, the CSA acted as a de facto 'scientific ombudsman' for the Commission, being a visible and trusted first port of call for a wide range of stakeholders who wished to discuss issues related to scientific evidence with the Commission. The fact that the public perceived the CSA in this way showed the usefulness of having such a function. Also, I was engaged in examining how best to frame the Commission needs for evidence, how to best source that evidence in an unbiased manner and how to ensure transparency in the process.

As demanded by my terms of reference, I established and oversaw a Commission-wide network to act as an internal coordination and communication tool for foresight. More than 200 staff from 21 DGs were assigned to the network and contributed actively. This allows the Commission to be better prepared to seize the opportunities presented by future technologies and societal change, as well as to manage potential risks. The network organised workshops on foresight and produced dozens of 'technology fiches' outlining current science and technology trends and their implications for EU policymaking. The CSA office also provided all aspects of science and technology foresight to the European Strategy

and Policy Analysis System (ESPAS),[14] a joint foresight undertaking of the Commission, Council, Parliament and European External Action Service (EEAS).

During my tenure, I spoke at some 250 public events, including the largest general science conferences in Europe and the United States. I gave more than 100 interviews to the media and sent more than 1600 tweets, all written by myself. I also represented the President on various occasions, such as the inauguration of the world's largest radio telescope (ALMA) in Chile in March 2013, and the launch of the first satellite of the Copernicus Earth Observing System from the European spaceport in Kourou in April 2014. The CSA was in great demand to speak about European science issues. Having this attention helped to get across positive messages about European science and technology, but also the Commission's commitment to evidence-informed policy-making, to a wide audience, including opinion-leading media and social media.

Last but not least, I have been a strong advocate – and hopefully a role model – for attracting women to careers in science, for example by speaking at a European Council event on gender equality chaired by Council President Van Rompuy. I frequently engaged with young people to stimulate their interest in science (including a memorable interview with the Muppets-like Captain Busta![15]).

Sailing into the storm

> *Thus they went on living in a reality that was slipping away, momentarily captured by words, but which would escape irremediably when they forgot the values of the written letters.*
>
> **Gabriel García Márquez, *One Hundred Years of Solitude***

On 17 June 2013, the CSA's office and the President received an open letter signed by a number of scientists complaining that the Commission was ignoring the scientific evidence around endocrine disruptors. This was followed by other letters opposing it; this exchange of views has to be seen in the context of a wider dispute between two scientific camps in the field of endocrine disruptors who were bombarding each other with journal editorials. As I did not want to join either of the two sides, and found

this public discussion to be rather unhelpful for science, I invited three representatives of each side to meet in my office to explore consensus and identify areas of disagreement.

My engagement in this politically very sensitive topic triggered the fury of NGOs and journalists who had for a long time accused one of the two camps of having conflicts of interest (based on the fact that some had worked for, or cooperated with, industry), and saw my response to the letter and my invitation to meet for a scientific discussion as giving lobby interests a platform.

On 11 July 2013, the CSA's office received a first request for access to documents (the EU equivalent to a request under the UK's Freedom of Information Act),[16] submitted by French journalist Stéphane Horel, asking for access to all correspondence exchanged between the CSA and President Barroso as well as a number of industry groups, politicians and science advisers on the issue of endocrine disruptors.[17]

The meeting of the two scientific camps took place in my office on 24 October 2013, expressly without policymakers being present and with the participating scientists paying their own travel expenses (as the CSA office had no budget for organising such meetings). At the conclusion of the meeting, the participants agreed on a joint statement, and later on the full minutes of the meeting were published on the CSA website, in line with my desire for full transparency.[18] DG Environment and DG Health and Consumers appreciated the efforts of the CSA to get more scientific clarity on the issues and to calm the polemic between the two camps.

When at the end of 2013, the Commission decided to delay the endocrine disruptor legislation in order to carry out a full impact assessment, the NGOs and various media outlets constructed a story in which the CSA's intervention had led to the delay. I was accused of taking the scientific dispute 'to the highest levels' by copying the President and the Secretary-General into my messages – which in fact was my administrative obligation, as the CSA reports directly to the President. Several NGOs and journalists expressed suspicion that the CSA could override the political process by offering a short-track for lobbyists to bypass Commission procedures and undermine the work by expert committees. This grossly misinterprets both the role and the influence of a science adviser and, in fact, of the Commission President himself, who cannot dictate or override decisions taken in the College of Commissioners.

Endocrine disruptors were not the only hornets' nest I dared to stir. I also talked in public about the evidence regarding other political minefields, such as genetically modified organisms (GMOs). On 29 November 2013, the French MEP Corinne Lepage, in a public press conference held together with researcher Gilles-Éric Séralini, author of a disputed study about tumours in rats caused by a GM maize strain, called on me to resign as I had "*conveyed a one-sided view*" on genetic engineering. At the same press conference, Ms. Lepage wrongly accused me of being a former employee of Monsanto (a statement she later retracted following a complaint from me).[19] It is to be noted that neither the President nor the Commission at any time defended me in public against such damaging accusations.

One of the issues raised by Ms. Lepage was the fact that there was no conflict of interest statement for the CSA publicly available. I support transparency and wanted to publish such a statement when joining the Commission, but this request was denied as the Commission administration feared it could set a precedent for other senior officials (only the Commissioners are obliged to publish such a statement). Following Ms. Lepage's accusations I published – without the explicit authorisation by the Commission – a detailed conflict of interest statement on the CSA website.[20]

On 3 January 2014, a second access to documents request reached the CSA's office, this time submitted by the NGO Pesticide Action Network Europe, asking for all correspondence I and my team had with anybody on the topic of endocrine disruptors or pesticides. This was followed by a request by the NGO Corporate Europe Observatory on 21 March 2014, asking for all correspondence the office had with a list of 21 companies, business associations and lobby groups (interestingly, EASAC was included in the list), as well as any correspondence with a list of EC Directorates-General, the UK government and the US government on issues as diverse as endocrine disruptors, GMOs and the precautionary principle. It goes without saying that the handling of these requests – which by law need to be responded to within 15 working days – put an enormous workload on my team and considerably slowed down the work of the office.

On 20 May 2014, shortly before the European Parliament elections, I invited several of the NGOs that had questioned the CSA role to a meeting to ask them how they would want to see the role improved. While the atmosphere of this meeting was frank and open, the NGOs declined to offer alternative solutions.

On 22 July 2014, nine NGOs wrote to the then President-designate Juncker asking him to abolish the CSA role.[21] The NGOs alleged that *"the post of CSA is fundamentally problematic as it concentrates too much influence in one person, and undermines in-depth scientific research and assessments carried out by or for the Commission Directorates in the course of policy elaboration"*. They also described the CSA as being *"unaccountable, untransparent and controversial"*.

Let me analyse this criticism. First of all, consider the claim that there was *"too much influence in one person"*. The CSA never had a role in policymaking in the Commission, nor did the CSA have (or seek to have) the power to stop a policy process. The CSA never was, or meant to be, an evidence provider but rather an evidence translator who gathered data from the broadest possible range of sources and acted as an honest broker in translating this evidence for the President. It was entirely up to the President whether to take the advice offered, or not. Of course, in so doing, I was accountable to the President and my employer. While I did not shy away from politically controversial topics, the opinions I expressed reflected the consensus view in science, without disregarding minority opinions or uncertainty. My public speeches never left any doubt about the stance I took on various politically sensitive matters.

In particular, the anti-lobby NGOs criticised me for a lack of transparency. Without any doubt, transparency is an essential requirement for a science adviser as this allows public scrutiny of the advice given and checks on whether the advice indeed reflects the majority view of the scientific community. While it is normal that personal advice given to a high-level politician has a certain degree of confidentiality, there is no reason why formal advice given (e.g. written briefings) could not be published. However, it was the decision of the President whether advice received from his science adviser could be made public or not, and regrettably, this approval was not given.

Quite rightly, opponents of the CSA role wished to see greater transparency in the provision of advice. However, it would equally be welcome to understand the evidence base that the NGOs used to support their positions, and to see matching transparency of the advice requested and delivered within their organisations, some of which – e.g. Greenpeace – have Chief Scientists. It was bizarre to see Greenpeace UK's Chief Scientist Doug Parr criticising the very concept of having a Chief Scientist[22] – why is it OK for Greenpeace but not elsewhere?

The NGOs' letter triggered a big media response and an open response was coordinated by the UK-based organisation Sense about Science, which was signed by more than 700 scientists and scientific organisations.[23] Others from the scientific, think-tank and business communities voiced their support for the CSA role in separate letters sent to President Juncker. These included BusinessEurope,[24] EASAC,[25] research charities and foundations,[26] and the European Federation for Science Journalism.[27] Some media articles accused the NGOs of wanting to abolish the CSA post because of my well-known position on GM technology.

As a result, the NGOs wrote another letter on 19 August 2014.[28] In this, they said that they are not anti-science but believed that *"continuing the CSA position poses a risk to scientific policy advice in general"*. They demanded *"more objective and diverse expertise (be made) available to policymakers than any single adviser could reasonably be expected to provide"*. They again described the CSA role as *"fundamentally flawed"*.

This letter again reveals a misunderstanding of the CSA role, as it was never designed to replace any of the formal science advisory structures in the Commission, but to complement these and provide a voice able to help with the interpretation of evidence and uncertainty in an unbiased manner. In the past, science often did not speak with one voice, offering politicians a scapegoat which could be used to ignore scientific consensus or, worse, to ignore science altogether. Certainly, a single scientist cannot be an expert in all fields and I never claimed to be this. However, a CSA should be able to access the best science globally, and identify what is sound, peer-reviewed science and what is not.

The second NGO letter also triggered reactions from many others, which in a way was helpful as it thrust the CSA role into the spotlight. It was followed by a large number of articles in European newspapers,[29] and was actively also picked up in the blogosphere,[30] while the NGOs also reinforced their messages.[31]

In the meantime, the High-level Working Group on Innovation Policy Management of the European Council delivered its final report to the European Council in August 2014 recommending that the CSA role in the Commission should not only be retained, but strengthened and enlarged.[32]

On 23 September 2014, I submitted a major briefing file to President-elect Juncker, consisting of separate briefings about the CSA role and my experiences so far, comments on the President's Science and Technology Advisory Council, and ideas on how to improve the role of scientific evidence in EU policymaking. I also stated that I would not be seeking reconfirmation in the role were it to be continued. I did not receive a response.

In its first meeting on 5 November 2014, the new Commission decided to transform the former Bureau of European Policy Advisers (BEPA) into the European Political Strategy Centre (EPSC). I was informed one week later by email that the CSA post had ceased to exist on 31 October, and would not be renewed in the new structure. I was informed that I could no longer speak with the authority of the Commission, that no further travel by me or my team would be authorised, and that no future commitments by the CSA team could be honoured. Although not mentioned, the Science and Technology Advisory Council was also discontinued. Except for the creation of EPSC, none of these developments was proactively communicated by the Commission to the public.

It was a disappointment that my offers to meet with the new President or his Cabinet were never responded to, and it remains unclear to me from where the advice to abolish the role came.

Lessons learnt

> *The idea of a peninsular Macondo prevailed for a long time, inspired by the arbitrary map that José Arcadio Buendía sketched on his return from the expedition. He drew it in rage, evilly, exaggerating the difficulties of communication, as if to punish himself for the absolute lack of sense with which he had chosen the place.*
>
> **Gabriel García Márquez, *One Hundred Years of Solitude***

First of all, it is important to remind ourselves that EU policies are much more technical than national policies; this is because the bulk of them are about standardisation and harmonisation, which at the end of the day boil down to scientific-technical matters. Science is therefore crucial at the EU level.

The European Commission has very rigorous procedures and draws up its proposals from a wide number of sources, the JRC and the EU agencies being of particular importance in this context. Still, the wealth of competence and expertise already available is not fully valued and harnessed. This is partly because there are no harmonised guidelines for gathering, using and communicating scientific evidence which leads to very diverse approaches by different Commission services, and opens the possibility of evidence being procured and used selectively.

Even though the Commission – with or without a CSA – has a well-established science advisory system, this is not the case for the European External Action Service (EEAS), the European Parliament or the European Council. The EEAS does not have science anywhere on its organogram and does not seem to have discovered the value of science diplomacy. The current Parliament, elected in May 2014, consists of 751 MEPs from 190 different national parties, all with their respective philosophies. The Research Service of the Parliament was established only in October 2013 and is still in its infancy. The European Council does not have a science service at all, and most Member States do not have formally appointed government science advisers. It became clear that a CSA in the Commission would need counterparts (in whatever setup) in the other European institutions, as well as in Member State governments, to enhance evidence in policymaking. This is one of the reasons I devoted so much effort to establishing the European Science Advisers Forum as a platform for exchange between science advisers.

The fact that the CSA role was attached to the President directly gave it a high public visibility from the start, and the independence 'to say the things the rest of the Commission cannot say' – and thus the ability to trigger debate about issues that otherwise might have been politically too sensitive to address. It also enabled the President to have ad hoc and direct personal access to scientific advice, and – even though the CSA did not have any institutional power – the role had a strong convening power (albeit a limited power to act on this, owing to lack of resources). Its unique position enabled the CSA to have a helicopter view of all Commission services, and to spot missing in-house collaborations and foster others. Being attached to the President did not mean that I saw him a lot – but it meant that people listened to me and doors were opened which otherwise might have stayed closed.

Many people inside and outside the Commission appreciated the fresh approach of the CSA role. In fact, there was far more appetite for scientific evidence in Brussels than I had previously thought. While widespread support for the role from the scientific community could be expected there was also strong support from business, which came as a surprise – in particular considering the fact that I had openly made critical remarks about the transparency and public engagement of industry, and its role in combatting global warming. Although NGOs tried to discredit this support from industry by accusing the CSA of being an additional lobbying conduit, I had a genuine feeling that industry was interested in having an evidence-based debate, and saw the CSA as a voice of reason that could help to make this happen.

The opposition from a few NGOs to the CSA role was disappointing and, at least in part, seemed motivated by my public remarks regarding the evidence around GM technology. The criticism from anti-lobby NGOs had a different nuance and was more focused on the way the role had been set up and the perceived lack of transparency. There is no doubt that such a visible role close to the President is prone to lobbying, and there is hardly any business association in Brussels that did not request a meeting with me in the past three years. I refused to meet many of them, in order to keep my stakeholder interactions balanced. It is therefore absolutely vital that the CSA role, if it were to be re-established in future, is allowed to be much more transparent, while respecting the need for confidentiality with the President.

Also, the CSA should be made a formal part of Commission procedures. Most notably the role should be a member ex officio of the Impact Assessment Board, able to monitor whether impact assessments are based on the best possible evidence. Being part of Commission procedures also means being part of the information flow. In the past three years, the CSA was isolated from the Commission machinery: isolated from the policymaking procedures; isolated within the Bureau of European Policy Advisers; and, most importantly, isolated from the Commission's in-house science service, the JRC. If the Commission were to consider having a CSA again, the role should be close to the President (or the Vice-President in charge of better regulation), but the CSA office and staff could be provided by the JRC, to ensure a closer link between the two.

It became evident that the mandate given to me was not achievable with a team of just three senior staff (two of them seconded from outside the Commission) and two secretaries. By comparison, the CSA office in the UK has more than 60 staff and the Scottish CSA office has more than 10. Delivering the mandate with such limited resources (including a budget that hardly covered the travelling, yet alone meetings) was an impossible task. The sheer number of requests posed an unmanageable workload on my team, which routinely worked more than 50 hours a week without any public relations support. One could not expect that everything would be perfect when implementing the CSA concept for the first time in the European Commission. One would have hoped, however, that the role would have been set up with the adequate resources, and with a minimum support in-house, which was not the case.

The CSA model is, of course, only one option for providing direct scientific advice to the President. The fact that President Barroso participated in all meetings of his Science and Technology Advisory Council while not being so forthcoming in his interactions with the CSA, might indicate that he felt more comfortable with a committee-oriented approach to science advice. To have a publicly outspoken science adviser, who challenges the evidence base of policies, requires political courage. Still, the President's Science and Technology Advisory Council was never implemented as a formal advisory structure, unlike bodies such as the European Group on Ethics in Science and New Technologies. It therefore disappeared with the end of the Barroso mandate.

Despite these many frustrations, having been the first CSA in the European Commission has been a very rewarding experience, and with a small but outstanding team, had quite an impact. Giving voice to the excellence of European science for the benefit of its citizens has been a privilege. I am convinced that the CSA role in the European Commission deserves a second chance, given the many achievements and the wide support it received; the challenge would be to learn from the mistakes and build upon the successes.

Úrsula, almost blind at the time, was the only person who was sufficiently calm to identify the nature of that determined wind and she left the sheets to the mercy of the light as she watched Remedios the Beauty waving goodbye in the midst of the flapping sheets that rose up with her,

abandoning with her the environment of beetles and dahlias and passing through the air with her as four o'clock in the afternoon came to an end, and they were lost forever with her in the upper atmosphere where not even the highest-flying birds of memory could reach her.

Gabriel García Márquez, *One Hundred Years of Solitude*

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Endnotes

1. See http://europa.eu/rapid/press-release_SPEECH-09-391_en.htm
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WHY IT MADE SENSE TO SCRAP THE POST OF CHIEF SCIENTIFIC ADVISER

Doug Parr

When President Juncker took up office, a coalition of civil society groups called on him to abolish the post of European Commission Chief Scientific Adviser (CSA), which had been created by his predecessor in 2012. By contrast, many science institutions supported a continuation of the role. In this essay, I want to explain why the civil society groups took such a stance.

An initial letter[1] setting out some of the issues and calling for the post to be scrapped was signed by nine non-governmental organisations. There was then a strong reaction from scientists and other groups,[2] who saw our call for the abolition of the CSA post as being an attack on the *"integrity and independence of scientific advice"*.

Perhaps surprisingly for those who were defending the CSA role, far from quelling dissent, the group calling for the post to be abolished then tripled in size as more NGOs from the environment, health and governance sectors supported a second letter[3] which elaborated why the CSA post had become an impediment to good science in policymaking. This second letter pointed out that *"it is precisely this integrity and independence (of science advice) that we are seeking to uphold"*. Many of the statements supporting the role of the CSA have come from leading scientists and well-respected scientific institutions.[4, 5] But, as was observed by public interest lawyer Alberto Alemanno, who has previously written about the CSA post, *"most of these statements of solidarity mostly accused the NGOs of being anti-science in their stance rather than constructively engaging with the legitimate concerns they advanced"*.[6]

Evidence for abolition

So what are the issues that caused the NGOs to call for the CSA role to end? One of the key worries is that, to quote the first NGO letter, *"vested interests have long realised that the more you concentrate scientific advice into the hands of one person, the easier it is to control"*. A big and powerful early supporter of a renewed CSA position was Business

Europe[7] which in its recommendations for the post notably did not suggest increasing its resources or its transparency. The same business lobby has identified a 'hit list' of gender-equality, environmental-protection and product-safety laws.[8] Its regressive position and record on environmental matters are so poor that progressive companies like Unilever are choosing to terminate their membership.[9]

Those who simply equate supporting the renewal of the CSA post with progressive positions on evidence and policymaking should take notice of whom, in the practical politics of Brussels, they are siding with. The political ecology of Brussels includes a heavy presence of corporate lobbyists[10] – said to be second only to that in Washington. Society needs broad-based and open evidence gathering to act as a bulwark against a policy stitch-up in favour of vested interests. A real worry for civil society signatories to both the letters about the CSA is that simply in terms of lobbying muscle, corporate lobbyists are always going to win out against those acting in the public interest. Rigorous science processes are therefore needed as a defence.

The CSA adds an extra layer (or centre of power) in scientific advice. As the second NGO letter put it, *"the Commission already has a set of processes and institutions providing scientific policy advice. The general problem is not a lack of scientific evidence, but the inconsistency with which the European Commission responds to the evidence presented even by its own services"*.

