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Interim evaluation & assessment of future options for Science in Society Actions

Executive Summary

Final Report

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Table of Contents

1. Executive Summary	1
1.1 Introduction	1
1.2 Study terms of reference and methodological approach	1
1.3 Policy context	3
1.4 Main conclusions of the interim evaluation	5
1.5 Main conclusions of the assessment of future options	9
1.6 Recommendations for the future	18

1. Executive Summary

1.1 Introduction

This report sets out the principal findings, conclusions and recommendations of the ‘Interim evaluation and assessment of future options for Science in Society actions’, which was carried out in the period November 2011 - July 2012 by Technopolis Group in collaboration with Fraunhofer ISI and Science-Metrix.

The FP7 Science in Society (SiS) programme formed part of the Capacities Specific Programme of FP7, and had a budget of some €330 million across the period 2007-13. The overall objective of the FP7 SiS programme was as follows:

“With a view to building an effective and democratic European knowledge-based society, the aim is to stimulate the harmonious integration of scientific and technological endeavour and associated research policies into European society”

At the time of the study the FP7 SiS programme had supported 177 discrete actions arrived at through a combination of open calls for proposals and direct procurement, and had committed approximately 50% of its budget. The thematic priorities of the programme have dealt with three main groups of issues and challenges: (i) how to ensure a more responsible and open governance of science (ethics, governance, scientific advice, public engagement); (ii) how to better include women and young people in the research system; and (iii) how to better communicate between the world of research and other components of our societies.

The study was carried out during a period of new policy developments relating to the forthcoming (2014-2020) programming period. The first proposals for Horizon 2020 - the successor to FP7 - were published, and the European Commission further developed ‘Responsible Research and Innovation (RRI)’ as a new way to conceptualise the challenges previously tackled under the Science in Society theme.

1.2 Study terms of reference and methodological approach

1.2.1 Interim evaluation

Technopolis carried out the interim evaluation with support from Fraunhofer ISI and Science-Metrix. The evaluation was configured in order to address a wide range of questions relating to the design, implementation and early results and impacts of the SiS programme over the period 2007-2011, as well as its evolution from its predecessor programme (Science and Society) under FP6. The study also investigated the nature and extent of integration of SiS issues within the Cooperation programme of FP7 and the relationship between the FP7 SiS programme and SiS research activities at the national level. The questions to be answered by the study were accordingly focused within the following five main areas:

- Evolution of the programme – Covering aspects such as the relevance, clarity and feasibility of the objectives; the extent to which the programme has covered the full spectrum of SiS issues; the extent to which the FP7 SiS programme succeeded in supporting larger, more strategic projects with more pronounced policy links (as compared to FP6 SaS); and, the extent to which the supported projects demonstrate a diversification of contexts and partnerships
- Project level results and impacts – Covering aspects such as the relevance and significance of project outcomes; achievement of objectives; impacts on stakeholders outside the partnerships; and examples of best practice or path-breaking studies
- Impacts of the programme – Covering aspects such as the impacts of the programme on scientific advice, decision making, policy development, and attitudes; impacts of the programme in shaping the European Research Area; and impacts of the programme on the SiS communities and landscape in the Member states and Associated countries
- Integration of SiS aspects within the Cooperation programme – covering aspects such as the nature, extent and quality of integration; the issues most frequently tackled; and the use of the new instrument ‘Research for the Benefit of Specific Groups – CSO’

- Connection between EU and national activities – Covering aspects such as the pattern of SiS activities at Member State level, including gaps / overlaps / synergies; and the impact of SiS Work Programmes on SiS policy at national level

The evidence base used to address the study questions was collected through a combination of methods, as follows:

- Desk research to review existing documentation and monitoring data relating to the FP6 SaS and FP7 SiS programmes. The documentation and data used for the study included (i) the programme Decisions and annual Work Programmes, as well as a number of planning and policy documents; (ii) the CORDA database, which provides extensive information on applicants to and participants in the two programmes, as well as all of the supported projects; and (iii) Science and Society questionnaire monitoring data and associated annual monitoring reports
- Interviews (n=53) with a range of stakeholders including Commission officials responsible for the SiS programme, Cooperation thematic programmes, and ERA policy; SiS expert/advisory group members at both EU and national levels; national officials responsible for SiS policy and support; and other selected stakeholders
- Questionnaire surveys directed to (i) FP7 SiS and FP6 SaS programme participants, to gather project and programme level feedback [355 responses obtained]; and (ii) Coordinators of FP7 Cooperation projects [525 responses obtained] to gather feedback on the embedding of SiS issues across the Cooperation programme
- Network and bibliometric analyses, to assess collaboration patterns and scientific output for the two programmes. The analyses were based on the networks and publications of supported FP6 SaS and FP7 SiS participants, using the EC CORDA and Elsevier Scopus databases
- A series of 50 case studies to investigate the planned and actual impacts of a significant proportion of the supported FP7 SiS and FP6 SaS actions

1.2.2 Assessment of future options

In parallel with the interim evaluation of the FP7 Science in Society programme, an assessment of future options for SiS actions beyond FP7 was carried out. This part of the study was led by Fraunhofer ISI with support from Technopolis, and aimed to establish:

- The ongoing need to address SiS topics beyond FP7
- The main issues and gaps in the relationship between science and society, their relevance and potential for action
- The core issues and activities that a future programme should focus on, including the adequate level of resources and appropriate tools
- The advantages and disadvantages associated with alternative courses of action, in terms of the (scientific, economic and social) impacts they may generate and risks and uncertainties involved

In order to assess future policy options for SiS/RRI under Horizon 2020, the study team employed a mixed methods approach. In the first instance a programme of desk research was carried out to review the scientific and policy literature on current needs, opportunities and challenges in relation to SiS/RRI. This literature review was then used as the basis for the development and launch of a major public consultation exercise that sought to canvass opinion from across the member states and from various stakeholder groups concerning future options for SiS actions.

The consultation exercise consisted of a Delphi-style survey that included various statements concerning future situations or outcomes in relation to the various SiS/RRI themes, and asked respondents to indicate their desirability, expected positive impacts, means of achievement, risks and timeframe for occurrence. In addition, the public consultation canvassed opinion on the most appropriate option in terms of mechanisms for advancing SiS/RRI objectives in the future. The public consultation remained open for a period of three months from March – June 2012 and a total of 1,065 individuals participated in the survey. The respondents were drawn from 25 different countries and while the majority were from the scientific community (universities and research institutes), significant numbers of responses were also obtained from businesses, public bodies, civil society organisations and private individuals. Just more than half of the respondents were women,

and just more than half indicated that they had expert knowledge, with the reminder indicating that they had common knowledge of the issues under discussion.

The results of the public consultation were then discussed and further developed through two workshops involving experts in the various SiS/RRI themes. The first workshop was held in April 2012 and utilised the inputs of 29 invited experts in order to validate and build on the survey results. The second workshop was held in June 2012 and involved 26 invited experts who provided more in-depth input on the preferred policy options in each of the six RRI themes.

The full results of the consultation exercise and workshops were analysed and further desk research carried out in order to arrive at a final overall assessment of future policy options for RRI actions.

1.3 Policy context

The current and future policy context was important for the assessment of future options, particularly in light of (i) the planned changes to the FP introduced by the proposals for Horizon 2020, and (ii) the corresponding development of the concept of Responsible Research and Innovation (RRI) as a new and preferred way to conceptualise the challenges previously addressed by the SiS programme.

