European Commission

SCIENCE AND TECHNOLOGY ADVISORY COUNCIL

Science for an informed, sustainable and inclusive knowledge society

Policy paper by President Barroso's

Science and Technology Advisory Council

Brussels, August 29th, 2013

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Introduction

The welfare of modern society depends to a large extent on the continuous advancement of scientific knowledge, the development of technical and practical knowhow and the fostering of entrepreneurial spirit. Extraordinary advances have taken place in science and new technologies in the last decades[1]. For example our understanding of genetics, synthetic biology, neurosciences, material sciences, computer sciences, space science and advances in nanotechnologies have provided both a deeper understanding of the grammar of nature and new opportunities for industrial and economic development. Innovative engineering tools and new forms of manufacturing have also shown how to foster better communication, to improve access to information and how to use many resources more efficiently and with reduced environmental impact. These developments offer new opportunities to tackle major societal challenges; enhance economic prosperity and a fair distribution of wealth for all members of society; address climate change, energy and resource scarcity; stimulating advances in healthcare and reducing the impact of aging societies, and many other potential benefits.

During this period, the global and European context in which these advances are taking place has also changed significantly. Complex issues of sustainability, global competitiveness and equity have loomed ever more critically in the conscious minds of many EU citizens[2]. And yet, if knowledge from scientific research is to become the driver of a knowledge-based economy, how do we ensure that its evolution and development reflect not only a step forward into sustainable development but also meet societal expectations and concerns?

In 2012 the *Innovation Union flagship initiative*[3], the proposals for *Horizon 2020*[4] and the *Communication on A Reinforced European Research Area Partnership for Excellence and Growth*[3], just to quote some recent policy papers on research and innovation, highlight the idea that European future prospects depend on our ability to deliver growth that is *smart*, *sustainable*, and *inclusive*[5]. The term "inclusive" illustrates the need to gain public support for the necessary changes in technologies, production processes and societal transformations[6]. The EU encourages citizens to become active actors in the innovation and research policy designs of the EU. The Science and Society link therefore has been considered an important strategy pillar of European science and innovation policy[7].

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[1] Compare: Uzagalieva, A., Kočenda, E., and Menezes, A. (2012): Technological innovation in New European union markets. *Emerging Markets Finance and Trade*, *48* (5), 51-69. And: Parrilli, M. D., and Elola, A. (2012): The strength of science and technology drivers for SME innovation. *Small Business Economics*, *39* (4), pp. 897-907.

[2] Compare: Barr, S. (2012): *Environment and Society: Sustainability Policy and the Citizen*. Ashgate Publishing: London. With respect to energy systems, compare: Huijts, N. M. A., Molin, E. J. E. and Steg, L. (2012): Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. *Renewable and Sustainable Energy Reviews*, *16* (1), 525-531. With respect to risks, compare: World Economic Forum (2013): *Global Risks 2013.* 8. Edition. WEC: Genf, p.63f. http://www3.weforum.org/docs/WEF_GlobalRisks_Report_2013.pdf, accessed on July 26, 2013;

[3] http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/flagship-initiatives/index_en.htm

[4] http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=h2020-documents

[5] http://ec.europa.eu/euraxess/pdf/research_policies/era-communication_en.pdf

[6] Renn, O. and Schweizer, P. J. (2009): Inclusive risk governance: concepts and application to environmental policy making. *Environmental Policy and Governance*, *19* (3), pp174-185.

[7] From a policy viewpoint, additionally to the EU research programmes some examples of relevant EU policies include the *Science and Society Action Plan* (COM(2001)714), the *Action Plan Life Sciences and Technology* (COM(2007) 175), the *Nanotechnology Action Plan* (COM(2007) 505 final), the *Digital Agenda for Europe* etc.

