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Developing World-class Research Infrastructures for the European Research Area (ERA)

Report of the ERA Expert Group

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This is the Final Report of one the seven Expert Groups set up by DG Research of the European Commission in the context of the follow-up to the Green Paper "The European Research Area: New Perspectives" adopted by the Commission on 04 April 2007.

Expert Groups were set up for each of the six ERA dimensions identified in the Green Paper, and one on the overall vision and rationales for ERA.

The list of Expert Groups is as follows:

EG 1: Realising a single labour market for researchers
EG 2: Developing world-class research infrastructures
EG 3: Strengthening research institutions
EG 4: Sharing knowledge
EG 5: Optimising research programmes and priorities
EG 6: Opening to the world: international cooperation in S&T
EG 7: Rationales for ERA

The overall objective of each of the Expert Groups EG 1 to EG 6 was to identify and define possible measures and actions concerning the relevant ERA dimension, taking into account existing expertise, available evidence and the major elements stemming from the debate launched by the Green Paper. Expert group EG 7 was tasked with developing and expanding rationales for ERA and refining or suggesting a reformulation of the ERA vision proposed in the Green Paper, based on an analysis of the main issues and factors affecting the efficiency, effectiveness and attractiveness of the European research system.

More information on the ERA Green Paper debate, public consultation and follow-up can be found at: http://ec.europa.eu/research/era

PREFACE

Knowledge in general and scientific knowledge in particular is the basis of competitive, modern economies. That is why Europe's ability to sustain a competitive edge in knowledge creation and innovation is at the core of the Lisbon Strategy for Growth and Jobs. Thus, it is of key importance to develop a European research and innovation framework which can respond to existing and future challenges posed by the globalisation environment of research, technology and economy. The development of the European Research Area (ERA) is a vital element within this process. With the Green Paper on new perspectives for the ERA the Commission launched a much needed debate about ways to accelerate its realisation.

World Class Research Infrastructures as one of the pillars of an ambitious ERA-vision…

I believe it is justified to put forward World Class Research Infrastructures as one of the pillars of an ambitious ERA-vision for the future. Indeed, the existence of and access to leading research infrastructures play a key part in maintaining Europe's competitiveness in both basic and applied research. State-of-the-art research infrastructures with the appropriate critical mass of scientific research skills are vital for promoting innovation, and offer the conditions that are required to carry out cutting-edge research and high level human capital development.

Research infrastructures also play a clear societal and economic role by generating discoveries and opportunities for new industrial applications. High-quality research infrastructures serve as beacons for high-tech companies, research establishments, and educational institutions. The innovative results of research conducted in these infrastructures have a multiplier effect, creating new economic activities and fresh employment opportunities. Moreover, high-quality research infrastructures attract talented researchers and as such, they are powerful tools for stimulating mobility of researchers.

Deployment of ICT-based infrastructures…

The vision for a future European Research Area must include and encompass the deployment of ICT-based infrastructures (e-infrastructures) such as high-performance communication networks, appropriate 'middleware' and grid–enabled data infrastructures, as they connect research communities within and across different science disciplines. Virtual presence tools, focused on accelerating the creation of collaborative research communities, boost the research process and enable new ambitious goals and visions to be realised with greater speed and efficiency than was hitherto possible.

Prioritisation is needed…

For many research infrastructures, their construction, maintenance, and modernisation are complex processes that require substantial investments. Budget constraints on governments and institutions alike make it difficult to meet the rising demand for funds to develop new initiatives or ideas.

Consequently, prioritisation is needed, as are the further development of joint cross-border initiatives and the involvement of all potential stakeholders. Therefore a coherent policy at the EU level for the implementation of Research Infrastructures is urgently needed.

With the establishment of the European Strategic Forum on Research Infrastructures (ESFRI) and the e-Infrastructure Reflection Group (e-IRG) and with the publication of ESFRI's roadmap for new and upgraded large-scale research infrastructures, Europe has taken a major step towards the development of such a policy. However these initiatives are not sufficient. The main challenge today is to set up a process that turns ideas into practice, to complement the "what" with the "how".

In this report the ERA Expert Group on Research Infrastructures presents its ideas as to how Europe could develop a common strategy for the implementation of the next generation of pan-European research infrastructures, taking into account the input of all stakeholders. The expert group believes that this strategy should lead to a new role for the European Commission in this field that should move it from being a pure project funder to becoming a catalytic agent and stakeholder in the establishment of pan-European research infrastructures. With this new role the European Commission will be able to contribute, together with the Member States and other stakeholders, to the much needed restructuring of the research infrastructures landscape in Europe.