Horizon 2020 is the financial instrument that will implement the Innovation Union initiative. It will run from 2014 to 2020, with an €80 billion budget, and is the successor to FP7. It will combine all research and innovation funding currently provided through the Framework Programmes, the innovation related activities of the Competitiveness and Innovation Framework Programme (CIP) and the European Institute of Innovation and Technology (EIT). It has three key objectives:

- Excellent science – Supporting the EU's excellent science base and strengthening its position in science (€24.6 billion budget)
- Competitive industries – Building and strengthening industrial leadership in innovation in Europe (€17.9 billion budget)
- Better society – Helping to address and tackle major EU-level societal challenges and concerns (€31.7 billion budget)

The 'better society' objective reflects the policy priorities of the Europe 2020 strategy and addresses major crosscutting societal challenges and concerns that are shared by citizens in Europe and elsewhere. These include longer and healthier lives; reliable, clean, efficient energy; efficient use of resources for the protection of the planet; inclusive innovation and secure society; a safe, secure food supply; and smart, green transport. This challenge-based approach will bring together resources and knowledge across different fields, technologies and disciplines.

Responsible research and innovation (RRI) is a fairly new concept being debated in the European and Anglo-American STI policy communities. Although no broadly accepted understanding of the term has emerged, a working definition for RRI has recently been presented by von Schomberg¹

"Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)".

RRI is part of a general approach to the governance of science and technology that seeks to better align innovation impacts with societal demands and values. It focuses on four main aspects:

- A purposeful focus of research and innovation to achieve societal benefits
- The comprehensive and meaningful involvement of all relevant societal stakeholders (including the public) throughout the innovation process with the aim of enhancing the public good
- Comprehensive (ex-ante) impact assessments

¹ Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields, von Schomberg, R [Ed] (2011)

- The development of flexible governance arrangements in order to better respond and adapt to changing circumstances and new knowledge

Historically, RRI related primarily to preventing harm, particularly in terms of physical risks (health and safety, and consumer protection). However, as safety and sustainability have become key aspects of (corporate) social responsibility, a broader set of important RRI practices have emerged. Ethics reviews for research proposals have also become widespread (notably within the FPs) and local, national and European ethics committees and councils have been established.

STI policy has been increasingly rethought in terms of governance (rather than government), with horizontal relationships emphasised, and relevance and responsibility becoming important elements of science and innovation strategies. The (perceived) impact of emerging technologies over the past decade (e.g. in biomedicine) have led to new institutional arrangements for RRI in specific areas, and a greater focus on responsible development, innovation and governance being built into research policy (e.g. in the area of nanotechnology). Democratic aspirations – influenced by a decreasing trust in authority / expertise and various specific controversies – have also pushed the dialogue and engagement aspect of RRI.

The starting point of the recent debate within Europe is that research and innovation in the ERA must respond to the needs and expectations of European society while respecting its values and being responsible. Societal actors (researchers, citizens, policy makers, business, third sector organisations, etc.) have difficult choices to make as regards how science and technology can help tackle the different societal challenges that are faced, and they must all work together during the whole R&I process to align outcomes with the values, needs and expectations of European society.

There is often a considerable time lag between groundbreaking research being conducted and the point at which EU citizens and business regularly use innovative products or systems that are based on this research. This creates a risk that future public concerns, which were not foreseen by policy makers or researchers at the time, could hamper development or take up of the results of innovative research and innovation.

In an effort to overcome this issue, as well as to deepen the relationship between science and society and reinforce public confidence in science, Horizon 2020 will favour an informed engagement of citizens and civil society on research and innovation matters by promoting science education, by making scientific knowledge more accessible, by developing responsible research and innovation agendas that meet the concerns and expectations of citizens and civil society, and by facilitating their participation in Horizon 2020 activities.²

Since 2010, the Commission has been developing a framework for responsible research and innovation, which will be pursued and supported through Horizon 2020. The framework consists of six key elements:

- People and civil society engagement in the research and innovation process
- Gender equality and gender in R&I content
- Science education, both in terms of the future generation of researchers, and a broader effort to enable the general public to understand and engage on science issues
- Open access to science information and research results funded by public money
- Ethics compliance, with trust, integrity and participation guiding new developments
- A governance framework encouraging responsible research and innovation

Preliminary plans indicated that the SiS programme structure of FP6 and FP7 would disappear under Horizon 2020, but that much of its focus would continue within a cross-cutting RRI approach. The RRI concept that is emerging is a governance approach and set of cross-cutting requirements that relate to a number of themes, such as ethics, societal awareness, excellent research and industrial engagement. RRI can therefore be understood as an evolution of the Science in Society (SiS) strand of FP7, with the themes pursued by the SiS programmes evolving into the underpinnings of Horizon 2020.

² MEMO/11/848 Brussels

Building on the success of SiS projects in engaging the general public and civil society in debates around science, technology and innovation, RRI aims to go one step further and engage all societal actors (researchers, policy makers, citizens, businesses, etc) to work together throughout the research and innovation process, in order to ensure the results meet the needs of society as a whole.

1.4 Main conclusions of the interim evaluation

1.4.1 Overarching conclusions

The study found very strong support from EU and national policymakers as well as relevant research communities for the existence and continuation of a dedicated SiS / RRI programme.

The FP7 SiS programme has represented the only significant mechanism for supporting EU-wide coordination and collaboration in SiS research. As such it plays an important role in helping to both raise and reflect the political importance of integrating society more effectively within European research and ensuring a full and proper role for all types of stakeholder. It also provides a platform through which major pan-European initiatives and networks can be established and supported, leading to greater coordination of research efforts, more extensive and diverse collaborative activities, and a greater critical mass of effort to address key challenges relating to Science in Society.

The programme, in conjunction with its predecessor programme under FP6, has covered all of the important identified issues within the Science in Society domain, and has attracted high levels of interest and demand for participation among relevant communities. The actions supported to date have already made, and will continue to make, important contributions to both the understanding of problems and the development and widespread dissemination of effective solutions. The evidence collected through this study and set out in this report demonstrates clearly that such efforts should continue, both in terms of integration of good practices within mainstream European research and dedicated initiatives to develop and ensure widespread take-up of effective solutions.

1.4.2 Design of the FP7 SiS programme

The FP7 SiS programme has been designed to address a very broad range of objectives and seeks to generate a wide array of outcomes, building on the work conducted within the FP6 SaS programme. The programme aims to improve understanding of the role of science and technology in society and promote the development of an ethically sound and responsible European science system. It has sought to identify and address barriers to gender equality in research, and has sought to develop ways to enhance the numbers of young people from all backgrounds entering careers in science, research and technology development. It has also sought to develop mechanisms to increase the role of the wider public in science through stronger mechanisms and platforms for engagement and through improved communication channels.

The stated objectives of the programme are coherent and are well understood by applicants and participants, but are not described in specific or measurable terms and no quantifiable targets have been set for the programme. Nonetheless, various data sources enable progress against high-level objectives to be tracked and assessed. The programme objectives are realistic in the sense that the programme is able to effect progress in relation to all of its focus areas. However, the extent of progress made is difficult to evaluate due to the absence of defined 'success' indicators for measuring progress attributable to the programme.

The programme is clearly structured, with distinct action lines, activities, areas and topics specified through the annual Work Programmes. The work programmes are consistent over time and are reasonably clear and concise in their presentation of the priorities and intended impacts. As with all areas of FP7, there are well-established tools for the systematic collection and recording of data on participation patterns, and this has been used to help to reorient the programme in its transition from FP6. Systems for the monitoring of outputs, take-up of results and associated outcomes are less well developed.

While there are no significant problems with the overall design of the programme, it would be beneficial if the content of the programme were more closely linked to the expressed needs of user communities. Dedicated committees comprised of target groups (national education and research ministries, funding bodies, etc.) to advise on the programme priorities and work programmes and to act as target groups for programme results would strengthen the programme's focus and impacts.

Any future SiS programme should also be designed with clearer regard to the expected impacts that are being sought, with more detailed analysis of the intended target groups (for implementation of results) and more closely prescribed 'success indicators' that can be used to monitor progress towards the achievement of programme objectives.