The EU already has a vast amount of science advice and evidence-gathering capability. The Joint Research Centre[11] and European Environment Agency[12] produce a great deal of evidence and reports, both at the request of the Commission and independently, and existing Directorates have numerous advisory committees.

This view is not confined to NGOs. At a hearing in December 2014 organised by the European Parliament's Committee on the Environment, Public Health and Food Safety, Dr. Bernhard Url, the Director of the European Food Safety Agency (EFSA), was asked by UK Conservative MEP Julie Girling whether he thought President Juncker needed a CSA. Dr. Url replied that he thought that the European Commission had *"a lot of scientific knowledge in its agencies and the JRC"* and that there was *"enough scientific capability around (...) without a Chief Scientific Adviser"*.[13]

Alberto Almmanno makes a similar point: *"the creation of this role seems to have created more problems than those that it solves"*[14] and *"the burden of proof rests with the EU Commission to prove the merits, and more specifically, the rationale for having yet another source of scientific advice in the EU"*.[15]

A recipe for confusion

In fact, having an 'extra' source of science advice confused responsibilities and mandates, and made it unclear who was in charge, and where the crossover lay between science and policy processes. Take the example of endocrine-disrupting chemicals (EDCs).

A process was ongoing within the Commission to establish criteria to identify EDCs. In June 2013 the CSA received a letter from a group of scientists expressing concern about the EDC process.[16] In the next few days the CSA, Anne Glover, sent a note to the Director-General of the Commission's Environment Directorate asking him *"to provide (her) with factual information to allow (her) to respond"* to the critique.[17] However, the note was also copied to several of the most senior decision-makers within the Commission, including the Secretary-General and President Barroso's head of cabinet, and described the authors of the letter as being *"very eminent experts"*.

Two weeks after this intervention, the Commission's Secretary-General decided to delay the process of defining the criteria to identify EDCs.[18] In fact, after having criticised the Commission's work on defining EDCs, the authors of the letter dropped their opposition when they faced the experts working for the Commission at a meeting the CSA organised in October 2013. Moreover, over half of the signatories of the original letter had links to industries that would be affected by the regulation of EDCs.[19] But by then a Commission process had halted. From this example, we see that the intervention by the CSA:

- Added strong political content to a science-based discussion through copying to high levels in the Commission
- Bypassed scientific institutional processes within the Commission

- Presented the signatories to the letter as being authoritative on the issue of EDCs

- Created the impression that there was significant scientific controversy regarding the definition of EDCs when there was not.

The case study highlights the unclear mandate and relationship with other Commission processes of someone who is apparently senior but has no resources. This example should under no circumstances be seen as an allegation of bad faith on the part of Anne Glover. Think about the context: an unclear line between science and politics, lack of clarity about the relationship between CSA and Directorate processes, and an (apparently) authoritative group of scientists saying there is a problem on an issue which is outside your academic background. What would you have done? There is clearly an intrinsic difficulty in the nature of the role as it was created.

What can't a CSA achieve?

Across the European Commission there is variability in the quality of science used in policymaking which needs to receive far more attention. There is currently no mechanism to deal with these weaknesses, and the CSA had neither the authority nor the capacity to address them.

For example, the EU's climate and energy policy relies for its impact assessment on an economic model known as PRIMES. Energy policies involve hundreds of billions of euros of investment, yet the PRIMES model has been heavily criticised by civil society groups[20] and business groups as well as commission advisers[21] for its lack of transparency and questionable methodology.

Sometimes the gap between broad reviews of science and the resulting policy it delivers is large. Take bioenergy, for example.[22] Science tells us that impacts on the carbon cycle in both the biofuels and biomass sector are complex but important. Yet the changes in land use indirectly caused by the production of biofuels,[23] or the carbon debt arising from the use of wood as fuel[24] are not represented meaningfully in sustainability standards, potentially undermining any benefit that those bioenergy sources could provide in tackling climate change. The problem here is the ability of decision-makers to incorporate principles and insights into evidence gathering and policymaking.

There may be a case for a centralised audit function to scrutinise science processes. However the CSA post is neither designed nor equipped to address these weaknesses in Commission science policy advice. Instead, it adds another scientific advisory post – and one that functions in a flawed way. Flawed, because some of the activities of the CSA so far appear to have run directly contrary to science advice principles like transparency and clarity of responsibilities. For example, Anne Glover's advice to President Barroso was not public, and far from insisting on the robust levels of accountability required, she once commented that her advisory opinions should remain *"not transparent"* and *"immune from public scrutiny"*.[25]

The GMO debate

The call from NGOs was interpreted in a number of media outlets as a request to have Anne Glover sacked because of her views on GM crops. It is worth returning to the actual wording of our initial letter:

> *"While the current CSA and her opinions were very present in the media, the nature of her advice to the President of the European Commission remains unknown. We have not been able to obtain any information on what the Commission President has requested advice on, let alone what advice has been given. To the media, the current CSA presented one-sided, partial opinions in the debate on the use of genetically modified organisms in agriculture, repeatedly claiming that there was a scientific consensus about their safety whereas this claim is contradicted by an international statement of scientists (currently 297 signatories) saying that it 'misrepresents the currently available scientific evidence and the broad diversity of opinion among scientists on this issue'."*

The point the letter was making was about the CSA's presentation to the media of a supposed scientific consensus, in contrast to the secrecy surrounding the actual science advice she was giving. Coming late in to the discussion, I would accept that this might have been better and more clearly articulated. Nonetheless it is still surprising the extent to which this paragraph, despite being given extensive context in the letter itself, was interpreted as being NGOs wanting Anne Glover sacked because of her views on GMOs.[26, 27, 28] This may possibly be because one think tank in the UK composed its own open letter saying that the NGOs objected to the post

"specifically because they disagree with Professor Glover's advice on genetically modified crops and organisms".[29] In fact, a number of the signatories to the first letter, and a larger number to the second, have no general position on GMOs.

What should science advice look like in Brussels?

Following the controversy over the CSA post, a group of NGOs collectively developed a set of principles for science advice[30] that we want to see incorporated into the new arrangements that President Juncker is now establishing. These principles are not prescriptive about the structure to be adopted, and they were developed after extensive exchanges between the 18 NGOs who signed up to them. The key principles are as follows:

- Transparency of advice
- Clarity of the relationship between science advice and political choices
- Clarity of roles and relationships in the evidence-gathering and appraisal processes
- Independence of the advice from financial interests
- Full explanation of the reasons for policy decisions, and the role of science advice in coming to those decisions
- Public funding for information of public value.

There is also an important overarching principle that the public should be involved in framing the questions at stake. And explicit attention should be paid to uncertainties and knowledge gaps.

There is much to be done to establish a proper relationship between the plethora of scientific activity by EU research institutes and the policymaking apparatus. The CSA post actually muddied the waters rather than helping things, and its abolition is now an opportunity for a thorough appraisal of how these relationships can be better organised. Public involvement, transparency and independence must be central to any new arrangements that are put in place.

Acknowledgements

I would like to thank all the NGO members who contributed to the development of our principles of science advice, and especially to Martin Pigeon who helpfully coordinated and documented the ongoing discussion about the CSA role.

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LESSONS FROM FINLAND

Kari Raivio

As Commissioner Moedas undertakes his review of science advisory models for the European Commission, what insights can Finland offer? I was recently commissioned by the Prime Minister's office to undertake a similar exercise in Finland.[1] My terms of reference included a review of advisory structures in Finland and elsewhere, and a survey of the expectations of decision-makers. I was also asked to propose a new, more systematic framework for scientific advice.

Basing policy decisions on solid scientific evidence is seen in Finland as one element of an ongoing reform of central government structures and functions, responding to a set of shared challenges that were identified by a joint working group of the governments of the UK, Scotland, Sweden, Austria and Finland.[2] At a European level, the need for sound scientific evidence as the basis for the policies of the European Commission was emphasised in the mission letter of President Juncker to Commissioner Moedas.[3]

Problems in policymaking

'Evidence-based policy' was not part of the vocabulary of the Finnish government until quite recently. However, there is a growing recognition of the need to bring more and better scientific advice into political decision-making. The quality of legislative proposals and impact assessments submitted by ministries to the Finnish parliament has been deteriorating, as highlighted by the National Research Institute for Legal Policy and the Audit Committee of the Parliament. In international negotiations, the voice of a small nation like Finland will only be heard if it offers a convincing message, backed up by scientific evidence. And according to opinion polls, Finland's citizens trust scientists more than other professional groups, and would like to see scientific evidence play a stronger role in decision-making.

In the interaction between politics and science, the demand for information should be matched by supply. However, in Finland, as in many other countries, we see problems on both sides. Those on the demand side

include decision-makers (Parliament, ministers), civil servants dealing with legislation and implementation (Prime Minister's office, ministries), citizens and the media.

Decision-makers need reliable information quickly and in a concise form. The difficulties they face include separating the wheat from the chaff in the flow of information, and sometimes a sour attitude among researchers towards engaging with policy. The message from science may also be ambiguous or hard to understand. As a result, parliamentary committees in Finland usually consult representatives of the civil service, labour organisations and NGOs, but rarely scientists.

The schedules of civil servants are not as tight as those of politicians, and careful analysis of scientific information can be useful to their work. But not all ministries have the requisite expertise and capacity to critically review or commission research, even when resources are available.

On the supply side, we are far from self-sufficient, since only 0.6 per cent of global research is produced in Finland. Our universities are autonomous, and their research interests rarely coincide with the needs of the society. Our state research institutes cover only certain selected fields of science, and have not effectively contributed advice to policymakers. This is one of the reasons that the government recently reorganised the research institutes and significantly cut their budgets: the savings (a total of €57 million per year) will be transferred into a new strategic fund, which will support solutions-oriented research aimed at addressing national challenges. Priorities will be set by the government but the funding will be competitive and peer-reviewed.

Signals in the noise

Organisations analysing and transmitting scientific evidence in Finland include consulting firms and lobbyists, non-governmental research institutes and think tanks. Most of these have their own agenda that they try to impress upon decision-makers. They are often selective in their use of scientific information, cherry-picking data that supports their messages and their prejudices.

In preparing legislation, the government often sets up committees and working groups, but their main function is to engage various stakeholder groups, not scientific experts. The Climate Panel set up by the Ministry of the Environment is the only example of a bona fide scientific advisory group.[4] Its members are undoubtedly leading researchers in the field, and they serve voluntarily and willingly to advise in the preparation of climate legislation. The Ministry of Defence also has an advisory group that includes scientists, mainly for allocating modest amounts of funding for research. Academies of science and learned societies in Finland are active in promoting science (policy for science), but have not been engaged in advising the government (science for policy).

So the most pressing problem in Finnish scientific advice is accessing reliable and impartial expertise, and creating channels for systematic analyses of scientific knowledge, or rapid advice in unexpected situations and crises. The advisory system could be made more efficient if decision-makers, civil servants and the scientific community agreed to support reforms, but building trust between the different cultures of government and science takes time, patience and diplomacy. Improvements cannot wholly rely on external advice; scientific skills also need greater emphasis as part of the competence profile of the civil service, and in recruitment and ongoing training.

A blueprint for reform

The report I submitted to the Prime Minister contains 14 specific proposals, each with a clear rationale, to establish a robust advisory system. My three most significant proposals are: to establish the post of a government Chief Scientific Adviser (CSA); to create a Research Director position in every ministry; and to set up a Science Analysis Unit within the Delegation of Finnish Academies of Science.

The CSA would be located in the Prime Minister's Office, with a small staff, and would act as the hub of two networks, one extending to the ministries, the other to the scientific community. The former already exists as the Research-Foresight-Evaluation (RFE) group, chaired by the State Secretary, which includes a representative from each ministry. Its task is to coordinate horizontal projects across ministries, as well as commission short-term

studies and consultations to advance the government's programme. The effectiveness of this working group would be improved if each ministry were represented by a Research Director with doctoral-level training; this is not the case currently. The CSA would be the natural chair for this group, but the alternative would be for the State Secretary to chair, and the CSA to be a permanent member of the group.

The other network is needed to bridge gaps between the administration and the scientific community. In many countries, academies of science play an important role as advisers to governments. This is because their membership is based solely on scientific merit, and they are independent and non-partisan organisations. Academy members usually participate in advisory functions on a voluntary basis, without monetary compensation, because this is considered a type of peer review that relies on the solidarity of the scientific community. In a few countries, such as the USA, the advisory role of the national academies is mandated by law; in most others, these activities are organised by the academies themselves, and scientific advice is offered to governments on request, or proactively at the initiative of the scientific community itself.

For historical and linguistic reasons, Finland is blessed with four academies of science, two of them including all fields of natural and social science as well as humanities, and two representing the technological sciences and engineering. These four already collaborate within the Delegation of Finnish Academies, which is partly financed by the Ministry of Education and Culture, and is responsible for the international relations of Finnish science (for example, membership of the International Council for Science).

All four academies have expressed an interest in assuming new responsibilities for science advice to government, and are willing to allocate both intellectual and financial resources to this activity. The proposed Science Analysis Unit would organise systematic reviews of current scientific knowledge, drawing on the expertise of the best researchers in the country. It would also maintain and update a register of experts in different fields of science, who could be rapidly consulted if a need arises within the government. The CSA would act as a go-between in such situations. The basic financing of the unit would come from the academies, but the government would contribute by meeting the costs of reviews.

Further recommendations

In addition to these new structures for scientific advice, my report contained a number of other recommendations. These included clearer documentation of the evidence used in legislative bills and in the reports and statements of parliamentary committees. This would improve the transparency of decision-making and strengthen the trust of citizens in their elected representatives.

The state research institutes, even after their significant budget cuts, remain a valuable resource for evidence-based policymaking. They are in the best position to compete for new resources for strategic research. However, the legal basis of their mission should be clarified, and any irrelevant obligations scrapped.

Because of the importance of evidence in international negotiations, the role of science in and for diplomacy should be strengthened. Scientific experts should be invited to participate in international delegations if the issues under discussion have significant scientific implications. This is an unploughed field, since until recently the top brass at the Finnish Foreign Service did not even recognise the term 'science diplomacy'. However, since traditional approaches to diplomacy have not produced particularly impressive achievements for our foreign service, fresh ideas merit consideration.

Finally, the more active involvement of citizens in policymaking is a goal shared by both politicians and voters. Social media offer new tools for such participation, but some structure and moderation is needed for public discussions on legislation under development, and on the various arguments presented by scientists and other stakeholders. Initiating and guiding public dialogue would fit well within the mission of the Committee for Public Information in Finland, which was set up by the government to promote the dissemination of scientific knowledge; and also the Federation of Finnish Learned Societies, which has a combined membership of thousands of (mostly lay) people. Systematic reviews of scientific information, whether commissioned by the government or proactively prepared by the Science Analysis Unit, should be open to public feedback.

The road ahead

Following the publication of my report, the Prime Minister's office has invited comments from interested stakeholders on its content and proposals. As expected, reactions have been mixed. The principles of evidence-based policymaking and of the need for better mechanisms of scientific advice to government have not been questioned. More transparency and documentation of the basis for decisions is also uniformly supported, and most respondents have a positive view towards the idea of a competent Research Director in each ministry.

Opinions vary on the need for a CSA and a Science Analysis Unit, although the reasons for negative attitudes are not always clear. The most critical comments came from the state research institutes, which do not see the need for any new developments. This may reflect their current problems with restructuring and budget cuts, but their track record in providing scientific advice to the government does not justify their defence of the status quo.

Many stakeholders were afraid of increasing bureaucracy and costs, even though the budgetary implications of the proposals are modest compared with the amounts spent by ministries on commissioning research. My report may not have stated sufficiently clearly that the Science Analysis Unit should be seen as a project for which the academies of science are primarily responsible, with public funding only for reviews commissioned by government agencies.

Given the positive attitudes of politicians, civil servants and the public, strengthening scientific advice to the government should not be a controversial issue. How it will be implemented remains to be seen.

Kari Raivio **is the former Rector and Chancellor of the University of Helsinki (http://www.kariraivio.net/2).**

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EASAC AND THE ROLE OF EUROPE'S NATIONAL ACADEMIES OF SCIENCE

Jos van der Meer, **Christiane Diehl**, **Robin Fears** and **William Gillett**

Background

In 2001, the need to improve the process of providing science advice to policymakers at EU level was recognised by the science academies of EU Member States, which led to the establishment of the European Academies' Science Advisory Council (EASAC).[1] The organisation was set up to maximise the coherence, efficiency and accountability of delivery of science advice to policymakers in EU institutions, notably the European Commission and the European Parliament. In doing this, EASAC was also expecting to bring economies of scope and scale to the process by facilitating the sharing of expertise and resources between the science academies of the EU, Norway and Switzerland.

Policymakers have recognised for centuries the importance of having access to the best scientific understanding, and this is reflected not only in the existence of national science academies in most (25) EU Member States and in many other countries around the world, but also in the fact that these national science academies often receive some support from their governments. Having said that, the pressures on today's policymakers are such that it is easy for them to forget that they have established these highly skilled centres of excellence and networking, and, as a result, the potential contributions of our national science academies to the policymaking process are not always maximised.

Policymaking in today's increasingly globalised economy is becoming ever more complex, and strategies need to be aligned across national boundaries in order to successfully address policy areas which have an international dimension. In recent years, the alignment of national policies and regulations has become particularly important for the EU in the areas of bioscience, energy and the environment. At the same time, scientific and technological developments have been moving, and continue to move, very

quickly in these areas. It is, therefore, crucial that policymakers should be regularly provided with the best independent scientific analysis and advice on developments in these (and other) areas.

Being part of EASAC helps to strengthen those science academies in the EU which lack resources, by giving them the opportunity to work together with other academies to produce outputs of the highest quality for EU policymakers, and which they can then also use for national policymakers in their own countries. In addition, EASAC has been working with its academies to identify and develop the most efficient ways of providing science advice to policymakers at both European and national levels. It has then transferred this knowledge and experience to those academy fellows and staff who are engaged in providing policy advice, by drafting specific guidelines and by holding Science-Policy-Dialogue workshops.[2]

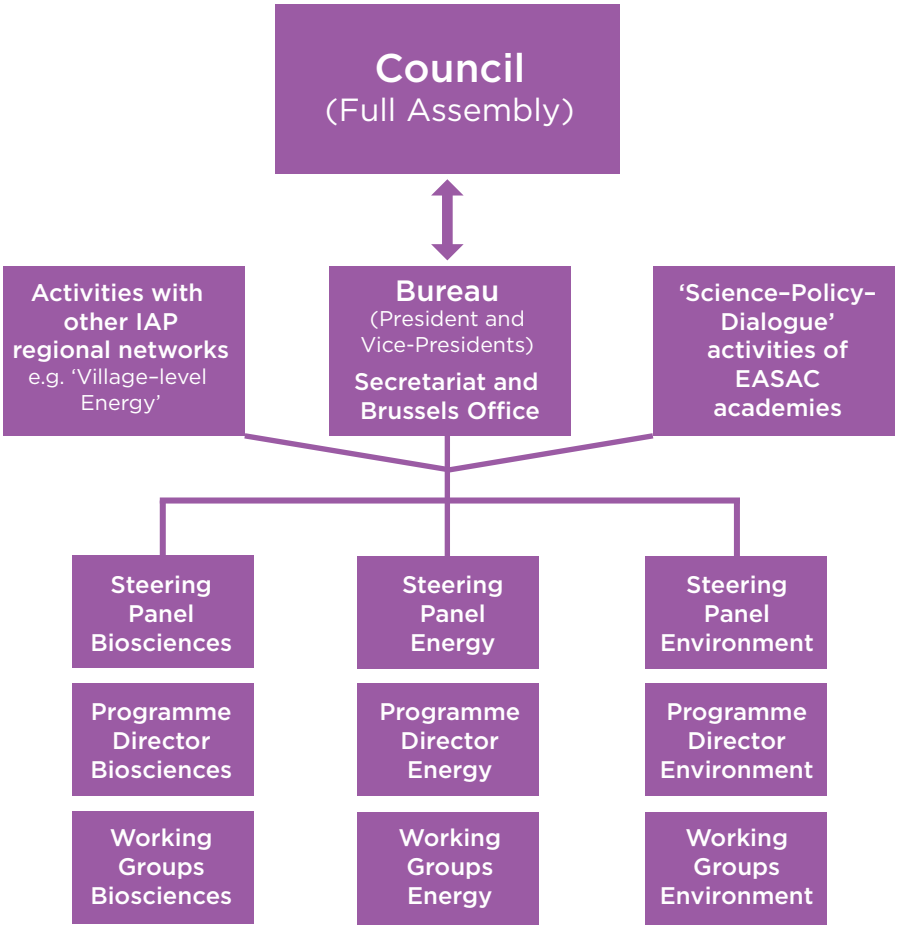
What is EASAC?