We look forward to a constructive dialogue on this report as well as to the specific initiatives which are required to move forward the implementation of a European policy on research infrastructures.

Norbert Kroo
(Chairman)

Executive Summary

World Class Research Infrastructures as one of the pillars of an ambitious future ERA-vision…

The existence of and access to leading research infrastructures is and will remain a key determinant of Europe's competitiveness in both basic and applied research. Adequate research infrastructures, together with the needed critical mass of research skills are vital for promoting innovation, and offer the conditions required to carry out cutting-edge research and European capacity building. High-quality research infrastructures serve as magnets for talented researchers. Research infrastructures (RIs) also play a clear societal and economic role by generating ideas for new industrial, societal and political applications. The innovative results of research conducted in these infrastructures have a multiplier effect, creating new economic activities and fresh employment opportunities.

Policy overview and trends…

Up to now the EC Framework Programme has been the main financing instrument by which the EU has supported the networking and joint research activities of pan-European RIs, with special attention to ensuring trans-national access of researchers to state-of-the-art facilities.

Europe has taken a major step forward in the development of a more coordinated approach for policy-making in the field of RIs with the establishment of the European Strategic Forum on Research Infrastructures (ESFRI), the e-Infrastructure Reflection Group (e-IRG), the release of the first ever European Roadmap for Research Infrastructures and by establishing the 'preparatory phase' instrument within FP7 which aims to facilitate the construction or upgrade of some of the ESFRI roadmap RIs.

Prioritisation is needed…

However the current policy is not sufficient. Budget constraints on governments and institutions alike make it difficult to meet the rising demand for funds to develop new initiatives or ideas. Consequently, prioritisation is needed.

The ESFRI-roadmap is widely recognised as an essential part of the decision making process for pan-European RIs. Based on the experience gained during this first exercise, ESFRI should further improve its methodology for assessing large-scale pan-European RIs, particularly with regard to the transparency of procedures and the involvement of relevant stakeholders.

Since Member States will continue to play a key role for decision making in the RI area, they should develop their national/regional RI planning to optimise synergy with the ESFRI activities. This will enable them to connect priorities defined at national/regional levels with the ESFRI roadmap. Moreover, coordination between the ESFRI roadmap and similar activities at national/regional level is an important component for a coherent RI policy, integrating both small and medium sized RIs with large-scale facilities.

More and better funding…

To speed up the implementation of the ESFRI roadmap, also taking in account the required investment for existing RIs at all levels, there is a need to improve the efficiency of their funding and to increase funding levels. Setting up of general guidelines for the evaluation of RIs should ensure better resource allocation. Consortia developing RIs should be stimulated to make innovative use of various financing instruments and mechanisms (Structural Funds, loans from the European Investment Bank, Public Private Partnertships, tax incentives, etc.) for the construction and longer term financing of pan-European RIs. In parallel, Member States should increase their funding level for RIs to ensure both the implementation of the new ESFRI projects and to provide adequate funding for existing RIs. A significant increase of EU funding is essential to provide a a catalytic and leveraging effects.

Creating a legal framework and transparent principles for management and access…

The implementation of new RIs, as well as improved networking and access to existing ones will require joint enterprises by the different stakeholders in an international environment. To achieve these goals the next generation of pan-European infrastructures will require legal and governance structures that can be more readily set up and used.

One option would be the creation of intergovernmental organisations with tailor made legal frameworks, based on best practice experiences from existing successful organisations (e.g. CERN, EMBL, ESO). However, the process of setting up such intergovernmental organisations is sometimes considered as lengthy, difficult and cumbersome. As an alternative solution, it is proposed to develop a new easy to use legal framework at a European level (through an EC regulation) to make available a new type of legal structure which may be used by the interested research institutions throughout Europe.

Guidelines for the management of pan-European RIs, as well as general access policy criteria for pan-European RIs should also be developed. The synergy between the Ideas, People, and Capacities specific programmes of the EU Framework Programme should be improved to further stimulate the visibility of RIs as valuable instruments for the European Science and Technology system. This includes better coordination schemes across these programmes to allow the use of funds in a synchronised and more effective way.

Deployment of the e-infrastructure…

The vision for a future European Research Area and a coherent RI policy must include the deployment of e-infrastructures, as they are the integrating mechanism, the glue between regions and different scientific disciplines.