1.4.3 Programme activities and their evolution from FP6

The annual work programmes (2007-2011) defined 71 research themes under which calls for proposals were issued, and projects have been supported within 56 of these. As such, the spectrum of objectives and thematic areas prioritised in FP7 has been largely covered but some gaps remain to be addressed in recent or future calls.

The programme has implemented its activities through a mix of Coordination & Support Actions (CSAs) and collaborative (research) projects. These instruments have been largely suitable for the activities funded, although in several cases CSAs have been used where collaborative projects would have been more suitable in order to allow more research content in the projects.

The programme recently launched a new series of CSA projects entitled 'Mobilisation and Mutual Learning (MML) Action Plans', with the aim to foster large-scale long-term partnerships that mobilise various actors and stakeholders at different levels and enable them to find effective solutions to major societal challenges through mutual learning and cooperation. Early indications are that this new project format has been highly successful in forming more significant and more balanced partnerships, in line with SiS objectives.

Experiences of involving Civil Society Organisations (CSOs) indicates that they can play an important role in helping to achieve a stronger integration of societal aspects into EC funded research, but the funding rules (which only allow CSOs to claim a 50% contribution to their costs) are likely to inhibit their full and proper involvement. The financial arrangements relating to their involvement in future programmes should be carefully reviewed with a view to increasing the share of eligible costs that can be funded from the programme budgets.

The FP7 SiS programme has succeeded in its ambitions to develop larger, more strategic projects with more pronounced policy links than was the case under FP6. The number of public bodies participating in the FP7 SiS programme is significantly higher than in FP6 SaS, they are involved in a larger proportion of the projects, and they account for a larger share of the participations and EC funding. The programme has had more limited success in bringing other types of stakeholder into the programme. While the participation rate of non-researchers within FP7 SiS is significantly higher than across other areas of FP7, the share of projects involving non-academic partners and the share of EC funding allocated to this group have both fallen since FP6 SaS.

The FP7 SiS programme has made significant progress in increasing participation by many new Member States and Associated countries in comparison with the situation in FP6. In all cases New Member States have a higher participation rate in the SiS programme than across FP7 as a whole, and this situation also holds for the majority of Associated Countries.

1.4.4 Achievements and impacts of the programme

Arguably the greatest impact of the FP6 SaS and FP7 SiS programmes has been to raise the political importance of science in society at the European level, and thereby raise awareness of the problems and the need for all actors to work together to resolve them. The importance that the Commission has placed on ensuring a proper role for all actors within European research and on addressing known problems and weaknesses has significant positive impacts on both the scientific communities and within public institutions across Europe.

It is too early to assess the impacts of the programme in achieving significant and widespread changes within European and national science and educational systems and in the effective integration of societal aspects within European research. However, the programme has already made major strides in enhancing understanding of the nature of the problems and the barriers to change in many areas, and has piloted new methods and techniques to address those challenges.

- Within the area 'gender and research' the programmes have made a major contribution to the definition of relevant indicators and collection of data on the role of women in science, and hence to a coordinated EU-wide monitoring system. This has led to significant advances in the understanding of gender imbalance in science, its impacts and the corrective measures needed.

The programmes have also contributed to the establishment and structuring of a community of interest across the EU, and have raised the visibility of gender issues in science at institutional level. The programmes have also made a major contribution to the development and dissemination of new policy tools that can be used to improve gender diversity, both within the research communities and within the research carried out by those communities

- Within the area of ‘science education’, the programmes have made a major contribution to the development of inquiry based learning (IBL) techniques and their dissemination throughout Europe, in order to begin to address shortages of Science, Technology, Engineering and Mathematics (STEM) graduates at all levels. Insights, tools and approaches have reached many policymakers and educational establishments through multiplier models of dissemination, and significant communities of interest have been established and supported. The programme has also contributed to the enhancement of young people’s interest in science, through prizes, events and other mechanisms
- Within the areas of ‘science communication’ and ‘public engagement’, the programmes have contributed to the development of new tools and working methods that significantly enhance the engagement of the public, policymakers and businesses in scientific debate and improve the provision of scientific information to relevant audiences. The programmes have made advances in establishing new ways to engage, in particular, civil society organisations and public bodies at local and regional levels. The development of Mobilisation and Mutual Learning (MML) Action Plans have also resulted in closer interaction between scientists, policymakers and CSOs in key policy areas, and provide an effective model for enhanced integration of stakeholders in European research
- Within the area of ‘Open Access’, the FP7 programme has launched a major pilot initiative to provide free access to the outputs of supported research, and has allowed all projects to recoup the costs of open access publishing during the time of the grant agreement. In addition, the SiS programme has supported dedicated actions that have helped to raise awareness of open access issues and have developed and implemented training courses on scientific writing and open access publishing
- Within the area of ‘scientific advice in policymaking’ the SiS programme has piloted new mechanisms for linking policymakers to sources of scientific advice, with considerable success, and has generated new tools to strengthen engagement of policymakers in scientific research. The programme has had a material impact in promoting and supporting modernisation agendas within universities and has developed and promoted improved technology assessment practice
- Within the area of ‘research ethics’ the programme has been effective in building improved networks of Research Ethics Committees and establishing central portals for the distribution of relevant materials and guidance. The programme has also contributed to the development and implementation of ethics frameworks and review procedures, not just across the EU but also within third countries. In addition, the programme has supported the development of new insights and practices in the areas of privacy and social impact assessment

A very significant proportion of the projects supported by the SiS programme have involved innovative approaches to the engagement of different types of actors both within the project teams and through new methods of dissemination. Not only has the programme been more successful than other areas of FP7 in involving non-researchers within consortia, but it has provided non-researchers with a fuller role across all stages of research, from formulation of project ideas, through research design and implementation, to dissemination and exploitation of results.

Participants in the programme report extremely high levels of attainment of project objectives. Participants also report very significant contributions to programme-level objectives, particularly in the areas of broadening engagement, improved understanding of SiS issues, and strengthening of the European science system. The projects have also had significant impacts on the organisations involved, enhancing their relationships and networks, strengthening their knowledge and capabilities, enhancing their capacity and improving their reputation and image.

The supported projects demonstrate clear European ‘added value’ in the sense that they tend to be much larger, more inclusive and more coordinated efforts than take place at national level. The majority of projects would not have proceeded at all in the absence of FP support.

The SiS projects employ a very broad range of mechanisms to disseminate their results to relevant audiences. Events (workshops, conferences, information days, etc.) are the most widely used dissemination route, followed by online information and published articles written for a general audience. Over half of the projects are also using the media (press, TV, radio) to promote their work.

While most participants have taken steps to disseminate their results widely, our investigations suggest a generally low level of awareness of the content of the SiS programme and its results. Policymakers and other stakeholder groups, including relevant national officials, find it difficult to engage with the large volume of work that has been carried out across a wide number of themes, and general awareness of the key achievements of the programme remains low even among key audiences. As such, there is an evident 'gap' in terms of efforts to appraise, aggregate and package the programme's content and results into a digestible form, and to disseminate this information widely to relevant audiences.

1.4.5 Interaction between EU and national-level activities

At the national level, SiS research communities, programmes and activities are often small and fragmented, and where funding is available it tends to be limited, ad-hoc and embedded within other programmes. As a result, systematic and concentrated national research efforts are scarce, and while the FP7 SiS programme has a relatively limited budget given its scope, it is still seen as one of the main vehicles for accelerating research efforts at the national level.

The availability of funding is the most attractive aspect of the programme from a national perspective because of the lack of alternatives, but (as a result) it suffers from high levels of competition and low success rates, and has difficulties in involving less well-established groups. National representatives in most cases would welcome a larger and more ambitious SiS programme.