There is a long tradition of academies of science in many parts of Europe. Whereas in previous centuries the role of these meritocratic groups consisted primarily in fostering scientific progress through close exchange of information among the best in their fields, the last few decades have seen a growth in the academies' public role to mobilise the best of European science, as providers of independent advice to policymakers and sources of information for the public, thus strengthening the transparency and plurality of democratic decision-making processes.

Until recently it would have been fair to say that, while many academies had developed an effective relationship with their national governments in advising on the scientific dimensions in policymaking, the development of an analogous relationship at the European level had been more difficult. Yet, the delivery of science advice to the European Commission, the European Parliament, Council of Ministers and to successive Presidencies of the EU Council has become increasingly important. In Europe, EASAC is the alliance of the 25 National Academies of Science of the EU Member States, and the science academies of Switzerland and Norway, who have agreed to work together in a network with a very simple, jointly funded administrative structure and common working procedures for providing science advice to policymakers in the EU.

The EASAC Council is made up of representatives of the participating academies and meets twice a year, usually in the academy of the country that will hold the EU presidency six months later. EASAC's operations are managed by its Bureau, which consists of an elected President, four Vice-Presidents and the immediate Past President, who normally work – in an extended format – together with the chairs of EASAC's three Steering Panels, the three Programme Directors and the Executive Director.

Figure 1: **The structure of EASAC**



The three EU Member States that do not have a national academy of sciences and are thus not represented in EASAC are Malta, Luxemburg and Cyprus. However, Academia Europaea, the pan-European Academy of Science, and ALLEA, the association of all academies in geographic Europe, are represented in EASAC, and the Federation of European Academies of Medicine, FEAM, has observer status.

EASAC's analysis and advice has to be scientifically excellent, independent, timely, relevant, comprehensible and endorsed by all its member academies. EASAC focuses on three main areas of policy for which high-quality, independent science advice is particularly important to policymakers:

1. Biosciences – including health and wellbeing, agriculture and food security
2. Environment – including climate change
3. Energy – including sustainable energy and energy security.

The member academies of EASAC take great pride in ensuring that EASAC's advice is totally independent, and therefore EASAC does not accept funding from any political, industry or other sources that could be perceived as compromising its independence.

EASAC's budget comes from the membership contributions of its member academies and the InterAcademy Partnership (IAP),[3] the global network of science academies. This network has over 140 member academies worldwide and receives support from UNESCO. EASAC is the affiliated regional network of IAP for Europe.

EASAC's working methods and guarantee of quality

EASAC is made up of its assembly (the Council), the President and Vice-Presidents, the Bureau, and three Steering Panels for Biosciences, Energy and Environment. Proposals for new topics usually come through one of these routes. In addition, EASAC maintains contacts with the EU's institutions and encourages them to express their interest in specific science topics; without compromising its independence, EASAC proactively takes into account the views of these institutions when identifying key issues for attention. Of particular importance for the quality of EASAC's work are the

Steering Panels, which play a central role not only in the selection of new topics, but also in guiding and reviewing the work as it progresses.

Once a new topic has been selected, a working group is established, for which the best expert scientists within the EU are selected with the help of EASAC's member academies. The working group usually meets 2–4 times over a period of 9–18 months. When the draft report is ready, it undergoes peer review by independent experts. Each report must be endorsed by EASAC's member academies before it is published in print and on the EASAC website.[4]

To enhance the immediate impact of each EASAC report, it is usually launched at a dedicated event in Brussels. EASAC often also publishes non-technical summaries – 'lay summaries' – of its reports, for use by its member academies when setting up public debates on important issues.

Table 1: **EASAC reports and statements published between 2011 and 2014**

Realising European Potential in Synthetic Biology	(Jan 2011)
EU Public Health and Innovation Policy for Infectious Disease	(Apr 2011)
Impact of Engineered Nanomaterials on Health	(with JRC, Oct 2011)
Infectious Diseases and the Future: Policies for Europe	(Oct 2011)
Concentrating Solar Power: its Potential Contribution to a Sustainable Energy Future	(Oct 2011)
Addressing the Challenges of Climate Change	(Nov 2011)
Plant Genetic Resources for Food and Agriculture	(Dec 2011)
Direct-to-Consumer Genetic Testing	(with FEAM, June 2012)
The Need for More Emphasis on Systems Approaches in Energy to Inform EU Policymaking	(Dec 2012)
The Current Status of Biofuels in the EU	(Dec 2012)
Carbon Capture and Storage in Europe	(May 2013)
Planting the Future: Crop Genetic Improvement Technologies	(June 2013)
Statement on the SET-Plan	(Aug 2013)

Extreme Weather Events in Europe	(Dec 2013)
Risks to Plant Health: EU Priorities for Tackling Emerging Pests and Diseases	(Mar 2014)
Management of Spent Nuclear Fuel and its Waste	(July 2014)
European Space Exploration: Strategic Considerations of Human vs. Robotic Exploration	(Sept 2014)
Antimicrobial Drug Discovery, Greater Steps Ahead	(Oct 2014)
Shale Gas Extraction: Issues of Particular Relevance to the European Union	(Nov 2014)

EASAC recognises that the publication of such a report is not the end of a project, but a resource to be used to catalyse further discussion and inspire action at the EU and national levels. Thus, the work on a particular topic may continue for years after the initial publication. A continuing challenge for EASAC, as for many of its member academies and other science bodies, is to find ways to stimulate and sustain public engagement alongside the interaction with policymakers. These challenges in the UK were highlighted in the recent collection by Doubleday and Wilsdon.[5]

When the academies see the need to provide a rapid response to an urgent policy issue, a shorter EASAC statement may be produced. This can be done within a few months, but must still be endorsed by EASAC's member academies before publication.

The member academies use EASAC reports and statements in their national context, and also help to draw attention to issues at an EU level. Often, articles based on EASAC reports are published in scientific journals, such as *Nature*, *The Lancet*, *Science Translational Medicine*, and *Nature Reviews Drug Discovery*.[6]

EASAC increasingly uses its portfolio of studies and reports as a basis for providing rapid advice, possibly within a few days, on issues that have been studied before. This growing resource allows EASAC to respond to public consultations of the European Commission, brief relevant Members of the European Parliament on topical debates or respond to ad hoc questions from any other organisations or individuals.

EASAC'S contacts with EU institutions

While EASAC's main Secretariat is based at the German National Academy of Sciences Leopoldina, it also maintains a Brussels Office at the Royal Academies for Science and the Arts of Belgium (RASAB). This Office facilitates interactions with EU institutions, helps to horizon scan for impending policy developments, maintains contact with key EU officials and organises launch events for EASAC reports and statements.

EASAC maintains contact at all levels with the European Commission, and collaborates with the Joint Research Centre (JRC). Together with the JRC, EASAC has produced joint reports on the *Impact of Nanomaterials on Human Health* and on *Management of Spent Nuclear Fuel and its Waste*. EASAC also maintains close links with a number of DGs, as well as with European Commission bodies such as the ECDC and EFSA.[7]

Previously, EASAC established a good working relationship with the Bureau of European Policy Advisers, especially the Chief Scientific Adviser, and looks forward to using this experience to build a similarly good relationship with the new European Political Strategy Centre (EPSC). As noted at the recent UK meeting hosted by the Royal Society,[8] in addition to building the capacity to supply science-based evidence to policymakers, it is also critically important to build the capacity to receive and use that evidence within the policymaking community.

EASAC also provides science advice to the European Parliament, both directly to MEPs and their assistants and through the Science and Technology Options Assessment Panel (STOA), which forms part of the European Parliament's DG for European Parliamentary Research Services (DG EPRS). EASAC is looking to increase its collaboration with the other services of the DG EPRS and the Policy Departments that support the EP's Committees.

EASAC also aims to inform the Council of Ministers and the European Council. This interaction is primarily channelled through its member academies, which are the first and preferred partner of national ministers and policymakers. By coordinating this interaction, EASAC guarantees that national science communities provide consistent recommendations to policymakers throughout Europe.

Science advice for policy beyond Europe

Many scientists are more accustomed than their policymaking counterparts to working closely with international colleagues across the world. Similarly, many of Europe's science academies are very well connected internationally, and EASAC itself participates actively in the global network of science academies (IAP) as a regional affiliated network for Europe.

Working on science advice for policy beyond Europe is a two-way process, allowing EASAC to use experience from other continents and countries to strengthen its advice to EU policymakers, as well as to use EU experience as a basis for supporting other academies in giving advice to policymakers in other countries. Moreover, at the global level academies can collectively deliver strong messages to intergovernmental organisations and other stakeholders. With these aims in mind, EASAC collaborates with the three other regional networks of IAP: the Inter-American Network of Academies of Sciences (IANAS), the Network of African Science Academies (NASAC), and the Association of Academies and Societies of Sciences in Asia and Societies in Asia (AASSA).

One recent example of such collaboration is EASAC's work with NASAC on 'Agricultural Biotechnology for Sustainable Development in Africa' and on the 'Smart Villages' project for energy provision in off-grid villages in developing countries. EASAC has also collaborated with IAP's other regional networks in delivering global statements on synthetic biology and on antimicrobial resistance.

Looking to the future

The need to provide science advice to policymakers at both EU and national levels is still growing, and the decision taken in 2001 to set up EASAC has resulted in a growing body of knowledge and expertise in the academies on how to provide such advice, especially at the EU level.

Although the science may indeed sometimes be uncertain and the policy area controversial, what should always be clear is that the processes for generating science advice have been conducted with rigour, respect and responsibility. Collective initiatives do not mean adopting a low common

standard of evidence, but rather ensuring consistency in the generation of high-quality science advice. One of the strengths of EASAC is that our advice takes into account the different experiences across the EU Member States, and this diversity of backgrounds may suggest alternative ways to inform policy options. Among the lessons learnt since the inception of EASAC has been the need to maintain scientific robustness at every stage of a project: initial prioritisation of topic to ensure a distinctive contribution; early scoping work; creation of a balanced Working Group; careful handling of scientific uncertainties; and independent peer review. EASAC has also learned how to increase the impact of its outputs, by early and sustained engagement with policymaking and other audiences.

EASAC is now firmly established as a committed EU stakeholder with growing visibility, a dedicated team, and a significant track record of producing timely, independent, clear and constructive advice for EU policymakers in the areas of biosciences, environment and energy. EASAC can and will also capitalise on opportunities to provide advice on topics outside these three core areas; for example, a report was recently published on European space exploration (cp. Table 1).

Support for the work of EASAC continues to come mainly from its member academies, including a particularly important contribution from the Leopoldina in Germany, which hosts the EASAC Secretariat, and from RASAB in Belgium, which hosts the Brussels Office.

EASAC has not yet exploited the full potential of the EU academies. As the demand for science advice for policy appears likely to continue to grow, and many of the national academies have limited resources as a result of the financial crisis, more funding will be needed to support EASAC's work in the future. This needs to be provided without compromising the independence – or even the perceived independence – of EASAC's advice.

The national science academies of Europe have an important contribution to make towards creating a better European dialogue between science and policy. They can help with setting up simple yet effective processes for feeding independent and timely advice from the science community to the

institutions of the EU. As a network, EASAC will be at its strongest when its individual member academies have developed their national science–policy dialogue to the fullest extent. In this way, EASAC could be said to reflect one of the key strengths of the EU as a whole.

Jos van der Meer is President, **Christiane Diehl** is Executive Director, **Robin Fears** is Director of the Biosciences Programme and **William Gillett** is Director of the Energy Programme at EASAC (@EASACnews).

Endnotes

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3

ECOSYSTEMS OF EXPERTISE

THE ROLE OF FOUNDATIONS AT THE SCIENCE–POLICY INTERFACE

Wolfgang Rohe and **Jeannine Hausmann**

Private foundations are established members of the ecosystem of expertise through their role as funders of research. In addition, some foundations pursue specific social and political aims and therefore are connected to both the worlds of science and politics. As the relationship between science and politics becomes ever more significant, foundations have new opportunities for engagement at the intersection of research funding and policy advice. It is now timely to consider foundations' room to manoeuvre and the principles that should guide their activity at the science–policy interface.

As financially independent actors that are at the same time able to behave autonomously of any political agenda, foundations have a unique role to play in civil society. They can trigger social processes of change that transcend party boundaries, contribute to the pluralisation of debates, and provide evidence-based arguments that help shape the political agenda. Improving the substantive understanding of complex social challenges and elucidating arguments for positive change can help to increase the quality of future political decision-making processes. Due to their independence, foundations enjoy a scope of action that transcends the state, the economy and even the traditional sphere of NGOs. Indeed, by affiliating with different systems within modern society such as science, politics, education, law and civil society, foundations have the opportunity to transmit scientific knowledge that furthers progressive societal aims – without, however, representing any single (party-) political point of view.

Foundations at the interface

Due to their limited resources in comparison to state institutions, foundations typically seek to allocate their funds to areas where they have a comparative advantage over other actors. One such area, which allows foundations to make the most of their distinct potential and capacity, is the science–policy interface.

Welzel has cogently summarised the particular value that foundations can bring to bear:[1]

> *"As relatively independent organisations, they (foundations) have the opportunity to pose new questions, to work out recommendations and to spur initiatives for organisational constellations and coalitions. They do not always need to be involved themselves in scientific research, but often the contribution of foundations lies in their suggestions, translations, reductions of complexity, or cross-linking of scientific subjects."*

As forces of a pluralistic democratic society, foundations are able to introduce subjects to the political agenda that require treatment and yet may be familiar to only a few experts, or are perhaps ignored because they are politically inconvenient. Since foundations can highlight issues that governments tend to overlook, they are in a position to expand the scope of policy debates.[2]

The contribution of foundations at the interface of science and policy is not limited to agenda setting. With regard to subjects that are already part of the policy debate, foundations can contribute to the plurality of perspectives on these subjects and to their substantive development. At the same time, they can also make an impact on the political culture of interpretation and public opinion. Foundations can thus contribute by promoting the diversity of potential solutions under consideration, and by helping to assess the effectiveness of different solutions. As politically independent actors, foundations are able to create new social constellations and include a wider circle of relevant groups. In short, they can generate input for societal processes of change beyond the mainstream, which is nonetheless adapted to political realities.[3] Despite this critical function, however, German foundations have only played a role in policy advice for about 20 years.[4]

Opportunities for innovation

There are numerous opportunities for foundations interested in engaging in scientific policy advice. One of these is to provide long-term support to independent think tanks, which make assessments for policymakers and work out possible solutions. In Europe, there are comparatively few foundations that provide institutional support to private think tanks; for

the most part, they support the work of think tanks only on the basis of individual projects. However, it is also possible to make a significant impact through financing specific research structures, since this allows entire thematic areas and not simply individual issues to be investigated over the long term.[5] This is particularly relevant with regard to the so-called 'grand challenges' – in other words, temporally, socially and substantively complex issues such as climate change, food security and resource scarcity. By supporting think tanks that address grand challenges, foundations can bring about sustained examination of these complex, interrelated problems.

The possible contributions that foundations can make here are not limited to generating politically relevant insights by advancing research. In order for there to be successful knowledge transfer from science to politics, personal relationships and networks between scientists and policymakers are essential. Foundations can facilitate this exchange by creating new forums and discussion platforms, and by developing new mechanisms of exchange. In this way, they are able to act as catalysts for policy-relevant ideas and evidence.

The sphere of action of foundations results from their unique ability to combine these two separate activities. On the one hand, they fund research that demonstrates to policymakers several alternative courses of action; on the other, they serve as mediators which can successfully bring together stakeholders from diverse fields. According to Thunert, think tanks and foundations can be highly effective at creating channels of communication and facilitating contacts between disparate actors.[6]

Stiftung Mercator (the Mercator Foundation) has experimented with investments to support independent think tanks as part of its contribution to engagement at the intersection of science and politics. Our observations here will be limited to examples from our own work with the Mercator Institute for China Studies (MERICS), the Sachverständigenrat Deutscher Stiftungen für Integration und Migration (Expert Council of German Foundations on Integration and Migration) (SVR) and Agora Energiewende. In all three organisations, in order to achieve a higher level of congruency between the conducted research and policy, exchange and network components have been institutionalised to varying degrees, in addition to research.

The **Mercator Institute for China Studies (MERICS)** is Europe's largest institute for research and knowledge dissemination on modern-day China. It was founded in 2013 by the Mercator Foundation for the purpose of transmitting a more accurate and nuanced image of China and having a positive effect on policy. Through structured knowledge transfer, public relations and international exchange, conditions are established for enabling decision-makers – especially those in Germany – to make more informed decisions about issues relating to China. To this end, the research institute collects and analyses information within four thematic areas: policy, economy, society, and innovation and environment.

The **Sachverständigenrat Deutscher Stiftungen für Integration und Migration (SVR)** was formed out of the conviction that foundation-financed think tanks can be especially effective, and their credibility can be enhanced when they proceed on the basis of mutual cooperation with several other foundations, or jointly with public partners. The SVR was established in 2008, along with six other German foundations, due to an initiative from the Volkswagenstiftung and the Mercator Foundation. Its focus is on offering scientific advice and support to policymakers and civic institutions in the areas of migration and integration, through research and policy recommendations. The SVR is not only dedicated to providing scientifically based recommendations, but is also engaged in their political realisation.

Agora Energiewende, a joint venture of the European Climate Foundation and the Mercator Foundation, aims to help transform the energy sector in Germany by promoting a process that connects and brings into dialogue experts and decision-makers from important energy-related organisations in government, the economy and civil society, as well as researchers and other influential actors. At the same time, it strives to elucidate different, scientifically evaluated paths such as how to successfully transform the energy sector into a system that is almost completely based on renewable energy. The alternatives presented by Agora Energiewende provide a basis for the political decision-making process. To ensure that its work is scientifically grounded, the organisation has an independent research budget and network of researchers. Agora Energiewende thus combines the goal of developing and offering for discussion scientifically founded courses of action with the creation of an exchange platform that transcends individual sectors.

Ensuring quality of research and policy advice

Drawing on its recent experience, the Mercator Foundation has begun to reflect on the distinctive quality requirements of both research and policy advice: in order for foundations to become involved at the science–policy interface, they need to adhere to practices for achieving credibility in both areas. With regard to the funding of research, it is necessary to respect the rules and norms of scientific inquiry. Even when foundations pursue particular socio-political objectives, the research they fund must meet the quality criteria of the respective scientific disciplines.

It is not enough, however, to adhere to the quality standards of scientific research; foundations must also uphold the standards of proper scientific policy advice.[7] They should not fall prey, in other words, to the desire to merely convince policymakers of a particular truth. As Edenhofer and Kowarsch discuss in their essay, the role of science in the area of policy advice is to support and prepare the way for decision-making processes by informing policymakers of alternative, evidence-based policy pathways, and laying out their respective implications, costs, risks and time constraints. Foundations should likewise encourage this model of opening up alternatives if they are engaged in supporting scientific policy advice. In this way, foundations are able to encourage the relevant discipline to explore different courses of action and support policymakers in their decision-making.