Europe should reinforce its e-infrastructure strategy by boosting the creation of virtual collaborative communities of researchers, ensuring the inclusion and participation of students and researchers from all over Europe in the highest levels of the knowledge society. A world leading European Network with a global perspective, smooth access and coordinated high-performance computing provision (such as GÉANT and its global extensions, Grid, etc.) should be further developed.

A trustworthy management system must provide seamless access to shared resources of all types and generic virtual presence tools must facilitate virtual research communities. Education and training programmes should be put in place both to accelerate the exploitation of the e-infrastructures by younger researchers and to improve their availability to wider user communities.

Europe should develop a coherent and managed layer of scholarly and academic research resources by bringing together Europe's research repositories and significantly increasing the number and quality of the knowledge resources available. A programme of research and co-ordination should help Member States to address the issues of establishing, managing and joining up research repositories.

Europe participating in global research infrastructures…

An increasing number of research infrastructures are now being developed at the global level. There is a need to identify or create an appropriate forum where global RIs can be discussed and carried forward at a high-level and where Europe should speak with a common voice. A set of strategic guidelines should be developed to help prioritise European involvement in global RIs. In addition, the European Commission should stimulate the creation of specific mobility (access) schemes to enable researchers to engage with RIs outside Europe and vice versa (for non-European researchers).

Towards a strategic coordination mechanism for RIs…

To ensure the effective implementation of a coherent policy for pan-European RIs there is a need for a 'strategic coordination mechanism' at EU level, involving all relevant stakeholders (Member States, ESFRI, e-IRG, the scientific community, Research Performing Organisations, industry …). This mechanism should

facilitate, in particular, an evaluation of RI initiatives, the better addressing of funding issues and resolution of problems of location of the new RIs. This mechanism should integrate the e-infrastructure strategy. Small and medium-sized RIs of pan-European interest should be taken into account to ensure an optimum use of the regional capacities.

Building on the existing experience of actions to support RIs within the EU Framework Programme for RTD, the European Commission would be in the best position to take a central role in developing this strategic coordination mechanism. It could be a European Research Infrastructures Programme modelled, for example, on the successful European Fusion Programme with well integrated national and European actions.

Table of contents

Introduction

Research infrastructures[1] (RIs) are essential to modern scientific enquiry. As the frontiers of research evolve and become more advanced and as our technologies progress, the demands for new, upgraded and more elaborate research infrastructures are becoming increasingly complex and more expensive, often placing them beyond the reach of a single research group, region, nation or even continent. A step towards better planning for the development or upgrading of RIs at European level was achieved recently with the creation of the European Strategic Forum on Research Infrastructures (ESFRI) and the e-Infrastructure Reflection Group (e-IRG). In 2006, ESFRI produced the first ever European 'roadmap' for new and upgraded large-scale RIs.

In part, these developments foreshadowed questions posed in the Green Paper published in 2007 on 'The European Research Area: New Perspectives'. The Green Paper argues that there is an urgent need to revisit the European Research Area (ERA) and puts questions to the EU institutions, Member States, regions and stakeholders. The Green Paper put forward for debate a vision of the ERA in which there should be better coordination, cooperation and knowledge sharing throughout the EU. It suggested broad orientations around six axes[2], one of them dealing with world class research infrastructures. It noted that, although progress has been made since 2000 to build the ERA, much ground work remains to be done, particularly to overcome the fragmentation of public research programmes and policies. A sense of urgency is stemming from the accelerating globalisation of research and technology. The need to re-examine the strategic development of world class research infrastructures within the ERA is, therefore, paramount.

To accompany and support this re-examination, the Commission made use of external expertise to elaborate on the issues presented in the Green Paper. It is in this context that an Expert Group on world class research infrastructures was set up (the list of members of and the terms of reference for the group are given in Annexes 2 & 3). The basic objective of the Expert Group was to provide rationale and present some building blocks for the development of a new strategic approach to the development of world class research infrastructures across the ERA.

In this report an overview of recent policy initiatives and existing trends regarding RIs is given and specific policy recommendations are made, taking account both the Group's own expertise and the results of the public consultation of the ERA Green Paper. These recommendations more specifically address the following challenges:

1. How could the EU effectively prioritise and decide on pan-European RIs and their funding?

2. Which legal framework(s) is (are) needed to facilitate the emergence, management and operation of new pan-European RIs?