Public concerns about science and technology

In spite of the fact that Europe's fate depends on a prudent utilisation of knowledge, most European societies face a growing distance between knowledge producers, users and citizens. Many innovative applications of science and technology lack significant public support, regardless of what the balance of scientific evidence suggests about the level of risk associated with any specific application[8]. In the abstract, the European population is still strongly in favour of science and its application (e.g. plant biotechnology). Eurobarometer 2011 data[9] show that 75 % of EU citizens are positive about science and 66% feel that science is making our lives healthier, easier and more comfortable[10]. However, since 2005 the share of Europeans experiencing trust in science has declined from 78 % to 66 %. In all countries, except Norway, Hungary and Luxembourg, some citizens have lost part of their trust in science[11]. The largest decline in trust has taken place in Germany, Italy and Poland.

Many people seem to be fixated on the risks and the uncertainties of new developments while commonly underestimating their potential for positive change and economic opportunities. Recent examples of public concerns on innovative products include, inter alia, the internet of things and smart cities (privacy); shale gas (risk assessment); GM food (socio-cultural concerns); dual use and biotechnology (biological threats); synthetic meat and animal cloning for food (safety and cultural concerns); personalised medicine, gene testing and DNA banking (benefits for society and socio-economic inequalities)[12]. Other concerns include carbon capture and storage (citizens raise safety concerns over storage facilities in their neighbourhood despite the fact that this technology is regarded as potentially beneficial to fighting climate change); smart energy meters (privacy issues); electronic health records (privacy and autonomy concerns) etc[13].

At the same time, social change associated with the advancement of knowledge has lost some of its attractiveness for at least two reasons[14]. Many European citizens enjoy increasing levels of economic prosperity and see less need for change. For the less privileged groups in society, sophisticated knowledge (for example in the financial sector) often seems to run counter to the common good and benefit only the rich.

This perception of a gap between those who produce and apply new knowledge and those who will be affected by the positive and negative consequences of these applications is exacerbated by new developments in knowledge generation and in the institutional settings where knowledge generation takes place. Due to the complexity, uncertainty and ambiguity of contemporary knowledge construction, knowledge claims are often contested and leave ample room for different interpretations[15]. Knowledge often increases the experience of uncertainty rather than reducing it. This has led to the problematic belief,

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[8] Compare public attitudes towards technologies: Pardo, R. and Calvo, F. (2002): Attitudes toward science among the European public: a methodological analysis. *Public Understanding of Science*, *11* (2), pp. 155-195. The discrepancy between risk perceptions of new technologies and statistical risk analysis is described in: Garner, D. (2009): ***Risk. The science and politics of fear.*** Virgin Books: London, pp. 290f.

[9]http://ec.europa.eu/research/innovation-union/pdf/competitiveness-report/2011/chapters/new_perspectives_smarter_policy_design_chapter_3.pdf

[10] In five countries, three quarters or more of respondents agree with the statement : Malta at 78 %, Iceland at 77 %, the United Kingdom at 76 % and Luxembourg and Norway at 75 %. http://ec.europa.eu/research/innovation-union/pdf/competitiveness-report/2011

[11] It is clear that specific uses of science differently affect public acceptance in EU MS and the EU as a whole. Levels of optimism about computers and information technology and solar energy have been high and stable over the period. By contrast, optimism in biotechnology, which declined steadily over the period 1991–99, rose considerably between 1999 and 2002 but from 2005 onwards, is in decline.

[12] Compare for technological trends in general: Allum, N., Sturgis, P., Tabourazi, D. and Brunton-Smith, I. (2008): Science knowledge and attitudes across cultures: A meta-analysis. *Public Understanding of Science*, *17* (1), 35-54. Compare for biotechnology: Frewer, L.J.; van der Lans, I.A., Fischer, A.R.H.; Reinders, M.J.; Menozzi, D.; Zhang, X.; van den Berg, I. and Zimmermann, K.L. (2013): Public perceptions of agri-food applications of genetic modification – A systematic review and meta-analysis. *Trends in Food and Science,* 30 (2), pp. 142–152.