The programme objectives are seen as appropriate, but progress is likely to be slow given the long-term nature of the objectives and the limited resources available for each individual area of the programme. The programme has nonetheless helped to achieve a range of positive benefits and impacts: a greater awareness and interest in the SiS programme itself and what it is trying to achieve; a structuring effect on the size, shape and focus of SiS communities and activities nationally; a networking effect between different countries, dispersed communities and stakeholders; a shift in attitudes as to the importance of SiS issues, pushing it up the political agenda and creating debate; plus some more limited and isolated impacts on policy.

Despite these early successes there is limited knowledge and understanding at the national level of the full spectrum of activities being funded through the programme and their results, and as such the impacts flowing from the individual projects are generally quite low at this stage. There are calls for information about the programme and its results to be packaged / communicated to interested parties more effectively.

Moving forward, the SiS agenda is regarded as highly important, both as a research topic and as a part of wider research activities, and national representatives are keen that the momentum and progress achieved so far is not lost. For many there is currently little or no alternative to the European programme and no likelihood of funding becoming available to fill any gap left by a reduced European focus. The SiS programme, how it is structured, and what it covers is therefore of the utmost importance for SiS communities across the EU.

1.4.6 Integration of Science in Society aspects across FP7 as a whole

There is an obligation placed on all Cooperation programme areas to include SiS aspects within their activities. The Cooperation programme documentation highlights the need for consideration of a range of SiS aspects and sets varying levels of obligations on projects. There is also clear evidence of a strong commitment to increasing awareness of the importance of SiS aspects within research across the Cooperation programme and to encouraging more projects to consider and incorporate these elements.

Feedback from Cooperation programme officials suggests that there has been a growing commitment across the thematic areas to embed SiS issues more widely, and most feel that considerable progress had been made since FP6 in increasing both the horizontal and vertical integration of SiS elements in all areas. There is appropriate variation between and within the

individual programme areas in the extent and ways in which the consideration of different SiS aspects are encouraged, based on the perceived relevance and appropriateness of these issues.

The obligations placed on individual Cooperation projects have changed behaviour in a significant proportion of cases. The majority of project coordinators have been able to effectively integrate relevant SiS aspects within their projects, and where this has happened, the activities and actors have benefited from this process. The majority of coordinators report that there are not any drawbacks to considering and integrating SiS issues, beyond the additional resource required. Any negative aspects tended to revolve around the difficulties encountered in finding and integrating specific types of actors in the project teams.

The end of project reporting questionnaire is the only clear way in which the embedding of SiS activities is formally captured, but this data does not appear to be used for monitoring purposes. Centralised analysis and reporting of this data is something that should be addressed in future Framework Programmes.

An additional mechanism for integrating societal actors (Civil Society Organisations) within the Cooperation programme has been the 'Research for the Benefit of Specific Groups – CSO' instrument. At the time of the study this instrument had only been used in two Cooperation programme areas, and only eleven projects had been funded through this route. One issue suppressing use of the new instrument has been the financial rules, wherein CSO participants can only be supported up to 50% of their eligible costs. This is widely considered to be insufficient and inappropriate for non-profit making bodies that typically have limited financial resources. Revision of this rule should assist the further integration of CSOs into future Framework programmes.

1.5 Main conclusions of the assessment of future options

1.5.1 Overarching conclusions

The underpinning objectives of the Science and Society (SaS, FP6) and Science in Society (SiS, FP7) programmes continue to be of great importance from a policy perspective, and while significant progress has been made within each of the major thematic areas of the two predecessor programmes, it is not yet possible to conclude that the ambitions and issues addressed by the FP6 SaS and FP7 SiS programmes have been fully addressed.

The Europe 2020 strategy reaffirms that the search for prosperity, jobs and a better life for everyone will be realised through the development of a smart, sustainable and inclusive economy, and that progress towards this will critically depend on research and innovation delivering the solutions that society needs. However, increased reliance on scientific discovery, innovation and technological change presents not only great opportunities but also threats, and it is important that *all* societal actors – not least the general public – are involved to an appropriate degree in the deliberation of priorities, the execution of public research and innovation activities and the use of the resulting insights, data or tools. The initial plans for Horizon 2020 define the major societal challenges to be addressed by the forthcoming programme, and also make clear that research and innovation must respond to and reflect the needs of European society, must reflect its core values, and must be responsible. These ambitions are just as important today, perhaps even more important, than they were when the Commission published its first Science and Society Action Plan in 2001.

The desk research, consultation exercise and expert workshops carried out as part of this *impact assessment* confirmed the continuing need for EU-level intervention in order to realise these important political and societal ambitions. This is a work-in-progress. The cost of inaction could be profound, with at best a loss of momentum in key areas of systemic reform, from governance structures to science education, and at worst a possible reversal in several important trends, from diversity to open access. The views of our experts and non-specialists converged and expressed high levels of conviction concerning the importance of further action at EU level within each of these areas. In addition, there are clear arguments supporting the need for a strong degree of leadership and coordination on the part of the Commission, moving forward.

Overall, the Impact Assessment weighed a range of potential future options and revealed a clear case for continuation of dedicated support (programmes) for research, coordination and support activities in each of the major thematic areas associated with the RRI framework.

The consultation found no material support for the cessation of a European-level SiS programme, and while such an eventuality would save tens of millions of Euros annually, our desk research suggests a withdrawal could limit or even reverse progress in areas that will be instrumental to the achievement of Horizon2020 and wider innovation policy objectives. The cost of inaction might very easily be one or two orders of magnitude greater than the cost savings.

A second key finding of the assessment was that the Commission should retain a dedicated unit to provide management, oversight and direct support for future RRI actions, and should not seek to redistribute responsibility for RRI across the various units responsible for the implementation of Horizon 2020 and other DGs. There are however strong arguments in favour of continued efforts to embed good practices across Horizon 2020 and for the Commission to continue to play a strong role in helping to coordinate and support Member State actions relevant to the RRI framework.

The results of the study also confirmed that while the various topics and themes associated with the concept of RRI have strong interconnections and relationships to each other, each has its own specific challenges and needs with regard to future action. As such, a slightly different mix of policy actions is needed within each thematic area.

1.5.2 Preferred policy options in relation to each RRI theme

1.5.2.1 Ethics

Social research has clearly and repeatedly emphasised that the general public demands that developments in research, technology and innovation should be carried out according to the best ethical principles, encompassing trust, integrity and participation of all relevant stakeholders, including civil society. On the one hand, risks to the health and safety of society and the environment must be minimised, while on the other hand, sound ethical principles must be applied to ensure the integrity of scientific results and the appropriateness of new technological solutions. In addition, human and animal rights must be properly protected while ensuring that an appropriate degree of academic freedom is preserved.

The public consultation re-affirmed the centrality of ethical issues to future research and innovation activities. The majority of respondents consider it desirable for further provisions to be made to ensure that all publicly-funded research projects are carried out according to ethically sound principles. A majority welcome the implementation of an EU ethics framework for responsible research and innovation based on fundamental ethical principles and European values, and most consider it desirable for awareness of ethical issues among EU researchers to increase within all scientific fields, and that proper treatment of ethical, legal and social aspects should become an essential part of all research, rather than simply a form of external control.

The public consultation highlighted that in most cases the ‘ambitions’ for a more ethically sound research and innovation system in Europe will be delivered through shared responsibilities and action at EU and national levels. In terms of suitable policy measures and instruments, the impact assessment found that a variety of actions are needed, including (i) changes to regulatory systems, via the introduction of new standards, guidelines, codes of conduct, etc, (ii) research funding programmes to support the investigation, development, and appraisal of appropriate solutions, and (iii) effective dissemination activities and implementation mechanisms to ensure wide take-up, including sustainable institutional structures. Success will be contingent on effective interconnections between the major stakeholder groups (regulators, funders, research institutions, industry, civil society organisations), and on suitable structures that enable policy learning. In the longer-term, empirical evidence as to the tangible benefits realised as a result of improved ethical frameworks and practices are needed, in order to assure the sustainability of the solutions.