In cases where the approach of exploring alternative policy pathways is no longer pursued, scientists frequently only resemble lobbyists, and over the long run this can undermine confidence in scientific expertise. As a result, a foundation's promotion of scientific research should not be limited to pursuing one hypothesis alone; instead, multiple courses of action and decision-making alternatives should be developed, justified and evaluated in terms of their consequences, costs and implications. Assessments that include a systematic feedback loop between the objectives and the means for achieving them can play an important role in this regard (see the essay from Edenhofer and Kowarsch).

Every initiative aimed at promoting and spreading scientific policy advice must keep in mind that science always produces uncertain knowledge and that the process of knowledge acquisition is never finished. While this may appear at first to be a disadvantage, it is in fact an advantage. Politics, after

all, must contend with continually changing conditions, especially when it comes to complex problems. And every decision necessitates new follow-up decisions, which in turn demand scientific evidence and grounding. This continual exchange between political and scientific modes of reasoning, especially in scientifically complex and politically significant areas such as climate change, gives rise to a process that is both synchronous and mutually stimulating.

Supporting future directions for advice at a European level

At the interface of science and policy, foundations should assume the role of an 'honest broker of policy alternatives'.[8] This does not exclude the possibility of pursuing socio-political aims that foundations will often espouse as actors in civil society. If the aims are located within a social consensus or have already been established by means of policy (e.g. in the area of CO_2 reduction), foundations can be active as advocates for the issue, or also serve as mediators, by demonstrating to policymakers scientifically based courses of action or alternatives for achieving certain goals. It is due to their roots in civil society and capacity for bringing together a diverse range of actors that foundations are especially well-equipped for this intermediary role.

In general, actors in civil society are able to achieve goals not only by actively exploring alternative courses of action, but also by focusing on and advocating one particular option at a societal level. Taking a stance like this makes an actor an 'issue advocate'.[9] A foundation needs to consider whether or not it might be able to achieve its goals over the long run most effectively by embracing this approach and, if so, how it should then explain its choice of this specific option to the public. In those cases where a foundation involved in funding research generally does not direct its partisan advocacy toward solving complex social problems, but rather toward the implementation of a certain solution, it is acting as a lobby organisation.

So far, relatively few foundation initiatives have focused on giving scientific policy advice to EU institutions. The EU has indeed enunciated its efforts and interest in better integrating intermediary organisations from civil society into the political process, and foundations in particular are supposed to be encouraged to be more active in the area of policy

innovation. These aims, however, have had little resonance; most European foundations still address policy on the national level, and as a result have at most an indirect impact on the decision-making processes in Brussels. However, due to the considerable impact of political decisions at the EU level on individual societies within the EU community, and the fact that almost every political field has in the meantime acquired a European dimension, a more substantial sphere of action has opened up for private foundations at the European level in the area of scientific policy advice. The Mercator Foundation strives to bring this level into clearer focus in its work. Along similar lines, Agora Energiewende has been strategically expanded by means of structured and wide-ranging processes of dialogue with key Member States and relevant European institutions, with the aim of improving the contribution of scientific advice to EU energy policy.

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EXPERTS AS CARTOGRAPHERS OF POLICY PATHWAYS FOR EUROPE

Martin Kowarsch and **Ottmar Edenhofer**

The European Commission faces a number of controversial issues in energy and climate policy with substantial implications for European economies and societies. These include post-2030 energy policy targets, issues of energy security, and the EU's contribution to long-term global efforts to mitigate climate change. For example: should we reduce EU emissions by 80%, 90% or 95% by 2050? Should we use nuclear power or energy from renewables? There are similar debates about reform of the EU's Emission Trading System (ETS). Are quantity-based approaches, such as the Market Stability Reserve, the best option for reform? Or would a price collar be more appropriate to stabilise the expectations of investors? Should the transport sector be included?[1]

In tackling such debates, multiple policy fields – including the economy, finance, energy, environment, health, agriculture and security – as well as many interest groups and multiple governance levels are affected by complex interdependencies. The EU has to manoeuvre through highly challenging and complex political spaces, characterised by competing objectives and trade-offs on different levels.

Framing questions and offering answers

The sciences, through systematic and deep-rooted methods, can assist decision-makers and support broader public discourse on energy and climate policy issues at the European level. They can help to better understand problems, as well as potential solutions, future scenarios and specific policy options. Ignoring evidence on natural and social system interdependencies when deliberating on, for example, optimal emission reduction levels and technology choices, might result in uninformed decisions and unexpected policy outcomes.

However, policymakers and the media sometimes place strong pressure on the sciences to come up with simple answers to complex questions. These demands for clear-cut, one-dimensional recommendations, preferably

expressed in single quantitative targets, extend the battle zone of political debate and consensus-seeking into the scientific realm. Though scientific experts do sometimes provide clear recommendations regarding such complex questions, they can only do so by disregarding some of the deep uncertainties, including disputes over value-laden issues.

Energy and climate policy can be seen as *"a problem from hell"*, according to the economist Martin Weitzman,[2] as it is characterised by large-scale, non-marginal risks and irreversible outcomes; deep uncertainty; global and intergenerational dimensions; and questions of justice and ethics related to a global problem of commonly pooled resources.

Normative judgments are sometimes opaque in scientific studies; they can include, for example, the choice of intergenerational discount factors, equity weights, the valuation of technological risks or the treatment of uncertainty. Yet scientific experts lack the legitimacy to make decisions for society at large on far-reaching, disputed, value-laden issues, particularly if they act as what Roger Pielke Jr. calls *"stealth issue advocates"*.[3] Consequently, as desirable as scientific expertise is in supporting EU energy and climate policy, fundamental challenges and pitfalls have to be dealt with at the science–policy interface. We therefore need an appropriate division of labour between scientific expertise and policy that allows for rational and evidence-based policies, but leaves social choices where they belong: in the hands of legitimate political institutions.

Insights from the IPCC

In this essay, we aim to draw some lessons for EU science–policy interactions on energy and climate policy from the experience of Working Group III (WG III) of the Intergovernmental Panel on Climate Change (IPCC). The IPCC, established in 1988, was awarded the Nobel Peace Prize in 2007 for building up and disseminating knowledge about climate change and response options. Its assessments are large-scale processes of social deliberation where multiple experts and stakeholders assemble, discuss and synthesise existing knowledge on complex issues to inform public policy. IPPC WG III, as a widely respected institution, analyses options for energy and climate policy at the global level, which is even more complex than the European level.

IPPC WG III recently employed a novel science–policy model which we will introduce below. To better understand its novelty, we first need to understand the predominant models and their weaknesses in responding to the question of how scientific assessments can be policy-relevant and credible, but not illegitimately prescriptive.

Proponents of the technocratic model of the science–policy interface argue that complex problems such as climate change cannot be understood and resolved by politicians, but only by scientific experts. Such technocratic optimism relies heavily on the assumption of constant progress in science and technology, as well as on a presupposition that science is value-neutral and objective.

The result of employing this model is that policy objectives and associated means are determined by experts, without any perceived need for substantial contribution and discussion by other parts of society. In our experience, the technocratic model is more widely held than one might wish, and risks ending in what Max Weber called the *"iron cage of bondage"* for society. This refers to a situation in which democratic institutions that are strongly relying on expert authority are not given alternatives, even though they exist, but rather are told to implement a single policy based on implicit value judgments made by the experts.

Weber vehemently demanded a division of labour concerning policy objectives and means, assuming that facts and values could be clearly separated in science. In the so-called decisionist model, policymakers and citizens discuss and decide upon the value-laden policy objectives through a democratic process, while the scientists' role is limited to finding the means (such as the policy instruments, technologies or measures) to achieve these objectives.

However, this model suffers from the same misleading assumption as the technocratic model. Facts and values cannot be fully separated in scientific studies, and nor can the evaluation of policy objectives and means; they are always entangled.[4] Assume, for example, that politicians formulate an ambitious emission-reduction target as part of climate policy. Research has shown that such paths only become feasible if there is intensive use of bioenergy; however, this may involve direct competition with food security, and could risk accelerating deforestation of rainforests, thereby threatening

biodiversity. In this way, certain means implemented to address the objectives of climate policy may undermine other social or environmental objectives. If more suitable means to overcome these trade-offs cannot be identified, the initial policy objectives must be revaluated, amended or even abandoned in light of the practical implications of the means. Objectives and means are interdependent via their implications, and cannot be proposed or evaluated separately. Researchers should not simply explore possible means to given policy objectives because the objectives alone do not necessarily justify the means, especially with the potential for such undesirable side effects. Rather, objectives should be critically and systematically reflected upon in light of the diverse implications of the means.

The 'Pragmatic-Enlightened Model' (PEM) of expertise in policy

Because of these weaknesses in the dominant science–policy models, IPPC WG III employed a novel 'Pragmatic-Enlightened Model' (PEM) of scientific expertise in policy. The PEM builds on John Dewey's pragmatist philosophy[5] and the interdependency of policy objectives and means via the implications of the means, as explained in the example above. The PEM claims a critical inquiry into such implications is needed because they can substantially change previous evaluations of policy means or objectives. This implies analysing the whole range of relevant consequences in terms of manifold (quantitative and qualitative) direct effects, synergies and undesirable side effects.

According to the PEM, scientific hypotheses, such as those on policy options, necessarily imply normative assumptions. Nevertheless, they can – theoretically – become objective when they have repeatedly turned out to be reliable for resolving the well-defined problematic situation or question at stake. The inclusion of different stakeholders in the assessment process is crucial to facilitate learning and deliberation, and in order not to exclude important policy objectives, evaluative criteria or aspects of policy implications.

Moreover, under the PEM, the interdependency between policy objectives and means implies exploring and comparing alternative public policy pathways (i.e. different combinations of policy objectives and means) and

their implications, in order to learn about and compare their strengths and weaknesses. Due to the huge uncertainty over disputed and value-laden policy issues, PEM-guided assessments should map out alternative policy pathways and their implications. This significantly reduces policy prescription in scientific assessments, while potentially still achieving high policy relevance and scientific credibility.

The role of the cartographer

Scientific experts therefore assume a role akin to that of the cartographer.[6] Jointly with stakeholders, they explore the political solution space by mapping out different pathways and their trade-offs or overlap, while clearly marking implied value assumptions and uncertainty along the way. Maps do not replace travelling; it is the policymakers who remain the navigators. Sound scientific advice does not provide one-dimensional recommendations for complex policy problems, but instead provides information on alternative policy pathways, each with its own trade-offs and obstacles.

The PEM portrays political decision-making as a perpetual learning process of self-reflection. It aims at transparent and iterative deliberation of the trade-offs – or overlap – between different policy objectives and means in co-production with stakeholders. When policymakers make a decision and implement one of the policy alternatives, the chosen policy will still need to be amended to account for errors and obstacles discovered ex-post. The sciences can only offer an early warning system for potential risks and trade-offs that can be expected along certain paths.

The PEM differs from the European Commission's regulatory impact assessment (which employs a refined cost–benefit analysis), in that it claims a systematic feedback loop between the objectives and means; the objectives (as well as related values and evaluative criteria) are thus never regarded as fixed. Moreover, the full range of practical implications is to be assessed, including the non-quantifiable consequences. Instead of fostering endless disputes about abstract values or denying normative assumptions in the sciences, the PEM potentially allows for a rational and more constructive debate about highly value-laden political issues, by exploring the implications of alternative policy pathways.

Putting the PEM into practice: the experiences of IPCC

The PEM recently provided some guidance to the IPCC WG III in its assessments.[7] The contribution of WG III to the IPCC's Fifth Assessment Report[8] assessed future pathways to alternative climate change mitigation goals in terms of underlying technological, economic and institutional requirements. This was done instead of recommending a specific mitigation goal or avoiding these disputed political issues altogether, acknowledging that researchers alone cannot settle these issues but have to assess alternative policies.

Adopting a multimetric perspective, the research community had conducted sophisticated multi-scenario analyses to explore the implications (including co-benefits) of alternative climate policies, timings and metrics. The Assessment Report also includes a chapter on ethical issues, to allow for a more explicit discussion of this crucial dimension of climate policy. IPCC WG III was successful in the analysis of future scenarios: costs, risks and (co-)benefits of alternative policy pathways were assessed, and governments accepted and appreciated this in the approval process.

But the approval process for the Summary for Policymakers (SPM) of the Assessment Report also revealed challenges for the PEM approach, particularly with regard to retrospective (ex-post) analyses. For instance, the country classifications for the report's assessment of progress in climate change mitigation had immediate relevance for political negotiations, resulting in the fact that governments objected and the figures and associated text were removed from the SPM.

Governments' concerns over the grouping of countries arose despite efforts to provide a balanced assessment of how emissions have grown as countries developed, and how these patterns have shifted over time. Some governments feared that approval of any country classification other than the one currently used in the negotiations could be disadvantageous in upcoming negotiations for a new international climate regime.

This IPCC's experience reveals that, while a policy-relevant, credible and legitimate ex-ante assessment may be successful, ex-post analyses come with undesirable political implications for several countries. Governments do not always want their policy decisions to be publicly evaluated in a

scientific assessment. However, ex-post analyses could be in the best interest of governments, since much can be learned for future policy design. In some cases, due to complexity and uncertainty, the only way forward may indeed be an iterative process between experts and policymakers, with ex-post analysis which allows for learning from policy experiences – which presupposes climate policy actions will be taken by governments despite uncertainty and risks.

A further challenge to the application of the PEM within the IPCC was the lack of research available to fill the manifold gaps on the 'map of knowledge' that was being created. For instance, future IPCC assessments could explore in more depth what the world might look like in the event of a global temperature rise of 1.5°C, 2°C or 3.5°C, systematically combining impacts and vulnerability with adaptation and mitigation strategies and linking these to existing, disputed policy narratives and value beliefs. Pre-studies and 'pre-assessments' are required to provide the knowledge for assessment processes.

Lessons learned for science–policy interfaces in Europe

The promises and challenges of the IPCC's cartography of the political solution space may also have interesting implications for Europe's science–policy interfaces.

Lesson one: **Organise integrated assessments**

Individual, smaller-scale studies and reports, though highly valuable, cannot adequately address the complexity associated with EU energy and climate policy, and their frequently far-reaching policy recommendations are not always sufficiently substantiated. Although more effort is needed, assessments are required because they arguably provide the most elaborate, comprehensive and formally structured knowledge synthesis for highly disputed public policy issues. The IPCC assessments, for instance, can be seen as unparalleled and stimulating learning platforms that allow for extraordinary – though sometimes painful – learning experiences.

Large-scale assessments could also be a model for the role of scientific experts in Europe's discussions on complex energy and climate policy

issues – on which there is as yet no serious assessment available. However, this does not necessarily require producing thick, comprehensive volumes over a very long period of time, as the IPCC does. Rather, the EU only needs to better organise and coordinate the scientific cartography of the political solution space in terms of: (i) standard metrics and definitions to allow for comparison and integration into a single synthesis; (ii) incentives for interdisciplinary knowledge synthesis regarding policy-relevant questions; (iii) quality assurance, for instance by enabling the rejection of entire assessment chapters or reports if they are deemed unsatisfactory by scientific peer review; and (iv) more systematic identification of research gaps. Undertaking assessments of policy-relevant issues should be accepted as a highly respectable and serious scientific task in and of itself, for instance by accepting such assessments as high-ranking, peer-reviewed publications.

Lesson two: **Use the PEM as a guiding vision**

Scientific assessments often face trade-offs between policy relevance, credibility and legitimacy.[9] The PEM's approach of mapping a broad range of effects and co-effects of alternative policy pathways jointly with stakeholders may help to tackle these trade-offs. In light of the insight that there are basically no facts without values, the PEM allows for a scientifically credible and rational discussion of even highly value-laden, policy-relevant issues, without straying into policy prescription. Though further evaluation is needed, this model can potentially serve as a strong, new guiding vision for European science–policy interfaces, particularly in cases of highly complex, uncertain, value-laden and disputed policy issues.

Lesson three: **Initiate more policy analysis**

Surprisingly, there are numerous gaps in research on EU energy and climate policy options, such as the Emission Trading System, and their implications, particularly from a social science perspective. One potential solution would have national academies of science and science foundations providing – ideally prior to large-scale assessment processes – higher incentives for the research communities to (i) produce and synthesise solution-oriented, policy-relevant research, both ex-post and ex-ante; (ii) enhance policy assessment methodology; and (iii) ensure the highest scientific quality. Though the maps of socio-economic knowledge regarding policy analysis

are still incomplete, they provide sufficient orientation for EU policymakers to act under uncertainty, which would allow for 'learning by doing', for instance regarding carbon pricing.

Lesson four: **Work on the science–policy culture**

Some policymakers and experts resist supporting such a cartography of policy pathways due to (i) adherence to their disciplinary cultures and a focus on methods rather than problems; and (ii) a lack of will to engage in such an onerous learning process, which often requires painful changes in opinion about policy objectives and means. Policymakers must learn how to appreciate maps of knowledge, including ex-post policy evaluation. A clear mandate for assessments is required from the policy side to support the cartography of the political solution space – which could potentially include the assessment of promising pathways that are deemed infeasible in political terms, or of pathways that are inconsistent with one's own political interests and values.

Researchers, on the other hand, must learn how to create such maps of knowledge and learn about political and ethical implications in their research in order to make them more transparent. Closing down debates through political decisions is necessary at some point in time, but prior to that there should be an open and participatory deliberation of the implications of alternative policy pathways. Then assessments could allow EU policymakers to manoeuvre through the complex terrain of energy and climate policy issues, exploring possible solutions to the 'problem from hell'.

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SOCIAL SCIENCE EXPERTISE IN EUROPEAN INNOVATION POLICY

Ulrike Felt[1]

Europe, more than ever, sees its future as *"connected to its power to innovate"*.[2] This vision is not only firmly entrenched in the current formulation of the Innovation Union as *"an action-packed initiative for an innovation-friendly Europe"*,[3] but is also reflected in expressions such as *"innovat(ing) Europe out of the crisis"*,[4] and is translated into European and national research and innovation programmes organised around *"societal challenges"*. In such a policy scenario, European citizens are expected not only to accept the steady flow of innovations, but also to help stabilise *"the innovation trajectory"* through their unconditional support.

With this shift towards innovation policy, a more central and active role is also envisaged for the social sciences and humanities. One of the core ideas is to *"embed (…) the Social Sciences and Humanities across all of the Societal Challenges of Horizon 2020"*,[5] as recently expressed by the European Commissioner for Research, Innovation and Science, and to use them to support the sciences and engineering in order to better succeed in developing and implementing innovations. While such a reassessment of the role of the social sciences should in principle be greeted positively, obvious tensions quickly surface: social sciences, even when they are portrayed as crucial for attaining the innovation goals, are often cast in the role of the junior partners – a role captured by the very notion of 'embedding' – and leadership remains largely with the sciences and engineering when it comes to framing the central problems at stake and developing solutions.

Thus, the question needs to be raised of the rightful place for the social sciences in making Europe and European policies, and their place in the research programme Horizon 2020. It becomes all the more important to reflect why social science expertise is central for policymaking in contemporary democracies, what kinds of expertise we can expect from the social sciences, and what the challenges are in realising this. This essay will argue for the need to engage in new kinds of knowledge relations and to open up novel ways of policy learning, beyond the technocratic modes that are so deeply entrenched in the culture of policymaking.