[13] Compare for carbon sequestration: von Borgstede, C., Andersson, M. and Johnsson, F. (2013): Public attitudes to climate change and carbon mitigation—Implications for energy-associated behaviours. *Energy Policy*, 57 (June), pp. 182–193; compare for health records: Luchenski, S., Balasanthiran, A., Marston, C., Sasaki, K., Majeed, A., Bell, D. and Reed, J. E. (2012). Survey of patient and public perceptions of electronic health records for healthcare, policy and research: Study protocol. *BMC Medical Informatics and Decision Making*, *12* (1), 40. doi:10.1186/1472-6947-12-40.

[14] Compare the classic essay by: Mongardini, C. (2002): The decadence of modernity: the delusions of progress and the search for historical consciousness. In: J.C. Alexander and P. Sztomka (eds.): ***Rethinking Progress.*** Unwin Hyman: Winchester, MA, pp. 53-66.

[15] Compare the analysis in: Forsyth, T. (2013): ***Critical political ecology: The politics of environmental sceince.*** Routledge: London, pp. 77ff.

allegedly supported by post-modern thinking, that all truth claims are more or less arbitrary and driven by personal or institutional interests rather than factual insights[16].

Challenges for improving public understanding of new developments in knowledge and technology

A principal challenge in science and technology information and education is therefore to convey a modern understanding of knowledge as a temporary, contested and multi-faceted body of truth claims and, at the same time, provide the assurance that it is the "fuzziness" of contemporary knowledge that leads to a successful and responsible application of knowledge in different societal domains. Uncertain knowledge is by no means arbitrary. It portrays reality much better than traditional deterministic models of the world. Complex models of reality have proven to be more successful than simple and unambiguous images of reality[17]. Even with all the uncertainty and ambiguity associated with new knowledge, the implications of this knowledge have the power to make human interventions more robust, efficient and even sustainable. Taking risks and exploring uncertain areas is thereby connected to creating new opportunities and to providing economic and social benefits to all.

To convey this message about the nature of contemporary knowledge to all parts of the European population is first and foremost an educational task. In particular, the science curricula of schools need to be revised to reflect this new understanding of knowledge and provide guidance on how to handle complex questions in an appropriate -but still knowledge-based- manner[18]. These attempts at revising school curricula need to be accompanied by additional efforts to launch programs on public engagement with science, knowledge and society. To focus on scientific literacy only is not enough. The participants of these programs need to become familiar with the concept that knowledge, technology, organisational structure and patterns of behaviour are closely interwoven and constitute the main fabric of our modern, knowledge-based culture[19].

Secondly, we need new and effective programs to help people understand the rationale for comparing risks and benefits and for making prudent trade-offs between the different values about which we care. The empirical analysis of people's attitudes towards changes in their environment, in particular new technological infrastructure, has shown that four factors are crucial for a positive position towards proposed changes[20]:

- *Why do we need change?* This cognitive aspect includes the insight that the proposed change is going to provide the service that is associated with this change and that the concomitant risks can be managed by the societal institutions mandated to deal with these risks.
- *What is in it for me?* People need to be convinced that the proposed changes will have a benefit either for themselves or for others for whom they care. If the common good is invoked it needs to be articulated in the form of concrete advantages to those who will need the services. Abstract promises such as "it will improve the competitiveness of a country" are insufficient to serve this objective.

[16] Leonardi, P. M. and Barley, S. R. (2010): What's under construction here? Social action, materiality, and power in constructivist studies of technology and organizing. *The Academy of Management Annals*, *4* (1), 1-51

[17] Duit, A., Galaz, V., Eckerberg, K. and Ebbesson, J. (2010): Governance, complexity, and resilience. *Global Environmental Change*, *20* (3), pp. 363-368.

[18] De Haan, R. L. (2011): Teaching creative science thinking. *Science*, *334* (6062), pp. 1499-1500.

[19] Tàbara, J. D. and Chabay, I. (2012): Coupling human information and knowledge systems with social–ecological systems change: Reframing research, education, and policy for sustainability. *Environmental Science & Policy*, 28 (April), pp. 71-81.