The main positive impacts to be generated as a result of improved ethical practices relate to a more ‘responsible’ research and innovation system, with fewer risks to society and the environment and greater confidence on the part of the public at large. Improved ethical frameworks can help to ensure that new scientific and technological trajectories are followed responsibly and in a way that secures public confidence and acceptability, minimising the potential for major new developments to encounter problems within the wider marketplace. Positive impacts should also be realised with regard to social inclusion, the solution of grand challenges and increased scientific excellence.

Relatively few contributors considered there to be any major risks associated with improved ethical frameworks for European research and innovation. Of those that did foresee an element of risk, the main concern was one of overburdening costs for stakeholders as a result of new requirements.

Experts from the ethics field unanimously agreed on the need for dedicated funding at EU-level in the coming years, and concluded that support for ethical debate and research needs to be extended beyond the most high profile areas of science and innovation (e.g. nanotechnologies, genetics, etc.) and into more mainstream areas such as environmental management, healthcare, social science research, etc. As Horizon 2020 focuses efforts on leading-edge scientific research and industrial innovation in order to address the major societal challenges, it will be more rather than less important that there are dedicated structures and funding to ensure that sound ethical practices are applied. The experts therefore also affirmed the importance of having a dedicated central unit in place to manage the ethical review process applying to EU-funded research and innovation projects. This review process, substantially improved under FP7, is still developing and there will be significant risks to the integrity of EU research if it was to be curtailed or left solely in the hands of sectoral units. As such, redistribution or reallocation of responsibility for ethics to other DGs, units or agencies was considered to be a retrograde step, with high risks and few clear benefits.

While the experts from the ethics field argued strongly for a continuation of a dedicated budget for research, support and coordination in the field of ethics under Horizon 2020, the importance of actions to support, coordinate and influence Member State policies and practices were also highlighted. The specific objectives would entail a commitment to develop and uphold the highest standards of ethics and scientific integrity throughout all European research in order to facilitate higher levels of trust in European research and innovation, throughout society. In operational terms, this means H2020 should ensure the universal implementation of the EU Ethics Framework for RRI through a variety of coordination and communication measures. In addition to information exchange and awareness raising, H2020 should also seek to develop and share new codes of practice and assessment tools. Such efforts should not involve the imposition of 'hard' legislation (such as EU Directives) but should relate to voluntary codes of conduct, standards, etc. In addition, there are clear benefits to be gained from further efforts to share good practices across countries and to promote the uptake and widespread application of new standards, codes and practices.

1.5.2.2 Gender

Despite significant efforts and some degree of progress in recent years, the fact remains that women are still largely under-represented in the research and innovation systems at both Member State and EU-levels, particularly within the higher (more senior) positions. There remains a significant challenge to further understand and break down barriers to the effective recruitment and retention of women in senior science and innovation posts. The arguments in support of improved gender equality in research and innovation are manifold, but can be broadly classified into 'justice-oriented' arguments and 'benefit-oriented' arguments. From the perspective of social justice, gender inequalities in terms of pay, conditions, roles and status need constantly to be tackled in order to ensure a 'fair' position for women in science. From a more utilitarian perspective, studies have confirmed that the relevance, quality and impacts of research and innovation activities are greater when carried out by gender-balanced teams. There are also obvious benefits to making use of the full talent pool within an increasingly competitive world, not only within research teams but also within all relevant decision-making bodies within academia and industry.

The public consultation carried out within the context of this study found very high levels of support for the contention that further progress needs to be made in relation to the gender in science field. The majority of respondents consider it desirable that targets should be set for gender balance within publicly funded research and innovation activities, and that gender action plans, training initiatives and transparent recruitment / selection processes should be used to help such targets to be met. There is also widespread support for the need to develop policies to address known barriers to entry and retention of women scientists, such as the need for alternative career paths, and to raise awareness of the scientific and economic benefits of improved gender balance at all levels.

The public consultation highlighted that the appropriate policy level of future actions to achieve the desired outcomes is at both European and Member State level, through shared responsibilities. Suitable policy measures and instruments for EU action include changes to regulatory systems, via the introduction of new standards, guidelines, codes of practice, etc., particularly in relation to ensuring transparent recruitment processes, gender action plans, and increased gender balance in

decision making bodies and in the research process as a whole. EU actions are also needed to support sustainable institutional structures and to fund further research to better understand the benefits of good gender balance, not only within research but also within public and private innovation processes. Success will be contingent on effective interconnections between the major stakeholder groups (regulators, funders, research institutions, industry, civil society organisations), and on the provision of improved empirical evidence as to the tangible benefits that can be realised through gender balance and mainstreaming of gender within all aspects of the research and innovation process.

The main positive impacts to be generated as a result of further action in the area of gender relate to improved social inclusion, a more responsible research and innovation system, and increased scientific excellence leading to increased economic competitiveness. Many studies have confirmed the positive impacts on research and innovation that can be realised through improved gender balance within these processes. Very few contributors (<10%) considered there to be any significant risks associated with future actions to improve gender equality, with the ratio between benefits and costs being the highest out of the six RRI themes addressed by the study.

The findings of the consultation exercise were confirmed and refined through two expert workshops, where input was received on the most important actions moving forward and on the relative costs and benefits of action / inaction. At an overall level, the need for continuation of a dedicated funding programme was emphasised in order to (i) maintain and strengthen the range of platforms and initiatives that have proved successful in developing understanding of this area and in promoting effective solutions, and (ii) continue to develop data to strengthen the business case for active policies to improve gender balance in all aspects of the research and innovation process. The risks of a loss of momentum at EU level are significant in both social and economic terms, particularly given the shortage of STEM graduates entering and remaining in scientific careers within Europe.

The importance of ensuring that all EU-funded research observes good gender diversity policies and practices, not just in terms of gender balance within project teams but also within research content and within decision-making bodies, was also emphasised. The progress made to date within FP7 in 'embedding' good practices across the programme is significant and provides an important lead to the Member States and major institutions in terms of their own policies and practices. Again, the risks of non-continuation of these efforts are seen to be significant. Ongoing coordination and support from the Commission for Member State's own activities in this area is also crucial in order to avoid a loss of momentum. It is not considered possible or appropriate for the EU to regulate or enforce its policies 'top down' on Member States and so the role of the Commission is to provide leadership and support, accepting the different conditions, starting points and cultures of the individual countries.

1.5.2.3 Governance

Research and innovation present manifold opportunities to increase prosperity and quality of life, and there is little doubt that society needs to maximise the positive benefits that can be realised through such endeavour. However, research and innovation does not automatically choose the right path and there may be many wrong turns and cul-de-sacs along the way. Questions of systemic efficiency may be especially prominent among budget holders, particularly at times of financial austerity. There may also be more fundamental concerns about the costs associated with new fields of investigation, where technological advances and economic gain may be offset by unanticipated and undesirable social or environmental consequences. Lastly, within an increasingly rich 'information age' policy makers have to rely on scientific and social scientific advice and evidence in order to develop effective policies, and yet there are considerable complexities and uncertainties in the translation of research evidence into appropriate operational responses. Evidence from research studies is rarely unequivocal, and can be subject to challenge, debate and subsequent revision. In all three cases, appropriate governance structures can help communities to make better, safer and more efficient decisions.

Research and innovation activities and institutions must be effectively governed to ensure their relevance, integrity, and utility. Science increasingly represents a collaborative venture between researchers, industry, policy makers and society at large, and it is therefore vital that effective governance structures are in place to ensure proper stewardship of this key resource. However, it is also important to preserve an appropriate degree of academic and industrial freedom in order to

allow new avenues to be opened and new methods to be developed. Science cannot operate independently from society, but nor can it be (or should it be) treated as a wholly utilitarian venture.