3. Is there a need to define common and transparent principles for the management of, and access to, pan-European RIs?

4. How to improve the role of e-infrastructure for research cooperation?

5. What measures are needed to address the global challenges of research and the related RIs?

1. The term 'research infrastructures' refers to facilities, resources and related services that are used by the scientific community to conduct top-level research in their respective fields. This definition covers: major scientific equipment or set of instruments; knowledge based-resources such as collections, archives or structured scientific information; enabling ICT-based infrastructures such as Grid, computing, software and communications; any other entity of a unique nature essential to achieve excellence in research. Such research infrastructures may be "single-sited" or "distributed" (a network of resources).
2. The other five axes of the Green Paper are: a single labour market for researchers, excellent research institutions, effective knowledge sharing, optimised research programmes and priorities and a wide opening to the world.

1. A European Research Area for RIs: an overview of EU policy initiatives

Since the EU Commission's Communication 'Towards a European Research Area' (January 2000), the idea of a common ERA has been the guiding principle for all Community R&D measures and a central pillar in realising the research goals of the Lisbon Strategy for growth, jobs and a dynamic and knowledge-based European economy. In this context, developing an EU policy for RIs has continuously been the subject of high level discussions and reflections over the last few years and will be even more critical in the near future. For the EU to become the most competitive and dynamic knowledge-based economy in the world, there can be no doubt that state-of-the-art research facilities are essential for Europe's researchers to stay at the forefront of research development and, thus, an important element within EU's research policy. Research Infrastructures of pan-European relevance can provide unique opportunities for world-class training as well as for stimulating researchers' mobility, knowledge and technology transfer. They are, in essence, the key drivers for European capacity building. They also contribute to the attractiveness of Europe in a globalising R&D environment.

In 2002 the European Strategy Forum for Research Infrastructures (ESFRI) was set up by Member States and the European Commission. At the Competitiveness Council of 25-26 November 2004, the Research Ministers called for the development of a European Roadmap for the construction of the next generation of large-scale RIs and asked ESFRI to establish this roadmap in close collaboration with the Commission. In 2003, the e-Infrastructure Reflection Group (e-IRG) was set up. The main objective of the e-IRG is to provide support at the political, advisory and monitoring levels, to help with the creation of a policy and administrative framework for the easy and cost-effective shared use of electronic resources in Europe (focusing on Grid-computing, data storage, networking and high power computing resources) across technological, administrative, and national domains. Both ESFRI and e-IRG complement each other in the construction of the ERA.

In October 2006, ESFRI released the first ever European Roadmap for Research Infrastructures, covering all fields of research. This Roadmap, which was the result of two years of intensive work, consists of 35 projects, and takes into account projects identified by other important bodies, such as the CERN Council for particle physics and e-IRG for the e-infrastructures domain. The 2006 ESFRI Roadmap is not exhaustive and future updates are foreseen. It is thus evident that ESFRI plays a major role in the development of a more coordinated approach for policy-making in the field of RIs in Europe.

Until now the EC Framework Programme has been the main financing instrument by which the Community has supported the networking and joint research activities of pan-European RIs. Since the outset, Community action has paid special attention to ensuring trans-national access of researchers to state-of-the-art facilities. On-going Framework Programme (FP) activities give direct access to about 30,000 researchers to existing facilities not located in their country.

The budget to support these activities has now increased from 730 M€ in FP6 (2002-2006) to more than 1.700 M€ in FP7 (2007-2013). EC support is open to infrastructures across all fields of science and technology. It also provides support for communication network development for all researchers in Europe and a further development of GEANT, GRIDS and Scientific Data Infrastructures. Indirect support from other FP7 programmes such as People and Ideas complement the use of RIs.

FP7 aims not only to promote coherent use and development of existing RIs, but also to facilitate the construction new pan-European RIs, or major upgrades of existing ones, in close cooperation with efforts made by the Member States. The construction of new infrastructures affects the direction of research for many years ahead. It is therefore vital to have the ESFRI Roadmap to define and prioritise the development of projects of pan-European interest.

2. Priority setting and decision making for pan-European RIs

A major challenge now relates to the implementation of the ESFRI projects. These projects will require cooperation between several countries to be implemented and there is currently no decision making process at the EU level. Member States will continue to play a key role for decision making in this area. The Expert Group is suggesting various complementary ideas to be explored to stimulate coordination between Member States and to develop the required decision making process for the ESFRI projects or other needed European RIs.