[20] The list is originally from: Renn, O. (2013): Citizen participation in public projects – State of research and conclusions for practice (in German). *UVP-Report*, 27 (1/2), pp. 38-44, here 40. A similar list of influential factors can be found in; Fiske, S. F. 2010: *Social beings. Core motives in social psychology.* 2. edition. New York: John Wiley, pp. 89 ff. Susan Fiske explores three aspects: Understanding , Controlling and Self-Enhancing . Personal utility is not on her list. This aspect is highlighted in: van Zomeren, M.; Postmes, T. and Spears, R. (2008): Toward an integrative social identity model of collective action: A quantitative research synthesis of three socio-psychological perspectives. In: Psychological Bulletin 134 (4), pp. 504-535.

- *Does this limit my options?* People tend to reject innovations or changes if they believe that their personal range of options or their personal freedom is negatively affected. Loss of sovereignty or the perception of being dominated by others are powerful threats to self-efficacy and autonomy. Innovations such as smart grids or self-learning computers may be good examples where this feeling of being governed by others may easily evolve.
- *Do I feel personally engaged?* Changes always mean interventions into one's way of life. If these changes are seen as something alien in people's neighbourhoods they are likely to be rejected. A good example is the ownership of municipal wind parks. If they are owned by a distant company people often feel that they do not fit into the landscape in which they live. However, if the people in the community own the wind parks themselves, they may feel that these generators seem to match the community's heritage.

Meeting these four conditions for a positive attitude towards planned changes and innovations are moderated by trust[21]. None of the four conditions can be met if there is insufficient trust in the decision-making process and in the institutions or organisations that are involved in this process. If people do not trust the authorities even the best education or communication program will fail because the truth claims therein will appear as not credible. Since these claims are, as stated above, uncertain and ambiguous, it is easy to dismiss them as being interest-driven positions disguised as facts. In essence, building trust and confidence in knowledge-producing institutions is therefore crucial for creating the appropriate conditions for a positive general attitude towards knowledge implementation and planned changes[22].

Key factor: Trust

How can trust and confidence in our knowledge-producing, and implementing, institutions be enhanced? As we have said before, polls all over Europe show that most public authorities have experienced an erosion of trust in the last decades. The record is even worse for institutions belonging to the private sector[23]. More trust is assigned to civil society actors. Even non-governmental organisations (NGOs), as they get closer to real power, for example institutional decision making, seem to suffer in terms of trustworthiness[24]. Many observers of the situation are convinced that the loss of trust can be compensated by better communication. The empirical evidence for this claim is not very convincing[25]. Good communication is certainly a necessary condition for improving trustworthiness, but it is not sufficient. First of all, trust is linked to transparency of decision-making and an effective interplay of checks and balances. Secondly, involving the affected stakeholders and citizens into the decision-making process can generate and enhance trust[26]. The change of perspective from being a "victim" to being a "co-generator" of political decision-making has a major impact on the perception of the governance process and contributes to the growth of trustworthiness assigned to the other actors in this process. The few pan-European participation processes that have taken place over the last decade clearly demonstrate that

[21] Earle, T.C. und Cvetkovich, G.T. (1999): Social trust and culture in risk management. In. G.T. Cvetkovich and R. Löfstedt (eds): *Social trust and the management of risk.* Earthscan: London, pp. 9-21.
[22] Siegrist, M. and Cvetkovich, G. (2000): Perception of hazards: The role of social trust and knowledge. *Risk Analysis,* 20, pp. 713-719.
[23] http://ec.europa.eu/public_opinion/archives/ebs/ebs_340_en.pdf, p.19
[24] Fehrler, S. and Kosfeld, M. (2013): *Can you trust the good guys?: Trust within and between groups with different missions.* Discussion Paper No 7411 (May). Institute for the Study of Labor (IZA): Bonn. Compare for climate change policies: Terwel, B. W., Harinck, F., Ellemers, N. and Daamen, D. D. (2009): How organizational motives and communications affect public trust in organizations: The case of carbon dioxide capture and storage. *Journal of Environmental Psychology*, *29*(2), pp. 290-299.
[25] Roberts, M. R., Reid, G., Schroeder, M. and Norris, S. P. (2013). Causal or spurious? The relationship of knowledge and attitudes to trust in science and technology. *Public Understanding of Science*, *22* (5), pp. 624-641.
[26] Arvai, J.(2003): Using risk communication to disclose the outcome of a participatory decision-making process: Effects on the perceived acceptability of risk-policy decisions. *Risk Analysis* ,23 (2), pp. 281-289; Compare also: Dovey, K. (2009): The role of trust in innovation. The *Learning Organization, 16* (4), pp. 311-325.