As such it is of clear importance that research and innovation within Europe is governed in a way that maximises scientific excellence, economic competitiveness and social inclusion, while ensuring a high degree of responsibility. The effective governance of research and innovation is therefore both a major challenge and a major opportunity, and forms a central and in some senses ‘overarching’ component of the RRI framework. Good governance is also increasingly required in order to manage the effective use of resources across national and disciplinary boundaries. Future solutions to societal challenges will in many cases be realised through developments at the interstices between scientific disciplines, and optimal use of resources relies on effective collaboration between different types of institutions.

The public consultation carried out within the study reinforced the importance of effective governance and signalled that it should remain as a high priority component within the RRI framework. The public consultation also affirmed that governance is increasingly concerned with ensuring an effective interplay between scientific research, industrial innovation and societal needs, encompassing elements of stakeholder involvement, good ethical practices, and effective policymaking based on sound scientific advice.

The public consultation highlighted that future actions are required at both European and Member State level, through shared responsibilities, and that support for sustainable institutional structures and the management of research funding flows are key mechanisms through which to ensure good governance. Success will be contingent on effective interconnections between the major stakeholder groups (regulators, funders, research institutions, industry, civil society organisations), and on the establishment of suitable structures to enable policy learning.

The main positive impacts to be generated as a result of more effective governance frameworks for European research and innovation relate to a more responsible system with higher levels of societal inclusion and greater potential to provide solutions to the grand challenges facing society. Relatively few contributors foresee significant risks arising as a result of stronger governance of research and innovation, although some see potential risks that the costs of R&I activities will increase in line with an increasingly ‘regulated’ system. A small minority of contributors also indicated that there might be a decrease in scientific excellence if the degree of governance by non-scientists were to increase.

While there is a substantial literature on the nature of good governance in public institutions (e.g. inclusive and equitable participation of representatives of key stakeholders; independent and authoritative; transparent and accountable; observe the rule of law; etc), there has been much less research into the relationship between good governance and RRI. The costs of poor governance are hard to quantify, however it is clear that the absence of appropriate oversight mechanisms can produce discord and unnecessary duplication, which in turn can reduce system efficiency and capacity by whole fractions. Similarly, poorly governed systems and institutions may deliver sub-optimal decisions, reducing social benefits while also weakening trust among beneficiaries and the wider public. The costs of biased or poorly considered scientific advice might very easily wrong foot decision makers and lead to a reduction in public well-being or environmental sustainability.

The experts contributing to the study emphasised the importance of continuation of dedicated funding for research, support and coordination in the field of R&I governance, as this permits the coming together of relevant actors from across the EU to debate and agree on the most important actions, to share good practice and agree on appropriate solutions.

Researching, packaging and promulgating good practice as regards different aspects of the governance of RRI should be a centre-piece of the H2020 RRI programme.

Without a dedicated mechanism to support such collaboration at the EU-level there is a significant likelihood that efforts to improve governance systems at national levels would be curtailed, and there would be detrimental impacts on the ability to take the RRI agenda forward in other areas. Advances in science education, ethics, gender, public engagement and open access all require effective governance systems to be in place to drive forward developments and appraise progress.

The experts also affirmed the importance of ensuring that good governance continues to be an integral part of the FPs, and that Horizon 2020 should retain a dedicated RRI unit to raise awareness of the importance of RRI and to support and monitor its implementation across all programme areas.

1.5.2.4 Open access

The principle of providing open (or free) access to the results of publicly funded research has attracted increasing levels of attention in recent years at national, EU and international levels. On the one hand, there is a broad acceptance of the idea that all research supported with public funds should be made freely available in order to maximise its potential for widespread use and impacts. On the other hand, a switch to open access publishing is non-trivial as it challenges both traditional publishing models and the existing systems of peer review that in some way assure or otherwise indicate the quality of published journal articles. While the benefits of open access publishing appear clear and the rationale behind such a move attracts widespread support, the attendant risks and potential negative consequences have yet to be fully understood. Furthermore, the mechanisms for open access publishing have yet to be fully developed.

The consultation confirmed a generally high level of support for the idea that publicly funded research should be made available via open access, that this should be a policy priority for action within all Member States and that researchers should be made aware of open access opportunities and should be able to make choices regarding its use. Responses to the consultation did not suggest, however, that printed journals would disappear entirely to be replaced by on-line digital publications.

The consultation indicated that future actions are required at both European and Member State level, through shared responsibilities, and that changes to regulatory systems (through standards, guidelines, etc.) and to research funding programmes are the most appropriate policy measures through which to increase open access publishing. Certain desirable future outcomes, such as the ability to access decentralised repositories through a unified European search portal, are naturally more amenable to action at the EU level. Critical success factors for the realisation of open access publishing were increased empirical evidence as to the benefits that this move would bring, along with good connections between the various stakeholders involved in the funding, production and dissemination of scientific knowledge. Suitable structures to enable policy learning about the costs and benefits of open access moving forward were also considered to be of high importance.

The main positive impacts to be generated as a result of increased moves towards open access publishing related to advances in responsible research and innovation, increased scientific excellence, greater social inclusion and increased economic competitiveness. In practical terms, a general switch to open access publishing is expected to save research funders hundreds of millions of Euros each year in reduced costs as compared with the conventional scholarly publishing system and that the resulting wider circulation of knowledge among non-academic readers might produce even larger financial gains through enhanced knowledge spillovers. There will be hidden costs no doubt, but the balance of opinion among experts and non-specialists alike is emphatic: open access is seen to bring a range of positive benefits and forms a key part of what it means to conduct research and innovation in a responsible way. The risks associated with a move towards open access were generally low but related mainly to the costs to various stakeholder groups of such a switch due to the need to migrate technologies and practices.

The experts contributing to the study emphasised the importance of continuation of dedicated funding for research, support and coordination in the field of open access. While further research into the most appropriate solutions is still required and while certain technical and financial barriers have to be overcome, coordination of and support to Member States to assist them in taking forward the open access agenda was considered to be just as important, arguably more so, than the funding of further research per se. Awareness raising activities were also highlighted as important.

In addition to a dedicated budget to support open access research, support and coordination, the experts highlighted the need for Horizon 2020 to continue to demonstrate and build on the good practice embodied in the FP7 open access pilot. Experts would wish to see the pilot extended to cover all research outputs, meaning that all funded projects would be expected to publish their results and data within open access journals or repositories. Open access principles and practice would therefore be fully embedded within all areas of Horizon 2020.

The experts also see a continued need for the Commission to help to coordinate and support Member States to implement suitable open access policies, and argued that a system of monitoring of Member State activities and progress should be implemented.

1.5.2.5 Public engagement

The concept of public engagement and its importance to a responsible research and innovation process has evolved rapidly over the past decade. Previously models were articulated based on the need to ensure that science and new technologies are accepted by society at large, and it was argued that there is a need to educate the general population in order to engender trust and acceptance. However, high profile controversies within the world of science have latterly led to a rejection of the so-called ‘deficit’ model, where the problem was described mainly in terms of a lack of adequate understanding on the part of the public and the solution was increased ‘one-way’ dissemination of information. Instead, a more interactive model has emerged in which society should be fully engaged in a two-way, transactional relationship with science and innovation.

For research and innovation to be ‘responsible’ it should be oriented towards societal needs and should be conducted in a manner that society finds acceptable. In order for this to happen society needs to be fully engaged at all stages of the research and innovation process, from the setting of research priorities through to the take-up and exploitation of new technologies. Increasingly it is expected that public engagement will not only improve public confidence, trust and support, but will also lead to more creative inputs, improved decision-making and the development of more appropriate and effective solutions.