2.1 Improving priority setting for pan-European RIs

The role of ESFRI

The ESFRI roadmap is widely recognised as an essential building block in the decision making process for pan-European RIs. It provides a common European view for future large-scale pan-European RIs covering a wide range of fields of science and technology. The 2006 ESFRI roadmap was a first attempt in that direction and understandably it had some limitations. The exercise is a rolling process and the document will be updated and improved to integrate new ideas where and when appropriate.

Based on the experience gained during the first exercise, ESFRI should further improve its methodology for assessing pan-European RIs, particularly by strengthening the transparency of procedures and the involvement of relevant stakeholders. Some fields of research which are currently less structured and organised should be stimulated to participate in the planning process and be more proactive at the European level. A better involvement of industry at this planning stage is also needed. All available information indicates that there are clear opportunities for European industry to become involved in RI projects either as suppliers or users. The industrial involvement could be improved through better links with e.g. the European Technology Platforms, the Joint Technology Initiatives or the future Knowledge and Innovation Communities of the EIT. The e-infrastructure dimension should also be better integrated within the ESFRI roadmap process. To that purpose the current cooperation between ESFRI and e-IRG should be increased.

Synergy with national/regional planning and roadmaps

In most fields, the ESFRI approach to the identification of pan-European RI needs has mainly focused on large scale infrastructures. Some Member States and regions have already started to use the ESFRI roadmap as a tool to support the development of their own national or regional policy actions on RIs and at the same time to place these actions in a wider European context.

There is a need to develop further these ESFRI type activities at the national/regional levels as this will enable priorities defined at these levels to connect with the ESFRI roadmap. Moreover, coordination between the ESFRI roadmap and similar activities at national/regional level would be an important component of a coherent RI policy.

2.2 Ensuring implementation of the ESFRI Roadmap

The credibility of the ESFRI roadmap is at risk without adequate funding[3] and a proper decision making process for its implementation. Decision making at EU level for a given RI is never easy because of the different interests of the countries involved, e.g. regarding financing and location issues.

The FP7 "preparatory phase" action for new RIs

The first FP7 research infrastructure call for proposals was targeted at supporting the 'preparatory phase' for the construction of the projects of the ESFRI Roadmap. The purpose of this action, based on a variable geometry approach, is to provide catalytic and leveraging support to the ESFRI projects helping them to reach the level of technical, legal, and financial maturity required to enable their construction. Project consortia should involve all the stakeholders necessary to make the project move forward, to take decision and to make financial commitments before construction can start (*e.g.* national/regional ministries and governments, research councils, funding agencies). Operators of research facilities, research centres, universities, and industry may also be involved whenever appropriate.

During this preparatory phase the European Commission can act as a 'facilitator', in particular with respect to the financial engineering needed for the construction phase. This instrument has only been launched recently and it needs to be closely monitored and evaluated to measure its effectiveness.

Towards a 'strategic coordination mechanism'

Although the 'preparatory phase' is a useful instrument to progress the implementation of ESFRI projects at the individual project level, it is still an intermediate step towards decision making.

To ensure the effective implementation of the identified pan-European RIs there is a need for a 'strategic coordination mechanism' at EU level, involving all relevant stakeholders (Member States, ESFRI, e-IRG, the scientific community, Research Performing Organisations, industry …). This mechanism should facilitate, in particular, a strategic evaluation of RI initiatives, the better addressing of funding issues and resolution of problems of location of the new RIs. This mechanism should also integrate the e-infrastructure strategy. Small and medium-sized RIs of pan-European interest should be taken into account to ensure an optimum use of the regional capacities.

The implementation process could be organised in a more efficient way, e.g. by pooling financial resources and establishing a multi-year implementation plan with financial phasing. Such a strategic coordination mechanism for RIs should also take in account small and medium-size RIs.

Building on the existing experience of actions to support RIs within the Framework Programme, the European Commission is in the best position to take a central role in developing this strategic coordination mechanism. It could be a European Research Infrastructures Programme developed, for example, on the model of the successful European Fusion Programme with well integrated national and European actions.

RECOMMENDATIONS OF THE EXPERT GROUP

- ESFRI should improve its assessment methodology for the roadmap in particular with regard to the transparency of the process and the involvement of all relevant stakeholders.
- Member States should develop their national/regional RI planning to improve synergy with the ESFRI activities.
- The EU should establish a 'strategic coordination mechanism' at the EU level to ensure the implementation of the Roadmap projects and a coherent ERA policy for RIs.