participants gained more confidence in knowledge-producing institutions[27]. Effective and fair participation has therefore been proven to promote trust and confidence among the actors involved. But here is a note of caution: participation is only one, albeit significant prerequisite for making people more willing to consider proposed changes from the benefit as well as from the risk side. Once people feel they have the right and the possibility to co-generate change and to own part of the change process they are much more inclined to assign trade-offs between risks and benefits and to value changes that promise the advancement of European ideals and goals[28]. But there is no guarantee for more acceptance[29].

More appropriate education programs, effective investments into initiatives for improving public understanding of the interplay between science, technology, institutional settings and patterns of behaviour, effective and targeted communication programs that are tailored towards different target groups in Europe, and last but not least a major drive for public participation are the main ingredients that can help Europe to live up to its claim of a knowledge-based continent with a broad future.

Conclusions: A new science and society contract

Europe's well-being and future depend largely on the generation and implementation of knowledge with respect to technical innovation, economic competitiveness, social cohesion and environmental resilience. Globalisation creates the conditions for success in which Europe has to find its place by means of a vibrant, scientifically-grounded knowledge-based economy. Europe's reliance on knowledge is not limited to the subsystem of science but includes other types of expertise, i.e. practical, experiential, tacit and indigenous knowledge[30]. One of the main challenges in generating and applying knowledge is the task of providing adequate incentives for innovative ideas to prosper, creating the conditions for an intelligent selection and diffusion of knowledge and improving the general level of education and skills so that all actors are capable of handling knowledge professionally and responsibly. The main goal is to enhance the capacity of knowledge production and application, including the development of adequate human resources, in order to bring the advancement of knowledge in line with economic, social, political, and environmental goals that all European countries share.

For Europe to become a sustainable, prosperous, democratic and secure society, it is important that legitimate societal concerns concerning science and technology development are taken on board, entailing an enhanced democratic debate with a more engaged and informed public and better conditions for collective choices on scientific issues. **A new science and society contract should be proposed**. Social learning and co-production of knowledge where appropriate together with the involvement of civil society in science and technology are all examples of relevant factors to address. This may be the European solution to a responsible and socially inclusive role of innovation as specified in the EU *Communication on A Reinforced European Research Area Partnership for Excellence and Growth.*

The Advisory Council feels that under the present conditions of financial constraints, increased pressures from a globalised economy, and pressing societal and environmental issues that need improved knowledge

[27] Compare: Hüller, T. (2010): Playground or democratisation? New participatory procedures at the European Commission. *Swiss Political Science Review*, *16* (1), pp. 77-107. And: http://www.macaulay.ac.uk/socioeconomics/research/path/PATH%20Policy%20Brief.pdf

[28] Compare the empirical results in; US-National Research Council (2008): *Public participation in environmental assessment and decision making*. National Academies Press, pp. 77ff.. Compare specifically for participation in impact assessments: O'Faircheallaigh, C. (2010): Public participation and environmental impact assessment: Purposes, implications, and lessons for public policy making. *Environmental Impact Assessment Review*, *30* (1), pp. 19-27.

[29] Mercier, H. and Landemore, H. (2012): Reasoning is for arguing: Understanding the successes and failures of deliberation. *Political Psychology*, *33* (2), 243-258. Compare also: Bora, A. and Hausendorf, H. (2006): Participatory science governance revisited: Normative expectations versus empirical evidence. Science and Public Policy, 33 (7), pp. 478-488.