The public consultation exercise confirmed the central importance of public engagement for Responsible Research and Innovation. Contributors supported the idea that efforts should be made to raise the competencies of the general public to enable citizens to better engage with science and technology, and that social platforms should be promoted as a means to broaden the interest of civil society in science and technology and to enable their greater input into agenda setting. Greater involvement of citizens in the work of Civil Society organisations engaged in S&T was also considered to be a desirable outcome.

As with the other components of the RRI framework, public engagement was seen to be an activity that requires policy action at both EU and Member State level, and progress is expected to be realised most effectively through improved dissemination activities to a broader public. Opportunities for citizens to participate more fully in science and technology exist but awareness of such mechanisms can and should be improved. The public consultation also revealed that research-funding programmes could involve a greater degree of public input to their design and implementation, with the aim of increasing the public relevance and utility of the supported activities. Successful public engagement will be dependent on strong connections between the various stakeholders and on suitable structures and mechanisms for public engagement to be established. While increased public engagement in S&T is widely accepted as a desirable outcome, important questions remain as to what we mean by ‘public’ (e.g. civil society organisations, public representatives, individual citizens) and how they can engage effectively and efficiently.

The major benefits of public engagement encompass increased social inclusion, more responsible research and innovation activities, and more effective solution of the major challenges facing society today. Relatively few contributors foresee significant risks arising as a result of increased public engagement, although a minority argue that the costs involved in effective public engagement across all areas of research and innovation and at all stages of the process would prove to be excessively burdensome.

Experts in the field of public engagement endorsed the findings of the public consultation and stressed the importance of continued action at EU-level. Within the current economic climate and within the context of the major challenges facing society, a fuller engagement by the public in S&T processes is necessary to ensure that appropriate pathways are followed and that continued high levels of investment in research and innovation are delivering the outcomes that society wants. The experts highlighted the need for further investment to train scientists and scientific institutions in methods and techniques for public engagement, identify and share good practices, and to establish effecting monitoring and evaluation systems for tracking progress.

The need to embed and ensure good practice in public engagement across the whole of Horizon 2020 was also endorsed by the experts in the field. The need to ensure ‘full’ public engagement throughout the entire research process (rather than for example simple dissemination activities carried out at project completion) was emphasised, which implies the need for (i) new tools and methods to foster public engagement at the work programme and individual project levels across all areas of Horizon 2020 and (ii) appropriate monitoring activities that can differentiate between the

simple 'transmission of results' approaches and those involving full engagement with the public at all stages of the programme cycle.

1.5.2.6 Science education

Despite relatively high levels of interest in science and technology among young people in Europe, there has been a decline in the number of students studying STEM subjects (Science, Technology, Engineering and Mathematics) at university level, as well as well-documented shortages in the supply of skilled graduates into key technology sectors. The ambition to make Europe a leading global economy based on science, technology and innovation is unlikely to be realised unless there is a sufficient supply of well-trained STEM graduates entering suitable careers. Recent studies have highlighted skills gaps in key areas (such as ICT careers) and other research has indicated that other economies in Asia and the US are doing rather better than Europe in terms of investments in STEM education and in addressing skills shortages. As such there is a risk that unless this issue is tackled more effectively in future Europe will continue to fall behind other leading economies in both economic and social terms.

The ongoing failure to make scientific careers sufficiently attractive to young people in Europe and the worrying trends concerning declining numbers of young people studying STEM subjects at university level have already been addressed by the FP6 Science and Society and FP7 Science in Society programmes. The main focus of the activities has been to promote the development and uptake of new Inquiry Based Learning (IBL) teaching methods, which have been shown to be more effective than traditional (textbook-based) ones in interesting young people in STEM subjects. However, the scale of the problem has dwarfed such efforts and only limited progress has been made in addressing the problem. Further action is clearly needed if current trends are to be reversed.

The public consultation carried out to assess future options in this area confirmed that there is widespread support for the need to increase efforts to address the issue of science education. The vast majority of contributors see it as desirable for governments to take action to increase the number of young people entering science, research and technology careers, and most consider that inquiry-based science education will help to increase the number of young people studying science at higher level. Contributors also endorsed the need for greater international cooperation and exchange in the field of science education, and that more science activities such as science centres, museums and class room projects are also needed in order to effect progress. Partnerships between industry, schools and research organisations are also needed to help bridge the gap between science education and science careers, while new media and social networks also offer the potential for promotion of a more positive image of scientists and scientific careers.

The public consultation highlighted that the appropriate policy level of future actions to achieve the desired outcomes is at both European and Member State level, through shared responsibilities. Science education takes place at national level but the need for international cooperation and exchange, and in the sharing of effective practices, implies that EU-level action will be an important enabler of future progress. Suitable policy measures and instruments for EU action include support for sustainable institutional structures and dissemination activities to promote and assist in the take-up of effective solutions. Success will be contingent on effective interconnections between the major stakeholder groups (science and education ministries, schools, authorities, etc.), the provision of improved empirical evidence as to the tangible benefits of different strategies, and suitable structures that enable policymakers to learn about effective measures.

The main positive impacts to be generated as a result of further action in the area of science education relate to improved social inclusion, increased economic competitiveness, increased scientific excellence and a more responsible research and innovation system. Relatively few risks were associated with actions to improve science education, although the costs are likely to be significant, particularly if progress is made in a balanced way that does not lead to an increase in regional or social disparities.

The findings of the consultation exercise were confirmed and refined through two expert workshops. At an overall level, the need for continuation of a dedicated funding programme was emphasised in order to continue to tackle this major problem, but the experts argued that a more diverse range of actions are needed if further progress is to be made. These include further efforts to involve industry in addressing the problem of science education and to ensure a better connection between education and skills and between skills and jobs. Within this context there is a need to look beyond IBL methods to encompass other effective techniques for interesting young people in STEM subjects and

scientific careers. There is also a need for further research into effective strategies and for the ongoing exchange of practices across institutions and countries. The experts also highlighted the importance of not losing the momentum that has been built up by successful initiatives, and called on the Commission to ensure that the most effective ones (based on comparative evaluation) are supported into the future. The experts rejected wholly the idea of ceasing support for improved science education, due to the devastating consequences that this would have for Europe's future economic competitiveness.

The experts also indicated that while the Commission is not in a position to regulate science education, it could use its significant influence to support and help coordinate member state actions. Efforts to help identify and share effective practices are legitimate and should be pursued, particularly in light of the large differences between Member States with regard to this issue and the fact that language barriers exist between the national educational systems. A pan-European mapping study would also help to highlight areas where further action could be taken at Member State level.

1.5.3 Monitoring and evaluation of RRI under Horizon 2020

It is not yet possible to provide detailed advice on the design of effective and efficient monitoring systems for RRI actions under Horizon 2020, as the specific objectives of future activities have yet to be developed. However, once those objectives have been set, a series of quantitative and qualitative performance indicators should be agreed relating to the desired outputs, outcomes and impacts, and baseline data should be collected to clarify the current situation in relation to each agreed indicator. Regular monitoring of progress in terms of achieving the specified outputs and outcomes should then be carried out, and the full results published on an annual or biennial basis. In this way effort and actions can be adjusted in order to focus on the more effective actions for the achievement of the progress being sought.

While progress in relation to the RRI agenda requires some research to be conducted, much of the focus of future activities should be on coordination and support actions that bring the relevant stakeholders together to develop, agree and implement suitable measures that will affect progress. As such, monitoring systems and associated performance metrics should be centred on measuring progress in terms of the quantity and types of stakeholders involved and the quality of interactions between them, as well as the specific actions taken by those organisations to progress the RRI agenda. For example, output indicators in the area of science education may relate to the numbers of education ministries, authorities, schools, colleges and industrial partners from different countries involved in the EU-supported actions, and the proportion of those organisations adopting the specific measures to enhance STEM education, student numbers and career choices.