Making policy, imagining Europe's future

There are two reasons why social science expertise is essential. First, at a moment when Europe's future is more than ever imagined as dependent on and driven by innovations, careful consideration is needed as to how the very idea of 'societal progress' is imagined and practised. What meanings are attached to the notion of innovation – technoscientific and/or social? How do institutional contexts have to be reshaped to better address societal challenges? And how is innovation best brought about and stabilised? Making the future cannot be seen purely as a technoscientific challenge, but is also a societal, and above all a democratic challenge, raising the questions of societal participation and responsibility. As Michel Callon and his co-authors remind us, *"if the end justifies the means, only debate can justify the end"*.[6] The social sciences thus enter the scene as analysts, and, through actively addressing these democratic challenges, add an indispensable perspective to policymaking in a complex, turbulent and inherently uncertain world.[7]

Second, the close intertwinement of Europe's future and the future of European research demands consideration. Policy visions of the direction in which societies should develop always have tremendous impacts on the kinds of knowledge-generation activities that receive support and, vice versa, the kinds of knowledge-related activities that obtain funding clearly express preferences for a specific form of society to be developed. Understanding our knowledge system as a complex and fragile ecosystem in need of subtle and continuous care in order to become sustainable, policymaking has to develop increased sensitivities towards the long- and medium-term impact of choices, and move beyond focusing on short-term innovation gains. At stake is nothing less than a 'sociotechnical imaginary' of a common Europe, i.e. a shared idea of futures that ought to be attained, which are then *"reflected in the design and fulfilment of (…) scientific and/or technological projects"*.[8] As technoscientific projects *"encode and reinforce particular conceptions of what a nation (or Europe) stands for"*, it matters deeply who is engaged in making them, what spectrum of knowledge and experiences should be considered, and how cooperation can be realised between the social sciences and science/engineering, but also with civil society.

Framing the policymaking process

In order to understand the need for, but also the difficulty of, integrating social science expertise into the policymaking process, it is essential to identify the core concerns that seem to guide the process of making Europe's future.

The first concern addresses **international competitiveness**. Europe feels a continuous pressure to keep up with its competitors. The recent shift towards making innovations sustainable, smart or green can be seen as one move towards distinguishing Europe's approach from others. In this context it seems essential not to take these notions for granted, but to investigate what values they stand for and how these values are understood in different cultural contexts. At the same time, it is crucial to acknowledge that this drive for competition also impacts on dynamics within Europe: instead of Europe being seen as a single innovation space, it predominantly gets represented through rankings of Member States in terms of their capacity to produce, support and distribute innovation. As a consequence, a European core and peripheries are continuously reimagined on the European innovation map, weakening the very idea of cohesion. Thus we witness the simultaneous construction and deconstruction of the Innovation Union.

Urgency is the second concern. Expressed through multiple variations of the metaphor of the global race, Europe is pictured as at risk of falling behind, giving rise to the trope: 'We need to act now, before it is too late'. Any reflection on, or expression of concerns about, the direction that innovations take – as often expressed by social scientists or civil society actors – are seen as unreasonable doubts and delays, and are met at best with mixed feelings, and at worst with open hostility and accusations of technophobia. Opening up wider societal choices, or engaging in more reflection, are often equated with taking too much time and lacking the correct orientation towards key goals. Keeping several innovation trajectories open is not seen as a valuable strategy for sustainability but as a threat to efficiency.

Finally, there is frequently expressed concern about a lack of **societal support** for innovations. European citizens ideally should not pose too many questions or demand too much time to consider the impact of transformations on their value systems. Scientific and technological

innovations are simply decreed as public goods. Therefore we find an intensification of science communication, not for the sake of opening up technoscientific developments to public scrutiny, but rather convincing citizens to accept them.[9]

When looking at these three concerns from a social science perspective, a tendency to narrow down possible choices is evident. What gets forgotten are two kinds of obvious discrepancies: first, between understanding the Innovation Union as being mainly realised through technoscientific achievements, and an awareness that Europe's attractiveness as a place to live and work lies in its diverse cultural heritage; and second, between the valuation of science and technology as public goods by larger segments of society, and its evaluation within the systems supporting the development of innovations.

These tensions highlight the importance of analysing, making visible and carefully considering how societal and technoscientific value systems work and how they might diverge in important ways. The social sciences can make an important contribution to the understanding of these tensions and become key actors in addressing them, as they lie at the core of any democratic concern in technoscientific societies.

Horizon 2020: a space for social science expertise?

Within the framework of Horizon 2020, two new notions have made a high-profile appearance: 'social innovation' and 'responsible research and innovation'.[10] Both support a rethinking of research and innovation, opening it up to a wider range of inputs from different societal actors, while engaging in new kinds of relationships between social sciences and the sciences, engineering and medicine.

Such a move is welcome from a societal perspective, as it ideally would support a broader vision of science as public good. Yet it simultaneously raises the question of how the social sciences can become integral partners within the predominantly technoscientific structure of most projects. It seems essential that such policy expressions find a correspondence in research and funding realities, which do not limit the role of the social sciences to being strategic supporters, reporting, anticipating or sense-making agents, or reflective add-ons to what is being developed as the core

business – namely, scientific and technological innovation following its own logic. Only a full integration will allow policymakers to profit from the added complexity in analysis and in the identification of potential solutions to problems.

In this context, it is crucial to consider the position from which the social sciences enter such partnerships with the technosciences and engineering. European social sciences have a long, rich history and are rooted in a broad variety of national and cultural traditions, thus opening up a diversity of problem framings and understandings. While a narrow understanding of standardised knowledge-making might see this as a weakness, it is in fact an important strength and an opportunity to develop new forms of policymaking which reflect the multiple ways in which Europe is ordered, and find adequate ways to address these differences.

Diversity in the Innovation Union

Indeed, handling European diversity seems to be a challenge for policymaking. Although diversity in European policy discourses and beyond is frequently hailed as a key richness of Europe, the ways in which our scientific and societal worlds get addressed in the science policy realm (i.e. through rankings, mapping exercises, comparative statistics and the like) do not reflect this understanding in practice. Instead, we find 'epistemic maps' which order disciplinary territories and show which of the disciplines are central to the innovation logic at work. Often, maps of Innovation Europe highlight the places where the intensity of science-and technology-related activities is high, where the institutions and single researchers of high reputation are located, or where most of the 'excellence funds' (e.g. ERC funding) are concentrated. University rankings and assessment exercises also express clear value orders.

While ordering the innovation world in this way is not a problem per se, it becomes problematic when the effects are not carefully considered and when there is inadequate reflection on how deeply they frame the imagination of what is possible, and where and whom should be paid attention to. In short, the issue of responsibility for creating and distributing such visions of order, and for the impacts they have, is rarely addressed in policymaking. These visions tacitly govern access to and distribution of resources, and serve as an orientation for researchers at an international

scale, yet they also frame the imagination of individual researchers, research institutions and national systems of innovation.

Policymakers addressing the full complexities of this picture would need to ask: what is made invisible and unaccountable through specific forms of representation? What if we chose to use other kinds of tools for orientation? Bringing in the broader perspective of social sciences reminds us that things could be different: that making futures – and in particular innovation-driven futures – is a fragile and complex activity, and that we do not live in a neatly scientised and engineered world. Rather, the world is messy and embattled, culturally formed and reformed, as well as guided by different orders of worth.

Acknowledging diversity in ways of knowing and living in this world is thus a crucial first step towards realising the very idea of 'responsible research and innovation' – namely, seriously addressing the societal aspects of innovation. And it could be precisely the role of social scientists – drawing on a broad range of methods and analysis – to create space for such complexities, as well as to insert them in the all-too-clean maps that are being produced and used to determine technoscientific developments.

Collective responsible innovation

Such reflections also point to how much place matters in the development of innovations. Considering that many of the developments in science and technology are not directed to a specific aim or to a concrete set of applications, it is essential to reflect on the visions and values that go into such developments. Policymaking should create the space to articulate such values and visions, and to foster **collective responsible experimentation**. The notion of experimentation points to the co-evolution of societal and technoscientific developments, the concrete outcomes of this process always being open, unpredictable and messy.

Simultaneously, the space in which experimentation takes place is no longer confined to the classical laboratory; innovations are taking place well beyond the controlled and isolated conditions of a laboratory, reaching out into society.[11] **Collective** experimentation points to the fact that, with the laboratory of society, we need to reflect on who can participate in shaping the experimental design and interpretation of outcomes, and who can

exercise the right to veto. Overall, it means allowing a larger set of actors to have a say in the values embedded in innovations, as well as potential directions to follow.

Responsible experimentation in turn points to the need to create spaces to articulate and reflect on the potential consequences of orders imposed on society through technoscientific policies. It also means thinking across disciplinary borders, as well as across the divide between science and societal actors. This needs us to articulate different kinds of knowledge-generation practices in research and funding; it means extending knowledge production to accommodate more inter- and transdisciplinarity (beyond the frequent lip service paid to this notion); it means acknowledging the diversity of models and rationalities of knowledge generation in social sciences and science/engineering; it means integrating social scientists as knowledge-able and value-able partners on an equal footing into the core of technoscientific innovations, but also into the policies making them possible.

Such collective responsible innovation would also need to reconsider the basic premises on which research and innovation are based. It would challenge the notion of the innovation race by asking questions about possible directions, rather than simply arguing about speed. And it would move away from the idea that there is a single stable future to be attained, shifting instead towards an understanding of the future as a process.[12, 13] For policymaking, this means reconsidering the way science and technology are institutionally organised and funded, to foster a stronger integration of social sciences with the natural sciences. It will be essential to create working environments (e.g. career structures, assessment exercises and accountability rituals) for researchers which allow them to engage in such experimentation without risking their careers, as well as educational approaches which move beyond narrow disciplinary models.

Europe as a unique laboratory

In one sense, Europe can be understood a privileged space, a unique laboratory where diverse models of society, cultural values, valuation practices, political traditions and histories co-exist, with different national ideals being realised through science and technology.[14] In this context, research policy becomes *"a testing ground, a laboratory, or arena for*

the invention of Europe".[15] Rather than seeing Europe's diversity as an obstacle to the smooth development and deployment of innovation (e.g. because of different perceptions of GMOs, nuclear energy or vaccination issues across Member States), it should be seen as a key resource for developing new understandings of sociotechnical innovation processes in both their global and local dimensions. As a consequence, European research funding, but also science policymaking more broadly, needs to explicitly identify and embrace the opportunities that the European knowledge space offers for the better integration of social scientific and technoscientific research, in order to fully capture the advantages of such differences.

Two important elements need careful consideration in any further development of research and innovation. First, a more comparative approach is required to identifying problems and designing solutions, combining social sciences as well as sciences/engineering. European social, cultural and value diversity should invite more research and development inspired by a comparative approach, to make Europe a unique space of collective responsible experimentation with 'the new'. This would improve understanding of how innovations can develop in different settings and how they can integrate different societal structures and value systems, e.g. in the governance of the life sciences or the energy sector.

Second, resistance or frictions with regard to innovations which occur in specific national contexts should not merely be seen as a problem or obstacle to smooth technoscientific development. Rather, they are a resource for understanding how innovations get socialised, adapted and stabilised, and how they acquire different meanings in different contexts. In the end, this allows us to develop innovations more capable of adapting to their environments, and thus more resilient sociotechnical systems.

A new role for the social sciences in Europe

Drawing my lines of argument together, I want us to reconsider the kinds of **knowledge relations** contemporary societies rely on, as well as how social science expertise should matter when addressing the grand challenges that lie ahead of us.

In proposing the notion of knowledge relations, I want to draw attention to the fact that all societal relations, including in policymaking, increasingly

rely on specific sets of expert knowledge. Beyond simply according a key role to technoscientific knowledge, social science knowledge and expertise can contribute complementary ways of seeing and explaining the world, and developing options. This means making use of the whole spectrum of knowledge-making practices, and a serious engagement with novel articulations of different types of knowledge – be they created by different disciplines or civic groups – in the process of developing innovations and accompanying policies.

But it also means conceptualising social science expertise in a broader manner, as more than an increase in routine expertise, i.e. more of the same in well-entrenched ways. Rather, social sciences could contribute to the policy process through other forms of expertise. In a complex world deeply entangled with technoscientific developments, more **interactional expertise** is needed in the policy process, meaning a deeper understanding of, and engagement with, the ways in which technosciences and societal developments co-evolve.[16]

Also, given the rich environment Europe has to offer, social sciences could contribute **adaptative expertise**, i.e. the capacity to address new and complex problems in policymaking through creatively *"transferring and transforming elements of diagnoses, interpretations, and solutions across contexts"*.[17]

Finally, social sciences do not simply reflect on developments, but should be seen as offering a specific kind of **contributory expertise** to ways of thinking about societal futures, innovations and their directions.

Science and technology need to be understood as complex sociotechnical phenomena. The social sciences open up new ways of learning, explicitly inviting us to think in new and unexpected ways informed by societal contexts. Building such insights into policymaking will allow Europe to better respond to the challenges and opportunities posed by complex and inherently technoscientific worlds.

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Endnotes

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POWER, TRUTH AND PROGRESS: TOWARDS KNOWLEDGE DEMOCRACIES IN EUROPE

Andy Stirling

Knowledge and power are comprehensively and intimately entangled. It is no coincidence that it was a key pioneer of the scientific method, Francis Bacon, who famously recognised[1] that *"knowledge itself is power"*.[2] The political implications for – and of – science remain seriously under-discussed. In this essay I focus on issues that have arisen in European Commission policymaking around the concepts of 'the Knowledge Society' and 'the Innovation Union', and unpick some key dilemmas and responses for the governance of science and technology – and for democracy more generally.

A starting point is to note that Bacon's observation was not just incidental to the emerging form of European science;[3] a central interest of science in power also featured in Bacon's telling methodological injunction in order to make of scientific progress, *"to put nature on the rack and torture her secrets out of her"*.[4] The resulting emphasis on reduction, isolation and control has left a lasting legacy, and this has arguably come at the expense of complementary modes of knowledge and action, more reflective of holism, connectedness and care.[5,6] Again, the implications extend well beyond science itself, reaching into the encompassing – and deeply interpenetrating – world of politics.

Alongside the observed configurations of nature itself, then, the kinds of agency in which knowledge is embedded stretch and fold the fabrics of the understandings so produced – highlighting here, sidelining there, and emphasising some connections over others. So – to start with the present topic – ostensibly lofty and disinterested European policymaking for *"the Knowledge Society"*[7,8] conceals much more particular, practical and worldly allures of political action and reward. The associated anticipated fruits of *"the Knowledge Economy"*[9] embody many assumptions not only about institutional means, but also political ends and their encompassing social conditions.

The highlighted structures of the particular economy envisaged in the Knowledge Society present a very specific – and highly political – vision for *"the reinvention of Europe"*.[10] Far from being disinterested and neutral, this vision is often actually very partisan in technological and institutional terms. For instance, certain kinds of knowledge are privileged over others in the prioritisation of a 'bioeconomy' rather than an equally knowledge-based 'eco-economy'. And these already-restricted imaginings of knowledge are then in turn typically taken to further privilege even more specific kinds of advanced biotechnology like transgenics. This effectively marginalises even other advanced biotechnologies (like genomic or marker-assisted technologies), let alone wider innovations.

The political veil

Other examples abound of such visible imprints of power in ostensibly neutral knowledge. By contrast with some branches of ecology, the dominant reductionism of modern biology has had the effect of exaggerating the role of apparently atomised genes over their systemic relations. This is not unrelated to the relative facility of appropriating intellectual property – genes are more patentable than the contexts which actually make them work. Likewise, aspirations to manage planetary control variables in order to secure expedient but unprecedented forms of environmental stability arguably reflect the interests of newly globalising expert institutions much more than they do the realities of the uncontrollable and ever-changing planetary environments themselves. And knowledges concerning the relative merits of different possible future energy infrastructures routinely incorporate assumptions about costs that are direct functions of expectations of the very investments these knowledges are supposed to inform. So apparently objective assessments can embody powerful circular driving forces, helping to bring about the very futures they ostensibly analyse. The point is not to dismiss these particular examples of knowledge, but to illustrate that all forms of knowledge alike are typically imprinted with their social conditions of production.

But the real dilemma in all such cases is that knowledge serves power most effectively when these political aspects remain most veiled. Only by donning the clothes of ostensibly singular and transcendent neutrality can knowledge effectively deliver the precious political commodities of legitimation and

justification. The result in policy circles is a carefully-nurtured obscurity concerning the intrinsically political nature of the forms, foci and fabrics of knowledge. To appreciate this is not to adopt some caricature position that 'anything goes' in science. However, even though there remains a multitude of ways of being wrong, there are also typically many different ways of being right – and hearing this can be very inconvenient to power. So this requires voices like those of Gramsci,[11] Foucault,[12] Wynne and Jasanoff[13] to provide repeated reminders that knowledges don't simply confer power, nor do they just constitute it. The crucial neglected fact is that knowledges are also themselves deeply shaped by power.

To see this is to spin on its heels the conventionally accepted predicament in analysis for policy of candidly 'speaking truth to power'.[14,15] For this is only one side of a relationship in which it is also the case that *"power inscribes knowledge"*.[16] Although sometimes uncomfortable, it is relatively easy to acknowledge that there are many perils and pressures around the apparently noble and apolitical callings of the expert in delivering supposedly authoritatively pristine knowledge. These challenges are real. But to end it at this is entirely to miss the other side of the relationship. What is scientifically 'true' may nonetheless admit a variety of equally valid but contending political interpretations. And an 'ought' cannot uniquely be derived from an 'is'. As many have experienced in 'evidence-based' policy processes, to speak this general truth about power is an altogether more perilous form of candour than merely to speak some particular truth to power.

Inconvenient truths

Across multiple forms of power in many different settings, these basic processes remain the same. The most inconvenient truth to speak is that whatever the knowledges on which local commitments rest, they are themselves in any way ambivalent or susceptible to social influence. For this is how knowledge loses its crucial, political load-bearing qualities. Then, both message and messenger become terminally unwelcome.

To take one small example on the theme of European governance of science, it was for exactly such reasons that the European Commission in 2008 disbanded the Expert Advisory Group on Science and Society (EAGSIS), for which I was rapporteur. As was confirmed in its final report,

published later,[17] EAGSIS was closed down because its members refused to succumb to pressure simply to legitimate an existing 'hardwired' programme of social science research on science policy, rather than discharge their responsibility to advise on its strategic direction. EAGSIS had politely – but clearly and repeatedly – pointed out a rather inconvenient truth in a succession of earlier reports:[18] most of what was presented as a programme of two-way public engagement ostensibly aimed at informing the overall direction of Commission research was better understood as an instrumental process of science communication aimed at promoting entrenched priorities.

In this tiny example of a much more general pattern, the recalcitrant experts were disciplined in a succession of ways: first, by being ignored; then by being variously chastised as unwise, naïve or impolite; then by being threatened that future prestigious expert advisory positions would be jeopardised; and, finally, by being effectively fired. With EAGSIS thus disbanded and its offending reports side-lined, the ongoing programme continued without the fig-leaf of legitimation-posing-as-oversight. The loss was not widely noticed!

Panel politics

Another personal experience represents a further small – but unusually clearly viewable – drop in a much larger, deeper and more murky ocean. Before the above episode, in 2003 to 2004 I was a member of the UK Science Review Panel examining genetic modification. Here, I tried to draw attention to some particular power dynamics in policy science which led to the tendency systematically to suppress various kinds of uncertainty. In the end, these efforts helped lead to an unusually open final report which systematically acknowledged in every chapter 'uncertainties', 'disagreements' and 'gaps in knowledge' alongside the usual preoccupation simply with risk.[19] Concluding in the voice of the UK Chief Scientist (who chaired the Panel) that science of itself could deliver *"neither a red light nor a green light"* for GM crops, the report was a rare instance of candour under pressure simply to provide justification. The onward ripples were not insignificant for UK government policy on GM crops over the ensuing few years.

But this did not occur without friction; I was quietly informed by a member of the secretariat of an entirely separate social science advisory committee

that Commission officials were being strongly lobbied by a leading scientific figure in UK regulation of GM crops to drop me from this EC committee on the grounds of my being a 'troublemaker'. Fortunately, this is an example where the science advisory system also displayed some integrity; after some tense encounters, the UK Chief Scientist of the time agreed formally to repudiate in the minutes of the Science Review Panel this attempted exercise to exert pressure against a member.