[30] Simmie, J. (2003): Innovation and urban regions as national and international nodes for the transfer and sharing of knowledge. *Regional studies*, *37* (6-7), pp. 607-620.

for their resolution, the EU should launch an initiative called "Public Contract for a Smart, Sustainable and Inclusive Knowledge Society". The main goal is to launch a European and national communication, education and deliberation program that pursues the following objectives:

- to listen to the aspirations of the citizens for new knowledge
- to demonstrate the usefulness of and need for new knowledge generation and application in Europe
- to highlight the economic, societal and cultural value of scientific knowledge and its application in various sectors of society
- to be sensitive, inclusive and responsive to public concerns and worries
- to place more emphasis on improved communication and dialogue programs that help to integrate public aspirations and concerns into a future oriented and sustainable pathway towards a responsive knowledge society

Science and technology are not only means for productivity and competitiveness but are integral components of European history, its cultural heritage and its visions. It is therefore essential to link all communication activities to a broader understanding of knowledge as part of the collective identity of Europe since the Age of Enlightenment. This broader understanding of knowledge may be the European solution to a responsible and socially inclusive science and technology policy design having in mind that solutions in different regions of the world may differ from this model.

Recommendations:

1. The Commission should introduce, and properly finance, a **thematic action on Science and Society in the Horizon 2020 programme**[31]. The Commission should also open a dedicated thematic programme on science communication in the Marie Curie programme (or other educational and vocational programmes in Horizon 2020) with the clear purpose to broaden the public engagement with science and technology and to involve experts in the dissemination and dialogue process;

2. The Commission should invest in more and more inclusive **pan-European citizen participation** and involvement programs aimed at advising the Commission (and or the European parliament) on science- and technology issues. A major topic should be the inclusion of evidence-based and precautionary decision making as important elements of dealing with opportunities and risks of new developments. Furthermore, the Commission should encourage meetings, conferences and symposia directed to bringing experts, civil society and policy-makers together. The Commission should establish a taskforce that collects all available education in science, technology and humanities material (publications, multi-media presentations, videos) that have proven to be successful and disseminate them into all EU member States in the native language; The Commission or the European Parliament should initiate a European wide competition for the best event "Science and Technology meet Society" with attractive prizes to win; The Commission should establish a teacher award for promoting excellent education in science, technology and humanities (PUSH). School teachers, at all levels, should be encouraged to submit short proposals (1 page max) for micro-grants (up to 5,000 Euros) to improve the way in which knowledge is acquired in their classes;

[31] In addition, Horizon 2020 rules should require Horizon 2020 projects to have a Work Package (WP) on communication of the scientific sector covered by the project (with ad hoc deliverables, such as citizens conference, communication tools and dissemination strategies –e.g. audio-visual- for lay people and information leaflets for lay people) and, if applicable, a WP on the societal, socio-cultural and ethical aspects of the topic being addressed. These work packages should be coordinated by professionals from the social sciences or communication research;

3. The Commission should establish a **European Radar System** for the early detection of risks and opportunities of new knowledge applications including a warning system for emerging social controversies and concerns of stakeholders and the general public (concern assessment). This should serve as an instrument for preparing policy makers and society to deal with potential side effects of new developments in science and technology and to become aware of risk perceptions early in the process; The Commission should also facilitate the establishment of a **pan-European platform and forum on public concerns about science and technology**. This platform should operate like a broker. It should help people to find reliable and robust information and to arrive at a balanced and well-reflected judgment of their own (pro and con information that meets predefined quality criteria). The European Radar could be instrumental for providing such balanced information. One option to implement this platform is to use EU structural funds to establish a public-private partnership or publicly financed information communication system (EU science TV channel and EU science communication web portal);

4. The Commission should encourage all knowledge-producing actors to **devote a part (for example, 3%) of the total national research budget to Science and Society issues** when they pursue projects in research and innovation. This dedicated amount should be earmarked in particular for dialogue and communication programs with stakeholders and the affected public; The Commission should encourage national and regional parliaments across Europe to conduct several open houses every year with sessions (e.g. Science-Cafés) where stories about successful and unsuccessful innovation processes are offered to the public in various presentation formats;

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Acknowledgements:

We wish to acknowledge the support and input from the staff of the office of the Chief Scientific Adviser and BEPA.