Periodic evaluations should then be carried out to determine whether, where and how the achieved outputs are leading to the desired outcomes and impacts associated with the RRI agenda. Outcome indicators in the area of science education may include, for example, changes to curricula and teaching methods as well as increases in the numbers of young people taking STEM subject options at secondary and tertiary levels within participating regions and establishments, compared to the baseline and in comparison with non-participating regions and establishments. Impact indicators might relate to proportionate increases in the numbers of people entering STEM careers within both scientific and industrial settings, which over the longer-term should enhance the capacity of Europe to meet the innovation challenges identified within the Europe 2020 strategy.

For several of the main dimensions or keys of the RRI agenda, such as gender and science education, relevant quantitative indicators and methods for monitoring and evaluation are relatively easy to identify. However, while there may be good candidate indicators for tracking activities and outputs and even impacts, the middle ground, that connects outputs to impacts will remain a challenge. Defining outcome indicators and gathering relevant data that can be used to distinguish the contribution of H2020 to changes in headline statistics will still demand systematic investigation and possibly even longitudinal studies to determine attribution. Programme-level monitoring data and aggregate indicators are simply insufficient on their own. In other areas, such as governance, the indicators may need to be described in more qualitative terms and also tied much more closely to the as yet-to-be-defined programme objectives. We can speculate only possible metrics, of course, perhaps the proportion of all research and innovation funding organisations where the governing body is chaired by a non-executive or where general meetings are held in public.

In all cases, however, it will be important for the Commission to gain a reasonably thorough and detailed understanding of the current situation, the so-called baseline, the problems that exist and the potential for these to be addressed through Horizon 2020, and the actions that can and should be taken to effect progress. Only then can suitably detailed performance indicators and targets for the forthcoming programme be defined, and full monitoring and evaluation plans drawn up.

1.6 Recommendations for the future

In light of the interim evaluation and assessment of future options, we recommend the Commission continue to run a dedicated SiS programme beyond FP7. Without a visible and significant commitment at EU level to continued action in this area, the current high level of awareness and support for these important policy objectives may be lost or diminished. We therefore recommend that the Commission reinforce its commitment to the Responsible Research and Innovation agenda by ensuring that Horizon 2020 contains dedicated structures and budgets for continuation of research, coordination and support actions in the RRI area.

While it is accepted that good RRI practices should be ‘mainstreamed’ within all areas of future Framework Programmes, the most appropriate conditions and mechanisms for achieving RRI objectives are not yet fully understood. There is also a clear need to formally and systematically trial competing solutions, in order to gauge effectiveness and compare their relative strengths and weaknesses in different settings. In addition, ongoing research is needed to determine the wider effects of the programme (outcomes) and to judge progress towards the achievement of RRI objectives. While progress in relation to the RRI agenda requires further research, the focus of future activities should be on coordination and support actions that bring the relevant stakeholders together to agree ways forward, define robust common solutions and support one another with detail design, implementation and learning. As such, we recommend the dedicated RRI programme has the capacity to fund both research and coordination activities.

We also recommend the Commission continue to monitor opportunities for encouraging member states to develop and implement new pan-European frameworks or codes of practice, possibly extending some elements of soft law into substantive legislation within the life of the H2020 programming period. Ethics and gender are perhaps the natural candidates for the extension of soft law as there is already substantial European legislation relevant to both themes.

Given the importance of RRI and the panoply of research and coordination activities required to move things forward, we recommend that a dedicated team be retained within DG RTD to coordinate RRI activities under the Horizon 2020 programme. A dedicated RRI team will permit the Commission Services to do more than manage the development of work programmes and implement calls for proposals, and should provide the leadership and argumentation necessary to achieve consensus among member states and stakeholders on these matters of substance. It would also help with ‘fund-raising’ and financial gearing more generally. We recommend the retention of a dedicated unit to pursue RRI actions in H2020 and provide the continuity and temporal perspective necessary to help drive the transformation of the European Research Area across the next programming period.

Any future RRI programme should:

- Be designed with more active input and ‘buy-in’ from key actors (such as national Science and Education Ministries, Research Councils, Industry Ministries, Innovation Agencies, Trade bodies, Civil Society Organisations, etc.) who can then steer the programme priorities and content and act as the primary audience for and users of the programme results. Ideally user committees should be established for this purpose and should remain in place before, during and after the programme funding cycle
- Seek to develop more clearly stated objectives that specify, ideally in quantitative and qualitative terms, the nature and extent of outcomes and impacts being sought. Suitable indicators should be developed to allow progress towards the achievement of defined outcomes to be tracked, and ‘baseline’ data should be collected to ensure that progress toward the achievement of objectives can be measured
- Ensure that supported projects have more clearly defined dissemination and exploitation plans, with closer involvement of the actors to be influenced by the work (e.g. policymakers and practitioners) from the outset

- Ensure that Civil Society Organisations (CSOs) have a strong role in all stages of the programme and project cycle, and as such the funding rules relating to their involvement should be revised to permit a higher share of their eligible costs to be covered by EU funding
- Seek to increase the use of the new Mobilisation and Mutual Learning (MML) instrument to further promote broad and diverse stakeholder involvement within Community funded research and innovation activities

Efforts should be made to avoid risks (perceived and actual) that might be associated with RRI, including imposition of excessive additional costs on research and innovation activities, and a loss of scientific excellence.

For the successful integration of RRI keys into the science and innovation process, a combination of bottom-up as well as top-down approaches is needed: As long as the decision-makers at the top of the respective organisations are not committed to the overall RRI aims, potential progress will be slowed down or even prohibited. On the other hand, the RRI keys need the engagement and commitment of every single researcher or innovator in order to yield the most benefits.

European innovation policy is more likely to reach its aims, if the private sector is centrally involved in the RRI debate and more actively supported by any future RRI programme, as already foreseen through the shift from "science in society" to "responsible research and innovation".

Efforts to embed RRI principles across Horizon 2020 should be more actively monitored in future. Annual monitoring reports focusing on RRI aspects should be published to ensure that progress is understood and corrective actions can be taken where necessary.

Monitoring reports should address several audiences, and not just the Commission Services. Member states' senior officials, research funders and researchers more generally all have an interest in understanding the appropriate balance between due diligence and the research itself. Individual impact case studies and analytical reports drawing on a cross-section of such empirical studies would be a valuable addition to the evidence base, and help various third parties to better understand the strongly positive impact RRI may have on different socio-economic missions, from advances in understanding to economic competitiveness to public trust.

Efforts should be made to identify and promote the tangible benefits that result from Responsible Research and Innovation, in order to ensure and enhance acceptance among the main stakeholder groups. At this point in time it is still too early to expect a wide range of quantitative, measurable and tangible results. Therefore Science-in-Society needs to be approached with a long-term commitment and realistic expectations as to what can be achieved in the short-, mid- and long term.

There is also a need to further enhance the uptake and exploitation of the significant body of new insights, tools and practices developed through the FP6 SaS and FP7 SiS programmes. As such, we recommend that part of the remaining SiS programme budget be devoted to a series of expert contracts oriented to the assessment, synthesis and promotion of programme results within each of the major SiS themes (gender, ethics, etc.). Additionally, this series of research syntheses might be required to establish the 'baseline' situation in relation to each of the six RRI keys. Notwithstanding how it is delivered, a series of 2013 baselines would be a good complement to this evaluation and would further help with prioritisation and sizing of budgets for H2020. It would also provide a key reference for future monitoring and evaluation activities. The 'Stocktaking 10 years of Women in Science' publication provides a good model for such efforts.

Lastly, given the long-term, evolutionary nature of the RRI agenda, we recommend the most significant initiatives and structures established to date should, wherever possible, continue to receive support in the latter stages of FP7 and under Horizon 2020.

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