To my knowledge, this remains the only example of an official UK science advisory body formally acknowledging what is almost certainly a much more widespread (and often more serious) reality. After all, both stakes and pressures are typically lower for a social scientist like the author than for natural scientists, who are more dependent on large-scale laboratory funding and whose expertise is more focal to the science directly in play. So it would be a strange coincidence if this unique official acknowledgement of attempted coercion should indicate that the only instance of such pressure had occurred in exactly a situation where it was most readily resisted and revealed. Anecdotal evidence suggests the phenomenon is more widespread – but less visible – throughout natural science.

Whatever the context, it is out of mutually reinforcing self-interest that those giving advice tend to share with those being advised a (literally) power-full policy etiquette. By all means talk of the responsibilities of 'speaking truth to power' – but don't mention the reverse relations by which power helps (partly) to shape the knowledge it receives. In this way, it is permissible to negotiate in private the terms under which the inevitable compromises are made between the contending imperatives of power and knowledge. But – like the proverbial making of sausages – to produce policy-relevant knowledge in public risks revealing such unsavoury sights that the final product is spoiled, and no-one ends up looking good. So, like Victorian attitudes towards sex, all are complicit in the dynamics of power, accepting that knowledge is spoken about in private between elite peers, but not in front of servants, children … or the public at large.

Speaking truth about power

So, these issues are rarely acknowledged within public research and innovation policy documents. Nevertheless, the importance of these dynamics of power is actually raised rather frequently, on occasions when the social science of science itself is invited to give its own 'independent'

expert policy advice. Just looking back over the past decade, there is no shortage of examples where European science governance institutions have (to their credit) commissioned and received exactly this message. What is notable, however, is not that the message is not sought (or consequently heard) by policymakers; what is striking is that this evidence for the implication of power in knowledge is so common in commissioned advice yet so systematically neglected in policy itself. To appreciate this, it is (fittingly!) necessary simply to consider the evidence. Let us look, therefore, at social science advice provided to support Commission research and innovation policy over the past ten years.

In 2007, a report by a diverse group of historians of science[20] began by emphasising exactly the points made above. *"We first stress the obvious: that science, whatever its achievements, is human-made; that science has always been linked to powers and interests; that science has limits and is not socially 'neutral'."* The report goes on to highlight that *"power relationships and interests are central in the science business"* and that as a result, *"social scientists and historians are part of power games, notably games of legitimisation"*. And power is a central focus of attention, not only between policymaking and science, but within and across different academic disciplines themselves:

> *"The fact that science is not a unified system and that it is made of quite different species (clinical medicine vs. experimental biology vs. epidemiology for example) leads us to recommend particular attention when policymakers have to consider the implications of a new technology or product. Organising the confrontation between these species in a fair way … (a way that counteracts the systemic asymmetries of power) is central."*[21]

Engagement on whose terms?

A second, roughly contemporary report[22] drew on contributions from a large number of researchers in the contrasting field of science and technology studies (STS), and synthesised the findings from an entire programme of Commission research. Reflecting experiences of exactly the kind related above, this document focused on the practice of public engagement. It observed that:

> *there is – despite the rhetoric – a persistent tendency on the part of senior people in powerful government and industry bodies often to see exercises in 'participatory process' simply as an effective means to justify (and so help deliver) what were referred (to) as 'pre-decided policies'."*[23]

Elaborating this, the report found that:

> *The type of discussion that can arise in public engagement may itself pose significant challenges. The focus often centres in one way or another on the exercise of political and economic power in the field of science and technology. The resulting queries over 'who?' and 'why?' may sometimes be rather uncomfortable for incumbent decision-makers and institutions. Who is accredited to engage in discussions of science and technology? Who asks the questions to be researched? Who prioritises the allocation of resources? Who makes the assumptions in interpreting the answers? How and when are results to be communicated and to whom? Which knowledge is held privately and subject to proprietary rights and which is placed in the public domain? What is stated and what left unsaid?*

> *A significant obstacle to public engagement often lies in the prevailing attitudes of senior figures – and wider cultural perspectives – in the institutions concerned with the governance of science and technology. In particular, there is in some such quarters a persistent scepticism over the status of public knowledge and understanding. There are tensions between institutional priorities and more widespread public values and interests. There is a reluctance to commit to open self-reflection and the sharing of power and influence."*[24]

Thus detailed in more specific forms, this is exactly the syndrome pointed to at the beginning of this paper. A third influential report, also largely drawing on STS scholarship, was produced in 2007 by a smaller Expert Group on Science and Governance.[25] Focusing directly on challenges presented by *"the Knowledge Society"*, it said:

> *The way we think and talk about science and innovation is still dominated by questions of scale – 'how much?' and 'how fast?' – but we're not so good at talking about directions – the outcomes to which all of this investment and activity is being directed. The metaphor of the race exerts a powerful stranglehold on these debates. And the choice we are often presented with in that race is faster or slower, forward or back, but with no option to change*

course. We do not devote enough attention to considering the plurality and diversity of possible directions."

Again, the crucial dynamic in focus is the use of knowledge to legitimise and justify the commitments of power.

Innovations and expectations

Moving away from STS, even when relationships between knowledge and power are addressed by traditionally more instrumental disciplines with less self-consciously critical identities, and interests focused more directly and operationally on 'innovation systems' as they actually exist (rather than as they might be wished), the message remains very similar. In a fourth report from scholars of innovation studies published in 2009,[26] the same essential problem is identified, under which the *"scope and variety of involved organised actors such as science organisations, industries, governmental agencies, parliaments, non-governmental organisations can be broad and heterogeneous, too. They have different interests, resources and power, and they negotiate in various inter-linked arenas on all kinds of rules and policy instruments".*

Again, the importance of politics and power are highlighted in the ostensibly technical business of research and innovation. *"Various methods exist to support the construction of priorities including more systematic approaches such as foresight, impact assessment and evaluation of past performance, and more political processes such as the various forms of negotiation and lobbying between different loci of power and influence involved in the formulation of a research programme."*[27] Even under instrumental perspectives, it is impossible to ignore the importance of power and vested interests.

In advance of the landmark Lund Declaration in 2009, a fifth report was commissioned from another large group of researchers,[28] this time in fields relating more broadly to interdisciplinary science and integrated assessment. Discussing dilemmas in mission-oriented research, this aimed to address global 'grand challenges' of the kinds on which the Lund Declaration focused. Yet here, again, neither the wider scientific perspectives nor the imperative of shared social goals were found to be enough to remove the challenges presented by the dynamics of power

in knowledge and innovation. Complicating the apparently self-evident missions presented by grand challenges, this report noted:

> *(…) the presence of strong vested interest with considerable lobbying powers, as well as the policy logic of existing institutions which might work against more fundamental reforms. (As a result) many of the participants expressed opinions concerning the priority setting process. The design process was described as non-transparent, undocumented and heavily influenced by lobbying groups. As a result, the interests of the already powerful are reinforced, and it is difficult for outsiders to make their voices heard. One reason for this is the governance structure with a formal 'proposition monopoly' given to the Commission. This creates a discussion with the Commission in the centre instead of the member states, which might reduce the number of voices that have a real influence over the research agenda. Reforms that increase both the transparency and the influence of the member states were called for."*[29]

In 2009, there emerged a sixth report on the related issue of scientific indicators.[30] This made a pithy observation directly addressing a similar point concerning the concentrating of power in research governance. *"The adage that science is too important to be left to scientists captures the normative challenge of integrating science in society, allowing for societal participation, but in such a way that its creative power is not subsumed by immediate interests."* Again, this underscored the recommendations made in all the previous reports concerning the importance of opening up more collaborative approaches to research and innovation.

It was in this vein that the 2007 Expert Group on Science and Governance had noted that *"democratic governance has become dislocated in ways that cannot be remedied by technical methods and tools alone"*. It concluded that *"policymaking should not stop at simple or mechanical solutions; it should address the complex issue of science and governance honestly, thoroughly, patiently and with humility"*.

And the 'science in society' report had argued for related qualities: *"European activities in (science governance) should be informed by, and should themselves incorporate, more effective forms of symmetrical two-way deliberation, empowering inputs from a wide diversity of social actors. In short, this might be thought of as a move towards a new style of 'cooperative research'."* [31]

Opening up and closing down

Yet simply to extol the virtues of honesty, humility, dialogue and cooperation says little unless we address the power relations under which such qualities are constituted, interpreted and accredited. Even Bacon's *"torture"* is, after all, a form of dialogue! As a seventh report for the European Science Foundation (ESF) found in 2012,[32] merely to recognise or advocate the *"co-production of knowledge"* can beg many questions. After all, *"co-production may use a large series of interactions, at different scales of space and time, and concrete forms"*.

So, as was stated in 2013 by an eighth report,[33] also commissioned by the ESF: "science and technology are now governed at an increasing number of sites, involving ever more diverse sets of actors in more disparate ways. This leads to complex and new forms of distribution of power and constant struggle over the directions to take." Where knowledge is recognised to be co-produced in collaborative dialogue, the need to address issues of power is accentuated, rather than attenuated. Noting that *"engagement and governance therefore represent locations (or spaces) where values and norms and thus power relations are negotiated"*, this most recent ESF report argues against pretending at the absence of power, but rather that its terms should be made more transparent.

The 2009 report for the Lund Declaration affirmed some particular details of this. Discussing the need for *"devising new political mechanisms and policies"*, this report identified a need for *"the kinds of institutional arrangements that are conducive to citizens' empowerment – that is, their autonomy of power and their ability to influence the decisions of public authorities. Some institutional arrangements are likely to increase efficacy and participation, while others are likely to reduce them."*[34]

One possible guiding imperative in the negotiation of such institutional arrangements was noted right back in the 2006 STS report. Rather than romanticising notions of academic neutrality and notional independence from wider power structures, this urged a form of positive discrimination as a crucial constituting principle in what it called 'transdisciplinary' or 'cooperative research'. *"Where notions of independence embody recognition of the need to counterbalance prevailing patterns of privilege and power, then it may be perfectly legitimate deliberately*

disproportionately to attend to some of the more marginal or 'excluded' (rather than conventional mainstream) viewpoints".[35] So: the nearest that knowledge may come to neutrality is in collectively deliberate cultivation of a plurality, explicitly constituted to counter dominant interests.

The overall message is clear. Where attention is devoted (as here) to a rather complete range of social science advice commissioned over the last decade by European science governance institutions, what is remarkable is that every single instance focuses directly – in one way or another – on the crucial roles played by power in knowledge. This is true of every quoted passage above. Not only are these dynamics strongly emphasised in diagnosis, they also form a priority focus for the policy prescriptions. On the face of it, then, with power relations within science and innovation given such a strong emphasis in the evidence base supposedly informing policy, one might reasonably expect to find the same broad issues highlighted in the official policies themselves.

Polite policy etiquettes

A few brief phrases in the background 'mood music' do seem to bear this out. For instance, in a 2008 EC document on public engagement in science,[36] Research Commissioner Janez Potočnik acknowledged that *"it is our task to set up new ways which both empower the public and reward those scientists who engage constructively with civil society"*. Implying no particular commitment or concrete intervention, other such 'apple pie' statements are readily found. Moreover, the example of the disbanded expert group described at the beginning of this essay illustrates how such references to public engagement may say one thing, yet do another. What is more remarkable about the actual Commission policy documents setting out concrete instruments for the governance of science and innovation over this period, is that they have virtually nothing whatsoever substantive to say about the need directly to address power relations in the production of policy knowledge. No deliberate policy interventions are proposed explicitly as a means to deal with this.

This picture specifically in the field of science policy contrasts strongly with EC policy discussions of governance more widely. For instance, the formative and influential 2001 White Paper on European Governance[37] (supposedly underpinning all European governance activities, including

on science) is very explicitly and directly concerned throughout with addressing what it acknowledges to be serious imbalances of power in the general politics of democratic governance. And power relations are also a very clear and explicit object of attention in official discussions of international arenas bearing on European innovation policy.[38] So there seems no noticeable general policy inhibition around discussing power – as long as the power and interests in question are those of other political actors.

It seems disproportionately in relation to dynamics of power within European science and innovation systems that too explicit a mention of power becomes awkward and indiscreet. So, the curious neglect of any need for remedial action in relation to power concentrations or lock-in in the field of science and technology does not reflect a general institutional culture or policy climate. Nor does the gap seem to reflect any general difficulty in operationalising such a broad concept as 'power'. As discussed in the first section, this policy etiquette of aversion even to the mention of power-in-knowledge seems particularly prevalent in the field of research and innovation policy – where addressing power would take its arguably most sensitive forms – those which are imprinted in knowledge.

Again, the detailed evidence seems to bear this out. When official Commission research and innovation policy documents are systematically reviewed, a striking general pattern becomes clear. In all the labelling and branding, there are plenty of signs of the overt influence of power in the promotion of science and technology towards particular ends: *"research and innovation as sources of renewed growth"*,[39] *"Science 2.0"*,[40] *"innovation: creating knowledge and jobs"*,[41] *"responding to societal challenges"*,[42] *"reaping the benefits of globalisation"* and *"the future of Europe is science"*.[43] In addition, fears are raised over the growing scientific and technological strengths of competing countries – significantly involving frequent explicit discussion of external power relations.[44] Also, where it is necessary in very technical terms for the purpose of implementing concrete legal frameworks, issues of power are dealt with very clearly and directly.[45] But across many thousands of pages of text in wider science and technology policy documents, issues concerning the actual dynamics of political power in research and innovation systems themselves are barely even mentioned, let alone subjected to deliberate or explicit attention. Overt questioning and criticism of the kind exemplified in the advisory literature reviewed above is almost completely absent.

Consultation in power vacuums

Many specific examples may be given to illustrate this. Consultation documents are issued with apparently no interest in the implications of vested interests or incumbent powers.[46] Research work programmes are designed as if power relations in knowledge production were of no particular interest – and policy action plans make no mention of them.[47] Technology platforms are developed for the promotion of particular strategies, as if the field were bereft of contending vested interests. Schemes are put forward for regional programmes and partnerships, without any attention to the relative degrees of power enjoyed by different actors.[48] Technological performance is anxiously surveyed and scoreboards devised, but none of the metrics seek to gauge issues like lobby activity, concentrations of power or asymmetric levels of influence.[49] Economic and business assessments are conducted, neglecting questions of market concentration or lock-in.[50] And voluminous statistics cover numerous obscure issues in research and innovation systems, but fail to indicate crucial issues concerning the concentration of resources to certain particular research or innovation trajectories within a given sector rather than others.[51]

Numerous very detailed public opinion surveys are conducted in the field of science and technology and issues of instrumental interest are exhaustively explored, like the degree of trust placed in experts, public acceptance, or the readiness for innovation.[52] But nowhere are respondents asked systematically for their views or understandings concerning the actual or appropriate distributions of power in research and innovation. And perhaps most remarkable of all is the picture given in documents on the burgeoning field of responsible research and innovation (RRI). Plenty of attention is given to exhortations and claims concerning the desirability of ethical or inclusive behaviour, but there is virtually no specific discussion of how to address the ubiquitous dynamics of power, vested interests and the strategies of incumbents, within which these qualities are set – and subject to which they are interpreted.[53]

What is arguably most telling about this quite comprehensive official neglect of the dynamics of power in science and technology policy are the rare exceptions. For, on the very few occasions when power is explicitly mentioned, it is disproportionately in reference to the notional power of civil society, rather than the more obvious power of incumbent actors.

For example, one report on embedding society in science and technology policy[54] makes significant reference to Chinese experience. Advocating the 'non-political' stance of official structures, this paper attributes partisan bias only to those groups outside of innovation systems, like NGOs, who *"are sometimes unwilling to pay the high price (in terms of image or power) of compromising their position in the debate"*. This reflects a far more general discourse on research and innovation in elite policymaking circles: the challenges of vested interests, strategic behaviour and accountability are typically far more comfortably addressed in relation to the relatively tiny resources of civil society than the manifestly more massive instances of similar challenges displayed by incumbent business and governmental actors themselves.

Towards knowledge democracies

This has been a relatively long essay. But my conclusions can be quite briefly stated. Not least, this is because simply to talk of power in research and innovation (as we have been doing) is arguably a large part of the solution. Power is a very complex, multidimensional and situated phenomenon, and to seek to analyse it and address its consequences need not of itself be seen as critical – let alone revolutionary. Power can obviously often be a force for good, but what this means in any given context – and to what ends – is best understood and negotiated by those most directly implicated or affected. And those who are generally most advantaged by such openness about power in its diverse forms are those who are most remote from it (and consequently most marginal or vulnerable in other ways). So, it is in keeping with the shared progressive strands in scientific and democratic traditions with which this chapter began not only to illuminate power, but also to challenge it. To do so is not to seek idealistically entirely to dispose of power, but very pragmatically to get the best out of it.

The problem is that where power remains unspoken and invisible, as it typically does in European research and innovation policy, then it becomes much more difficult to enact these everyday processes of democracy. And without speaking of power, illuminating it and challenging it, some of the other kinds of exhortation and virtue recommended in the many reports reviewed here also risk being subverted. Qualities like humility, responsibility, precaution, transdisciplinarity, co-production, cooperation

and reflexivity, for instance, are only able to exert their intended effects where the associated power structures are explicitly accountable (rather than implicitly denied). Without accountability, there seems little reason to suppose these virtues will be any less vulnerable to legitimatory pressures than the romanticised positivist values criticised here, such as expert objectivity, sound science or evidence-based policy.

What is interesting is how immanent this message is, even in the early provocative Baconian framings of power and knowledge with which this chapter began. For, despite his predilections for metaphors of torture, Bacon also recognised that *"we cannot command Nature except by obeying her"*. And herein lies an abiding dilemma in the exercise of power: behind the discourses of control, what passes for power is often a euphemism for privilege. In a complex and dynamic world, maintaining incumbency is often more about surfing waves of contingent events through successful rhetoric than it is about having any real control over the underlying currents. The setting of directions for research and innovation is therefore not necessarily best understood as an end in itself. The picture here is similar to the pressures discussed above to justify decision-making in general (as much as any particular decision). In science and technology, as elsewhere, power is perhaps best understood as the privilege of generally presiding over unfolding trajectories of change, rather than specifically controlling them.

If unfolding trajectories are to be steered in directions that are (as so much policy advice reviewed here calls for) more responsible, precautionary or progressive, then the virtues of humility, cooperation and reflexivity (also advocated in this literature) may yield altogether different benefits. Rather than being ends in themselves, these qualities are potential means to the greater end of democratic struggle. Here again, Bacon made a salient point with regard to money, that might equally be applicable to power: *"it is like muck, not good except it be spread"*. This observation by a founding figure in science reinforces the widely recognised 'Mertonian' aspirations of science itself – to communalism, universalism, disinterestedness and organised scepticism. Communalism is about the sharing of power; universalism is about directing it towards collective ends; disinterestedness is not about denying power, but balancing contending interests; and scepticism is about challenging power in all its forms. So, it is science itself that seems – ironically – to chart a very clear challenge for European governance of research and innovation.

If European science and technology are to progress in directions that best reflect and address diverse and contested social needs, then what is needed is not the power-denying polemics of the 'Knowledge Society', still less the even more overtly structured interests of an 'Innovation Union'. Where such hopes lie more is in resisting the suppression of politics in both these discourses. Instead of closing down around an engineered technical or deliberative consensus, what are needed instead are the many means to opening up more democratic struggle over the directions of research and innovation trajectories. Here, there are no panaceas: neither methods, principles, values, discourses or institutional designs will of themselves or alone fully embody such struggle. What is crucial are the interactions between these arenas. It is by distributed compasses rather than universal gridlines that the small everyday capabilities and heuristics of challenging power may most readily effect their diverse ends.

At a practical level, the struggle for knowledge and innovation democracies means challenging (and building alternatives to) a number of currently very prevalent pressures. European research and innovation governance should be wrested free of burgeoning instruments of justification and legitimation. Monovocal talk of 'sound science' and 'evidence-based policy' (as if these determine particular decisions) are neither politically nor scientifically credible. Pressures to put in place individual chief scientists through whom to channel all expert policy advice similarly suppress the complexity, diversity and context-dependency of knowledge. And the language of 'pro-innovation' policy, without saying which innovation or why, is particularly erosive of accountability.

Alternatives to these monolithic discourses and institutions lie in the myriad methods and practices reviewed in the literatures summarised here. In short, these allow more rigorous and accountable plural and conditional understandings of which directions for research and innovation align best with which values and interests, and why. Instead of hierarchically-structured multidisciplinarity, or mission-directed transdisciplinarity, there is a need for explicitly power-challenging 'hyperdisciplinarity'. In the end, what these offer are ways to resist the self-application of Bacon's doctrine of torture – not just on nature but on science itself. Since nature is so complex, diverse and indeterminate – and scientific understanding is so successful through fostering communalism, plurality and scepticism – why should science be forced to speak in a single voice? Engaging equally with the subjects and objects of knowledge, there seems to be the same disposition to control.

It is in these senses that science and democracy are ranged against the same forces: they are not so much in contention as mutually reinforcing. Like science itself, knowledge and innovation democracies are best seen not as destinations, but as struggles; and it is arguably in celebrating and nurturing such democratic struggles that the most pressing imperatives can be found for European governance of science and technology.

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4
THE APPLIANCE OF SCIENCE

BEHAVIOURAL GOVERNANCE IN EUROPE

Holger Strassheim and **Rebecca-Lea Korinek**

"We post a signpost: no deep thinking here. Things are bad enough already." What John Rawls once wrote in an unpublished footnote[1] could qualify as the motto of the behavioural movement in public policy across Europe and elsewhere. Behavioural experts are not getting tired of emphasising the beauty of simplicity. Cass Sunstein, Professor of Law at Harvard and former 'regulatory czar' heading the White House Office of Information and Regulatory Affairs, even argues that the future of government depends on it.[2]

Indeed, there are good reasons for declaring simplicity the mantra of modern government. Behavioural studies have shown that simplifying messages and reducing complexity may have large effects on people's behaviour. For example, making registration forms or information letters clearer, and options more salient, can move decisions in desired directions, e.g. by encouraging people to enrol into pension schemes or change energy providers. Even if these 'nudges'[3] do not work, proponents argue that their costs are extremely low and they cause no harm. Just like signposts.

In its most recent World Development Report, *Mind, Society and Behavior*,[4] the World Bank discusses the advantages and challenges of behavioural governance. While highlighting that behavioural insights and interventions can improve the design and implementation of development policies, the report also points to the complexities of the approach: multiple cognitive, socio-cultural and policy factors have to be taken into account to make behavioural governance work. The uncertainties and unintended side effects related to these factors are not fully understood. Moreover, behavioural experts and policymakers need to account for cultural influences on their own choices, critically re-examining the normative implications and unquestioned certainties of behavioural approaches. Paraphrasing the proverb well known to economists: there ain't no such thing as a free nudge.

A world of choices

Behavioural governance is understood here as every mode of governing which is informed, designed or implemented by focusing on psychological as well as cognitive mechanisms of behaviour, in both individuals and collectives. There is a behavioural element to public governance when policymakers seek to change people's behaviour – e.g. in non-smoking policies or food safety – or when people's behaviour affects the effectiveness of certain policies. Behavioural governance is based on two core insights:

Firstly, when situations are complex or ambiguous the behaviour of individuals is influenced by heuristics and biases. In contrast to standard models of rational choice, people often use mental shortcuts and simple solutions even if this means acting against their own interest. In their seminal studies on decision-making under uncertainty, Tversky and Kahneman identified three central heuristic principles – representativeness, availability and anchoring – that have formed the basis of behavioural approaches until today.[5] According to their research, people trying to predict the future intuitively rely on similarities and stereotypes (representativeness); the probability of risks is assessed by the ease with which instances or occurrences can be brought to mind (availability); and in many situations, estimates are biased by an initial value or a starting point that works as a default (anchoring). People may ignore the fact that they do not know enough, or fail to learn from new information. When consumers' decisions in credit markets, for example, are influenced by such mental shortcuts, they may resort to borrowing at extremely high interest rates, while in the aftermath of an earthquake, more people are likely to purchase insurance. Heuristics shape the ways risks are perceived.[6] More information rarely solves the problem; it can just add to the existing amount of information, while increasing uncertainty.

Secondly, the social environment in which people make decisions may trigger some of these heuristics and inhibit others. The way books in a bookstore are presented, or the order of the items on a restaurant menu, make certain decisions easier than others. Everyday action is embedded in informational infrastructures that simplify the presentation of options, evoke certain associations or make certain options more visible than others. In their popular book *Nudge*, Sunstein and Thaler speak of *"choice architectures"*. Choice architectures are ubiquitous: the order of traffic

lights, the display of food in a cafeteria, the design of a web page, all shape the salience of options and the likelihood of certain choices. Since choice architectures are inevitable, policymakers are advised to actively engage in designing arrangements that support desirable policy goals and reduce behaviour seen as suboptimal. This is the core argument of behavioural approaches: avoiding pre-structured contexts is not an option. Following this line of thought, both policymakers and experts should seek to become choice architects.

Simplicity and its (side) effects

One of the most prominent examples of designing choice architecture at the European level is the EU ban on pre-ticked boxes for online purchases. Orthodox economics predicts that decisions should not be influenced by a pre-selection with respect to certain products or add-on components, e.g. in travel insurances. By contrast, behavioural economics has shown that defaults significantly increase the probability of specific purchasing behaviour. As of 13 June 2014, the EU Directive on Consumer Rights prohibits pre-ticking, targeting problems connected to anchoring heuristics. In this case, simplification simply means removing defaults.

There are multiple other examples of actively setting choice architectures. Sunstein and Thaler famously call them nudges, defined as interventions that do not force anyone and preserve freedom of choice, but still have the potential of promoting welfare. Indeed, recent studies on evidence from randomised controlled studies suggest that some of them are working well: text message reminders to bank account holders to save money increased savings balances by 6 percent; emails to homeowners comparing their electricity bill with that of their neighbours and rating them (‘great’, ‘good’ or ‘below average’) led to reductions in power consumption equivalent to energy price reductions of 11–20 per cent; and automatically enrolling people in pension plans dramatically increased participation and retention.[7]

Unfortunately, we do not know much about the side effects and unintended consequences of nudges. As simple as they may sound, they still intervene in a complex environment. For example, a recent Swiss–US study on a behavioural energy conservation campaign found that giving people feedback on their water use successfully reduced water consumption, but this coincided with an overall increase in electricity use. An explanation

for this unforeseen outcome is what researchers call the 'moral licensing effect': the people who saved water felt entitled to be wasteful in another area.[8] Moral licensing is well known in many areas of behavioural governance such as obesity policies or fitness campaigns. It is just one of the cognitive factors that form part of the complexities which behavioural interventions are confronted with.

Mental models and policy mix

The recent World Bank report points to a second set of factors that might influence how behavioural governance works.[9] Anthropologists and ethnographers have demonstrated that cultural contexts have an effect on the formation and expression of heuristics and biases. Mental models, the interrelated schemes of meaning that people use when they act and make choices, are shaped by economic relationships, religious affiliations and national contexts. This needs to be recognised when designing nudges, so that they are communicable in different communities.

On a more basic level, cultural context may also influence certain behavioural heuristics. Experiments based on a classical vignette from behavioural economics among representative samples in capital cities around the world revealed significant differences in choices depending primarily on the economic status (not nationality) of respondents. The choices of poor people in Jakarta or Lima mirrored the choices of poor people in the USA. Cultural stereotypes may work similarly. During an experiment in India, high-caste and low-caste boys were randomly assigned to groups that varied the salience of caste identities. When their caste was not revealed, the performance of high-caste and low-caste boys in certain problem-solving tasks was statistically indistinguishable. Making caste salient to the individuals changed their problem-solving capacity significantly, triggering a vicious circle of competence loss and confirmation of stereotypes. Thus, economic status and cultural mind maps exert a strong influence on individual behaviour, suggesting caution when making assumptions about decisions in different contexts.

A third set of factors is related to the embeddedness of nudges in a wider mix of policy instruments. More often than not, behavioural interventions are interwoven with classical policy instruments such as prohibitions,

standards or tax incentives. The US CARD Act, signed into law by President Obama in 2009, is an example. It was designed to counter practices by US credit card companies that took advantage of self-damaging consumer decisions, as described by behavioural economists. (Evidence suggests that consumers ignore future costs when considering immediate purchases; are overly optimistic when assessing fees that they may incur; and tend to anchor repayments to information on minimum payments.) The Act bans certain types of hidden fees, and mandates lenders to include an explicit calculation on bills that compares minimum repayments and the costs of repaying over 36 months. As a combination of hard regulations and nudging, it is especially difficult to evaluate. While a first study seems to be encouraging, there is not enough evidence to fully assess its impact.[10]

Of course, the difficulties of appraising the dynamics and effects of mixed policy instruments are well known to evaluation researchers; this is not a specific problem of nudges. It does, however, shed some light on the limits of simplification. All in all, much more research is needed to get a better understanding of the cognitive, socio-cultural and policy-related factors influencing how behavioural governance works. The complexity of these factors also explains the current insistence on simplification. While nudges may work in carefully orchestrated and isolated settings, it is difficult to know how they behave in the real world.

Changing ecosystems of expertise in Europe

While the design of behavioural interventions and their complexities have become important topics in current discussions, there is one aspect that has received less attention: the factors influencing the choices of behavioural architects themselves. A recent report by the European Commission's Joint Research Centre (JRC)[11] makes it clear that applying behavioural approaches to EU policymaking requires a better understanding of the ways expertise and evidence can be used in policy processes. In order to incorporate the findings of behavioural science, policymakers need to be aware of political as well as methodological limitations. The timing of the application of behavioural studies within the policy process is just as important as knowledge about the pros and cons of different types of studies (e.g. experiments, randomised controlled trials, surveys and qualitative research studies). The authors conclude that behavioural study *"will not offer a silver bullet to solve policy problems"*.

Indeed, the rise of behavioural economics is already changing the *"ecosystems of expertise"*[12] in Europe and beyond. In the UK, it is associated with the Behavioural Insights Team (BIT), an organisation that has gained both national and international influence by experimentally developing and disseminating behavioural interventions.[13] BIT conducts experimental trials, designs behavioural interventions and advises other organisations on how to apply behavioural insight in the public domain. It has become a paradigmatic example, inspiring the creation of similar project units in other countries, e.g. the Social and Behavioural Sciences Team at the White House's Office of Science and Technology Policy (OSTP) and, most recently, the project group Wirksam Regieren (governing effectively) at the German chancellery.[14]

In contrast, Scandinavian approaches to behavioural governance are characterised by bottom-up networks such as iNudgeyou in Denmark and GreeNudge in Norway.[15] Situated at the interface of applied behavioural science, public institutions, NGOs and private stakeholders, these initiatives engage in research projects focused mainly, but not exclusively, on environmental policy and public health (e.g. reducing food waste, litter or smoking). As experiments in 'guerrilla research' they seem to point to certain problems with simplification, namely that it favours simple solutions designed by behavioural experts over more complex questions asked by consumer groups, environmental activists or lay people. While there are no studies of the organisation of behavioural expertise yet, it is plausible to assume that the modes by which behavioural findings are translated into nudges also determine the criteria by which desirable behaviour is distinguished from suboptimal decision-making.

There ain't no such thing as a free nudge

The diversifying dynamics of behavioural expertise in Europe provide an important lesson: there is no best practice to incorporate behavioural findings into policymaking. In each country, science–policy interactions are structured by cultures of expertise: the more or less unquestioned ways in which public knowledge claims are validated and perceived as politically relevant. These cultural preferences may affect the resilience and receptiveness of knowledge production, influencing the ability to learn from mistakes and decide accordingly.[16] At the same time, advisory systems have a choice architecture of their own, including certain heuristics and biases.

When implementing behavioural governance in Europe, both experts and policymakers need to critically re-examine the unquestioned certainties and normative implications of behaviourally informed policies.

This should include a reassessment of the role of social sciences in understanding decision-making under uncertainty. As the World Bank report shows, human society adds a layer of complexity to the analysis of individual behaviour. The structures of social norms and institutions heavily influence both individual decisions and the organisation of choice architectures. Considering them is essential to making behavioural approaches work and preventing unintended consequences and side effects. This could mean that nudging is much more time-consuming and costly than some of its proponents insinuate. The effort, however, might be worthwhile if it helps to redesign public policy beyond rational choice models, by cautiously taking into account the human factor.

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INNOVATION: MANAGING RISK, NOT AVOIDING IT

Claire Craig and **Mike Edbury**

Different nations, as well as institutions from the European Commission to the United Nations, have constructed different ways of getting the science advice they need. The common requirements are for impartiality and authority, timeliness and the willingness of both the scientists and the decision-makers to respect the constraints and objectives of the other.

In October 2014, the UK celebrated the 50th anniversary of the formal appointment of a Government Chief Scientific Adviser (GCSA). To mark this anniversary GO-Science published the first themed Annual Report by a GCSA.[1] The topic of that report, *Innovation: managing risk, not avoiding it*, was deliberately chosen to reflect the enduring challenges for science advisers everywhere.

This short article draws on the findings of the Annual Report, findings that were informed by a series of chapters by eminent figures from a wide range of disciplines, as well as by workshops in Copenhagen, Berlin and Paris.[2]

The European economy is critically dependent on growth driven by science and innovation. Innovative economies are more competitive, respond better to change, see higher returns on investment and create increased living standards. Innovation is also essential for security and resilience, and will be needed to help meet challenges such as those posed by infectious diseases and the need to reduce carbon emissions. Yet all innovation requires change, and any change has within it the potential for both benefit and harm.

From the future of nuclear power to nanotechnologies, the choices that EU nations make, collectively and individually, matter greatly. They have an essential role in shaping the legal frameworks, institutions and policies that in turn shape the risks and incentives faced by others. It is this balance of risks and incentives that determines what choices innovators, entrepreneurs, investors, inventors, bureaucrats and citizens will make.

However, innovation is not an unalloyed good. Discussion of innovation has become almost inseparable from discussion of risk, and paradoxically, this discussion has become more prominent precisely because the innovations of previous generations have made our lives much safer. People living in advanced economies have become more risk-averse compared to previous generations.

The task of designing systems of regulation and practice that are based on rigorous evidence and well-informed public debate is difficult. In some areas, regulatory systems have become sclerotic and stifle growth. In others, uncertainty about 'who is accountable for what' acts as an inhibitor. Debates about risk are often highly technical, while at the same time being at least as much about values and choices, about who benefits and who pays. Social, political and geographical contexts matter hugely, and this is especially true when seeking to establish frameworks across national boundaries. When governance goes wrong, we can miss out on major potential benefits, or suffer needlessly.

Innovation, risk and government

Despite these challenges, there is much we can do to frame debate and decisions more effectively. Debates about new technologies are rarely helpful when conducted in the abstract: where there is little evidence and few specifics to consider, people's views are naturally determined primarily by their existing worldviews and views about the origins of the innovation, rather than what is actually known about its benefits and risks. So, for example, in the case of GM organisms the most effective questions are: 'what gene?', 'in what organism?' and 'for what purpose?'. More generally, the issue at stake is rarely a simple question of 'yes or no?' or even 'how fast?', but more often, 'in which direction?', 'what are the alternative choices?', 'who leads, gains and loses?' and 'why?'.

Sometimes decision-makers seem to assume that acknowledging uncertainties and the breadth of opinion and debate on an issue will inevitably lead to delay and complexity. This is not the case; we all constantly make decisions based on imperfect information, both professionally and personally, and that is ultimately the only way to get things done.

How to frame discussions of risk and innovation

Science is usually one lens amongst several through which to examine innovation and risk. It is an essential lens, but not the only one: economic, social, and political lenses may also need to be used. Debates about risk are also debates about values, ethics and choices; about how benefits and risks are judged; and about fairness, or who benefits and who carries the risk. If these broader questions are ignored, conflicts can become intensive and disabling. It is important that scientists working with decision-makers recognise the breadth of the discussion; and equally important for decision makers to realise that science is a vital component of that discussion. Widening the conversation is a democratic necessity and an expression of responsible citizenship.

The science of risk and risk communication

Confusion sometimes starts with misperceptions about concepts as basic as those of hazard and risk. An important distinction needs to be made between hazard and risk. A simple illustration can be found in the contents of our kitchens. These are full of hazards: sharp knives, boiling kettles, exposed electric filaments in toasters, salt, bleach and other noxious chemicals. We avoid the risks posed by these hazards by reducing our exposure to them. So we avoid poking metal conductors into our toaster, or pouring bleach into our stew. Risk is a product of the hazard and our exposure to it, and therefore a hazard to which there is no exposure poses no risk.

Understanding this terminology really matters, and getting it wrong leads to poor debate and decision-making. An extreme example of the need to consider carefully the distinction between intrinsic hazard and practical risk is the case of radiation: the response of many countries to the nuclear reactor disaster at Fukushima in 2011 was more a reaction to a deep-seated fear of radioactivity rather than a careful analysis of actual radiation exposures, which were very small outside the site of the power station itself.

Another example is provided by the regulation of Bisphenol A (BPA), a chemical used to make plastics, including materials used in direct contact with food. Risk assessments indicate that health concerns from exposure to BPA are low. However, regulatory provisions introduced by the European

Commission, and now in train in some EU member states, lead to risks of their own due to potential issues with the safety and effectiveness of replacements for BPA.

A first step in making a scientific assessment is to review existing evidence. Good examples are the Cochrane Reviews of the evidence underlying different medical practices. Similarly, the EU Joint Research Centre, the European Academies Scientific Advisory Committee and bodies under the auspices of the UN such as the Intergovernmental Panel on Climate Change (IPCC) play an important role. The approach taken by all of these is the use of 'meta-analysis' – a rigorous review of all of the evidence available on a particular topic.

But reviewing the evidence is just the beginning of the discussion of risk; how this evidence is communicated is equally important. Scientific knowledge is contingent knowledge – it is dependent on the nature and reliability of existing evidence, and subject to modification and improvement by the emergence of new evidence.

When science meets values

Our individual responses to innovation and risk are shaped by our family, friends and colleagues, and by our national identity and values. These social and cultural factors influence our decisions on which dangers to accept or avoid; inform our views on the fairness of the distribution of risk and benefit; and, crucially, influence who is blamed when things go wrong.

As a result, there are large variations in tolerance to different types of risk between countries and cultures, and therefore the approach to risk and to judgments about risk may differ within and between countries. In some cases these factors influence the way in which a country may approach and manage its whole system for considering risk and innovation. In other cases, apparently similar systems of governance, evaluating similar technologies, may produce different analyses of risk and different judgments.

We can only have a high-quality discussion about innovation if we understand that the discussion must be about both science and values. There are some areas of technology and innovation that trigger particularly strong and immediate value-based responses, and these typically vary

between different communities and countries. Obvious examples in biology and medicine are animal research, stem cell research and reproductive technologies. In energy, almost all technologies can trigger strong emotions, whether we are considering fossil fuels, wind technologies or nuclear. In the environment, major arguments are triggered by the consequences of the release of waste and by-products created by humans, ranging from oestrogen contraceptives excreted in urine to the over 10 gigatonnes of carbon emitted into the atmosphere each year by the burning of fossil fuels. In the food industry, GM organisms, pesticides, industrialised processes for agriculture and animal husbandry, and mechanisms for the control of animal and plant diseases, each cause strong responses in some communities and some countries.

In many of these areas there are profound differences in the attitudes of the populations from different countries, and one of the consequences of having a European Union of 28 nations is that almost every technology evokes immediate and strong reactions in one or more nations. We need to be more aware of these differences, so that we can have healthier and clearer debates that make better policy at all levels.

The precautionary principle, like many principles, is both simple and at the same time subject to variable interpretations and expectations.[3] As one of the participants at recent workshops run by GO-Science said, it was originally designed as a form of amber 'pause' signal, and is now often used as if it were simply a red 'stop' signal.

The implications of this drift in use become particularly stark when combined with a further theme in the Annual Report: the need to consider the implications both of action and of inaction. This theme is central to debate on issues as controversial as pesticides, vaccines and GM technologies. For instance, if we choose not to develop GM crops at all, we are intentionally reducing our options for creating greater food security and tackling the implications of climate change and population growth.

Institutions and trust

Concerns about risks are often rooted in concerns about the adequacy of the institutions that produce, predict and manage them. This is likely to be particularly important for risks that are pervasive, not visible, and whose

technological or environmental causes may only be understood by acquiring particular types of expertise. We therefore rely on judgments about the values and behaviours of those in charge. The trusted expert or institution is typically expected to act with care for those affected, to be competent and to be free from self-serving bias. For the ordinary member of the public, the best frame of mind may be 'critical trust': neither outright scepticism nor uncritical acceptance.

The array of challenges presented to regulators is in many ways sector-specific; regulating medical products poses completely different challenges to regulating telecommunications, for example. However, some issues are generic, and one of these is the asymmetric incentives that are presented to many regulators. Put simply, a regulator which allows something to happen that causes harm will probably be in deep trouble, whereas a regulator which stops something from happening that would have caused benefit will likely suffer no consequences.

This is a very difficult problem to solve, because proving the counterfactual to a preventative decision by a regulator is well-nigh impossible. The best hope that we have to deal with this problem is to do our best to make regulators accountable for all decisions, both positive and negative.

Ultimately, a decision has to be made

Because of the new insights outlined in our report and elsewhere, we are optimistic. Even where an area is complex, uncertain and highly contested, there are examples of very effective decision-making that rely on working with interested publics and scientists. A UK example is the Human Fertilisation and Embryology Authority, developed to regulate the application of embryology research to reproductive technologies. It is an outstanding example of regulation working alongside legislation in the face of emerging scientific understanding and competing values.

These and other experiences show that a sophisticated regulator, empowered to conduct public debate as part of its work, can deliver advice over a prolonged period whilst both science and technology continue to evolve.

The challenge for the EU arises from the diverse national perspectives on different innovative technologies. That is an issue for politicians rather than scientists, but nevertheless scientists should expect science to be seriously considered, evaluated and communicated as part of the discussion.

Therefore the European Commission needs continually to strive to ensure rigorous scientific input, which should inform the processes of preparing legislation in Council and Parliament. It follows that, like other regulators, European regulators should seek independent advice. They should foster and promote public discussion and debate, and the outcome of that debate should inform the regulator itself, policymakers and legislators. Meanwhile, GO-Science will work with existing EU networks to pursue further opportunities to exchange ideas and good practice on these issues at the EU level.

Note: The views expressed in this article do not represent the views of the UK Government.

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Endnotes

1. Government Office for Science (2014) 'Innovation: Managing Risk, Not Avoiding It.' The report can be found here https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381905/14-1190a-innovation-managing-risk-report.pdf
2. Government Office for Science (2014) 'Innovation: Managing Risk, Not Avoiding It – Evidence and Case Studies.' The report can be found here https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381906/14-1190b-innovation-managing-risk-evidence.pdf
3. For more on the precautionary principle, see European Environment Agency (2013) 'Late lessons from early warnings: science, precaution, innovation.' and a Guardian series which started with this piece http://www.theguardian.com/science/political-science/2013/jul/08/precautionary-principle-science-policy

BIOMEDICINE AND THE LIFE SCIENCES: CORE ISSUES FOR SCIENCE-BASED POLICY ADVICE

Jörg Hacker, **Stefan Artmann** and **Sandra Kumm**

In democratic and pluralistic knowledge societies, science-based policy advice fulfils three functions. First, it provides political decision-makers with state-of-the-art scientific knowledge that is reliable, relevant to societal concerns and transparent with respect to uncertainties. Second, science advice can systematically analyse policy options for the solution of societal challenges and evaluate them in the light of given objectives. Third, it contributes to public debate on policy goals and objectives by probing the rationality underlying differing normative ideals and concepts of common welfare.[1]

There are as many topics for science-based policy advice as there are public problems that can be analysed by scientific methods – including societal challenges caused by developments in science and technology. During the last forty years, the tremendous progress in biomedicine and the life sciences has been one of the core issues of science-based policy advice and it is, in our view, a good bet that this will not change in the foreseeable future. Biomedicine and the life sciences present a special class of public policy issues, but they can be understood as a test case that illustrates some of the opportunities and challenges for future directions of scientific advice in Europe.

Biomedicine and the life sciences are revolutionising our understanding of life and health

We are all concerned about our bodily integrity and health. More or less consciously, any human being evaluates her or his corporeal abilities against some standard of wellbeing that varies according to many cultural, social and individual factors. This comparative evaluation almost always influences, with a strong normative force, decisions about how to lead one's life.[2] It is therefore understandable that we nourish high hopes – and foster

deeply engrained worries – about any research that has the potential to expand, for good or bad, the power to control our bodily functions and to change our conceptions of health.

Since the 1940s research into the molecular foundations of living systems has been advancing our understanding of the nature of life and the clinical abilities of physicians at an ever-accelerating pace. Examples of this progress are abounding; we will just mention some of the topics that have been considered by the German National Academy of Sciences Leopoldina and the European Academies' Science Advisory Council (EASAC) in the last few years. These topics include the efforts to combat infections that can pass between animals and humans, the impact of climate change on infections, the challenges facing antibiotics research, and the European public health policy for infectious diseases. Statements have been published on predictive genetic diagnostics as an instrument of disease prevention, and on the effects of a limited legal approval in Germany of pre-implantation genetic diagnosis. Challenges and opportunities for taxonomy (a discipline with a long history) and for synthetic biology (a promising new field of research) were analysed. Scenarios for the future development of high-throughput ('omics') technologies in Germany have also been developed.[3]

Any reader of the statements published by EASAC and the European national science academies will surely conclude that not only do biomedicine and the life sciences involve many of the most promising research programmes of our time, they are also revolutionising the art of medicine – and thereby transforming human self-understanding.

In constitutional democracies, citizens who are interested in, or concerned about, the consequences of biomedicine and the life sciences can freely speak out for or against public policies on scientific research, technological innovation and healthcare. This usually results in a broad spectrum of opinions – e.g. on the regulation of stem cell research – that are discussed in the public sphere and taken into consideration in political decision-making. This pluralism of legitimate interests voicing their diverse views is a fundamental characteristic of democracies, and pertains also to normative (juridical and moral) dimensions of public policies on science, technology and health.[4] In open societies, these interests are part and parcel of the bargaining processes at the end of which decisions about public policies are made.

A well-functioning science policy advice system can help supply state-of-the-art information on those high-impact sciences. Cool-headed advice is needed on options for dealing with hotly debated issues, and critical competence is required in scrutinising goals and objectives of public policies on ethically challenging issues. Science-based policy advice can make a strong contribution to fulfilling those needs.

Enhancing evaluation, cooperation and the appreciation of values

Reflecting on the experience of the Leopoldina in contributing advice on biomedical policy, two general aims have emerged. The first is to offer scientific advice to help evaluate distinct policy options to achieve an agreed goal. The second – perhaps more fundamental – is to help provide a forum and vocabulary to enable different value positions to be articulated and to explore room for compromise.

The first type of these aims can be applied to any kind of allocation problem; given an agreed policy goal, it is necessary to determine the optimal use of different kinds of resources in terms of costs and benefits. A good example comes from giving advice on antibiotic resistance. There is a broad agreement on the principal goals of public policy on antibiotics: the spread of antibiotic resistances must be reduced and new antibiotics have to be developed. The general means to reach these goals are also relatively uncontroversial: more research is needed, the transfer of scientific discoveries into clinical application must happen more smoothly, and the proper use of antibiotics by physicians and the general public should be encouraged. But it is a great challenge to advise on how the human, institutional, financial and other resources of science, innovation and public health systems should be optimised in order to stop the spread of antibiotic resistances and to develop new antibiotics. Not only does this involve questions of funding and organising science, from basic research to clinical studies; it also implies legal frameworks (e.g. the certification conditions for new active agents), social aspects (e.g. health education on the sensible use of antibiotics) and economic factors (e.g. tax incentives for research and development).

In 2013, the Academy of Sciences and Humanities Hamburg and the Leopoldina published a statement, *Antibiotics Research. Problems*

and Perspectives,[5] that proposed a scientific agenda and made eight concrete recommendations, ranging from strengthening basic research and facilitating clinical research, to restricting the use of antibiotics in veterinary medicine and consistently implementing antibiotic consumption records, to intensifying socio-economic research and establishing a national round table on antibiotics research. In their statement, the Academies emphasise that:

> *"The concerns of antibiotic resistance and the lack of antibiotics can only be resolved or at least alleviated if the policymakers in the fields of science, politics, society and industry decide to cooperate and act on a national and international level to pursue a variety of concerted efforts."*[6]

Following this example, a general aim of science-based policy advice on allocation problems should be to enhance cooperation between all stakeholders in order to optimise the use of resources for public policies on research and health. The two main instruments to reach that aim are communicating to stakeholders the best available scientific information about what we know and what could be done, as well as evaluating, against given policy goals, the options for action as impartially as possible.

Negotiation of compromises and the appreciation of values

The second type of aim for science-based policy advice covers any sort of value conflict; given the need to define policy goals, it is necessary to support the negotiation of compromises in the appreciation of values needed for the definition of public policies.

A good example of such a value conflict is pre-implantation genetic diagnosis (PGD). PGD is a diagnostic procedure that allows parents at high risk of having a child with a hereditary disease to have a child unaffected by the disease. The procedure involves examining in vitro fertilised embryos for the presence of particular genetic changes indicating hereditary diseases. In Germany, an intense public debate on PGD arose in 2010 after the Federal Court of Justice had delivered a judgment that a ban on PGD could not be derived from the Act on Embryo Protection.

In 2011, the Leopoldina, together with the German Academy of Science and Engineering (acatech) and the Berlin Brandenburg Academy of Sciences

and Humanities (BBAW), published an ad hoc statement *Preimplantation Genetic Diagnosis (PGD). The Effects of Limited Approval in Germany*,[7] which recommended that PGD should be placed on an equal legal footing with prenatal diagnosis, and that the German legislative should vote for a limited approval of PGD. The statement covered not only medical but also juridical and moral aspects of the issue, and summarised its normative conclusions as follows:

> *"If it is assumed that avoiding having a child cannot be demanded by the state under any circumstances, then legally approved embryo selection by a woman within the context of a limited approval of PGD may contribute to the avoidance of terminations of pregnancies, including late terminations. Furthermore, unaffected in vitro embryos could then be 'saved', since they could, with the consent of the woman, be transferred. As a result, limited approval of PGD would mean that the procedure would no longer be associated with the inevitable death of unaffected embryos. At the same time, the dignity of the woman would not be violated since she could make the decision herself in accordance with her own conscience. Even if the dictates of her conscience do not concur with the moral or religious views of others, the fact still remains that respecting the conscience of individual persons and accepting moral beliefs, but not stipulating these attitudes in a legal sense so as to render them generally binding, is a characteristic of a free democratic constitutional state. Should specific morally binding attitudes exist, a decision based upon conscience would preclude the performance of PGD."*[8]

This citation concisely exemplifies the general goal of science-based policy advice on value conflicts, which are amongst the hardest problems in the context of biomedicine and the life sciences. The aim of the advisers should be to develop strategies of fair bargaining between all stakeholders in order to support the negotiation of compromises in the appreciation of values. Such compromises allow the involved parties to define the goals of public policies on research and health as consentaneously as possible. Against the background of the best available scientific information about what we know and what could be done, the most useful method of science-based policy advice for the development of fair bargaining strategies is to reconstruct and to analyse – as impartially as possible and as sympathetically as necessary – the actual principles that connect the value preferences, the policy evaluations and the political actions of each stakeholder.

Scenario-building to help guide advice on policy options

Science-based policy advice in constitutional democracies ought to respect the division of labour between politically responsible decision-makers and advisers who want to help find reasonable ways of defining and implementing public policies. Winston Churchill reportedly once said, *"Scientists should be on tap, but not on top"*.[9] 'Expertocracy' or technocracy must, therefore, not be a future direction for science-based advice – even if we currently observe a trend, particularly when it comes to the contribution of science to sustainable development, to blur the distinction between advice and decision.[10] In democratic societies such a trend would lead to an erosion of legitimacy for political decisions as well as to a loss of trust in the impartiality of science-based advice.

If we want to draw a clear demarcation line between advising and deciding, it is best to think about science-based policy advice as suggested by the Hungarian-American economist and 1994 Nobel Prize winner, John C. Harsanyi, in respect to ethics – *"in terms of hypothetical imperatives"*,[11] i.e. in terms of propositions of the general form 'If you want X, do Y'.

Thinking in terms of hypothetical imperatives about the optimal allocation of resources, given certain policy goals, means to develop and apply techniques for cost–benefit analyses of public policy. How to model the probable effects of alternative science policies and how to study empirically the real effects of implemented science policies – both questions are an essential part of the task that the presidium of the Leopoldina described in its 2013 discussion paper *The Sustainability of the German Science System. Supporting the Future Development of Research, Teaching and Knowledge Transfer*, as follows:

> *"The societal impacts of science, the growth of knowledge and its substantive and institutional differentiation present science with significant challenges that can only be surmounted when its relationships to other areas of society are examined using the methods of scientific enquiry, thus allowing a more substantiated approach to the management of these relationships."*[12]

Recently, a Leopoldina working group on the challenges presented by omics technologies for Germany's infrastructures in research and teaching used the technique of scenario-building to handle complex questions of

science policymaking.[13] Harnessing the full potential of high-throughput technologies for scientific and medical ends requires, above all, the massive introduction of new training programmes for young scientists, the fast development of a nationwide IT infrastructure, and the goal-oriented cooperation of universities and non-university research institutions. The working group developed two scenarios for the establishment of a national omics and IT infrastructure as a network of distributed, topically-focused omics centres. These scenarios specify some main characteristics of that infrastructure – namely access, financing, linkage to European and international infrastructures, and training and career possibilities.

We know, of course, that the comparison between two scenarios for the development of research infrastructures is just a first step in advising on complex planning issues in science policy. Yet it seems to us that it is a promising step, going in one of the directions that should be taken by science-based policy advice on biomedicine and the life sciences in the future.

Practising the role of the impartially sympathetic adviser

New research programmes in biomedicine and the life sciences usually do not raise only questions of the optimal allocation of resources; first and foremost, they have a high potential to pose problems in the appreciation of values. An example is synthetic biology, the merger of biology, chemistry and engineering that further develops genetic engineering and biotechnology in order to purposefully modify existing living systems or to construct new ones from scratch. Synthetic biology is quite a young research programme that will, to our mind, become an even more important topic for science-based policy advice in the near future.

Together with the German Research Foundation (DFG) and acatech, the Leopoldina published a statement on synthetic biology in 2009, which has been adapted to the European level by EASAC.[14] The first-mentioned statement explicitly addresses the necessity of a systematic appreciation of values as regards synthetic biology:

> *Moral arguments in favour of producing artificial life are based on the anticipated benefits for medicine, agriculture, energy generation or the environment, thus making the exploitation of synthetic biology not only permissible but even advisable. Although synthetic biology is justified by the economic advantages and ultimately by the freedom of research, according to the general consensus it should, however, be subject to other basic rights such as the right to physical integrity."*[15]

The public debate about what goals public policies on synthetic biology should pursue will not lead to a consensus between all stakeholders. Neither is it a legitimate aim of political decision-making in constitutional democracies to suppress moral pluralism. Nor is it necessary for science-based policy advisers to wait for unanimity about normative questions before they begin their work; they can start with a task that Harsanyi has, mutatis mutandis, described as follows:

> *If two codes of behaviour are equally self-consistent, the choice between them is not a matter of logic alone, but rather primarily a matter of personal attitudes. However, analysis by moral philosophy of alternative codes of behaviour can help us to make our choice more intelligent."*[16]

Some future directions for science-based advice in biomedicine and the life sciences

"Making a choice more intelligent" should mean taking into account the internal consistency as well as the consequences of different normative systems when choosing between them. If stakeholders with different moral standards are involved in making political decisions about science and health policies, the best science-based policy advice can reasonably hope to do in making those decisions more intelligent is to develop bargaining strategies between the stakeholders that raise the probability of achieving a compromise, e.g. regarding the regulation of synthetic biology by law. The science-based policy adviser thus becomes a good host, or an impartially sympathetic referee in *"a properly managed debate with understandable and reliable communications that addresses the challenges of synthetic biology"*.[17] We are suggesting that any step towards such an ambitious, yet realistic, understanding of the role of the scientist as an adviser is a step in the right direction for science-based policy advice – in Europe and elsewhere.

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Endnotes

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2. An influential and much-debated analysis of the existential role and normative character of conceptions of health was made by the French physician and philosopher Georges Canguilhem in his 1943 'Essai sur quelques problèmes concernant le normal et le pathologique' (expanded 1966 edition translated as 'The Normal and the Pathological' by Fawcett, C.R. and Cohen, R.S. New York: Zone Books, 1991).
3. The statements of Leopoldina and EASAC are available at http://www.leopoldina.org/en/home/ and http://www.easac.eu/ respectively (last accessed 7 October 2014).
4. The constitutive role of pluralism in liberal democracies is one of the main topics of modern political philosophy. See, for example, Rawls, J. (1993) 'Political Liberalism'; expanded edition New York, NY: Columbia University Press, 2005.
5. See Academy of Sciences and Humanities Hamburg and German National Academy of Sciences Leopoldina (2013) 'Antibiotics Research. Problems and Perspectives.' Hamburg: Academy, and Halle (Saale): Leopoldina. pp. 49.
6. Academy Hamburg and Leopoldina (2013) p. 15.
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8. Leopoldina, acatech and BBAW (2011) p. 3.
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11. See Harsanyi, J.C. (1958) Ethics in Terms of Hypothetical Imperatives. In 'Mind' N.S. 67 (1958), pp. 305–316.
12. Leopoldina (2013) 'The Sustainability of the German Science System. Supporting the Future Development of Research, Teaching and Knowledge Transfer.' Halle (Saale): Leopoldina. p. 6.
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15. DFG, acatech and Leopoldina (2009) p. 87.
16. Harsanyi, J.C. (1958) p. 315.
17. DFG, acatech and Leopoldina (2009) p. 87. And see also p. 86 on 'a platform for structured discussions' about ethical issues.

FUTURE DIRECTIONS FOR SCIENTIFIC ADVICE IN EUROPE

Edited by James Wilsdon and Robert Doubleday

Across Europe, scientific evidence and advice is in great demand, to inform policies and decision-making on issues such as climate change, new technologies and environmental regulation. But the diversity of political cultures and attitudes to expertise in different European countries can make the task of designing EU-wide advisory institutions and processes both sensitive and complex.

In January 2015, **President Juncker** asked **Commissioner Moedas** to report on options for improving scientific advice within the European Commission. At a time when these issues are higher than usual on the political agenda, it is important that the case for scientific advice and evidence-informed policy is articulated and analysed afresh.

To support these efforts, this collection brings together agenda-setting essays by policymakers, practitioners, scientists and scholars from across Europe. Authors include **Anne Glover**, **Ulrike Felt**, **Robert Madelin**, **Andy Stirling**, **Vladimír Šucha** and **Jos van der Meer**. Their contributions outline various challenges but also constructive ways forward for scientific advice in Europe.

This project is a collaborative initiative of four partners: University of Cambridge's Centre for Science and Policy; Science Policy Research Unit (SPRU) at the University of Sussex; the European Commission; and Stiftung Mercator. It is also a linked activity of the new International Network for Government Science Advice (INGSA).

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