3. Implementing the ESFRI roadmap would cost € 14 billion over 10 years.

3. Funding of pan-European RIs

RIs, both planned and existing, place heavy demands on scarce financial and human resources. To speed up the implementation of the ESFRI roadmap, also taking in account the required investment for existing RIs at all levels, there is a need to improve the funding efficiency and to increase funding levels. The Expert Group suggests taking or exploring the following actions or ideas.

3.1 Ensuring efficiency of funding

Evaluation and efficiency of funding

It is widely recognised that funding should only be given to those RIs that meet certain needs in terms of excellence in research and education, capacity building, socio-economic impacts, etc. Therefore, transparent and high quality evaluation mechanisms for existing and new RIs are needed both at the national/regional and EU level. Accordingly, it is recommended that general guidelines for the evaluation of RIs are developed. These guidelines or evaluation models can be based on existing experiences, through a mutual learning process e.g. as part of the Open Method of Coordination (OMC) of the Member States.

Exploring complementary sources of funding

In addition to the improvement of funding efficiency through evaluation, other various existing financing sources and mechanisms should be promoted or considered for funding the construction and operation of RIs.

- *Structural Funds* can make an important contribution to setting up RI in the eligible regions of the EU. However, incentives are needed to encourage a greater share of research and innovation activities in the Structural Funds. We recommend considering adopting a lower complementary contribution (*e.g.* around 10%) when using structural funds for new RIs.
- The new *Risk-Sharing Finance Facility* (RSFF) instrument as part of FP7 and European Investment Bank's programme for Research & Innovation should be further promoted since it can help to make more financing available for promoters of RI projects.
- *Article 169 of the EU Treaty* could be used for longer term financing of pan-European RIs. The aim of article 169 initiatives is to go beyond mere coordination of national programmes, such as those in ERA-NETs, and to combine various national and regional programmes into a single joint approach. This article makes it also possible for the EU to participate as an equal partner in research and development initiatives being conducted by several Member States.
- *Public Private Partnerships*. A more active involvement of the private sector in the proposal and design phase of new RIs may generate Public-Private Partnerships (PPPs). Tax incentives for private investments could further stimulate industrial involvement. Specific regulations for charity and foundations (in many cases promoted by private firms) could be developed to stimulate their involvement in running costs. In some cases PPPs at European level could be set up, based on the experience with the Joint Technology Initiatives (JTI's). These partnerships can be implemented through Joint Undertakings within the meaning of Article 171 of the Treaty. They should combine private-sector investment and European public funding, including funding from the Framework Programme.

3.2 Increasing level of funding

As mentioned in section 2.2 there is a need for a 'strategic coordination mechanism for RIs' which would enable a proper financing strategy for RIs at the EU level. The success of this 'strategic coordination mechanism' will strongly depend on its capability to provide (part of) the necessary funding. Together with an increase in RI funding at the Member State level, EU funding would be greatly beneficial to speed up the implementation of RIs via its catalytic and leveraging effect. To ensure this effect the level of the EU funding should be at least of the order of 20 % of the construction costs. This would provide a strong incentive for Member States, which remain the main source of funding, for developing these RIs. At the same time the European Commission should move from is current role of ad hoc project funder to one of being a strategic long-term partner and stakeholder.

In addition to the provision of sufficient new resources for the funding of the construction and the operation of pan-European RIs, this financing strategy should include mechanisms to fully optimise the use of different financing instruments mentioned in the previous section e.g. by combining these resources.

There can be no doubt that within a future financing strategy for RIs at EU level, current successful EU financing instruments within the Framework Programme should be continued and further reinforced to support trans-national access to existing and new RIs and to network small and medium sized ones to ensure their optimum utilisation. These instruments could be complemented with new initiatives.

RECOMMENDATIONS OF THE EXPERT GROUP

- ESFRI should stimulate the setting-up of specific guidelines for the evaluation of RIs to ensure more efficient resource allocation.
- Consortia developing RIs should make innovative use of various financing instruments and mechanisms (Structural Funds, RSFF, PPPs, tax incentives, Article 169 of the EU Treaty, etc.) for the construction and longer term financing of pan-European RIs.
- Member States and the EU should increase their funding to ensure the implementation of the ESFRI roadmap and to provide adequate funding for existing RIs.
- Existing activities of the EU Framework Programme in support of research infrastructures (transnational access, networking and joint research activities) should be continued and reinforced.

4. A legal framework for pan-European RIs

The implementation of new RIs, as well as networking and improving accessibility to existing ones, will require joint enterprises by the different stakeholders in an international environment. Achieving the next generation of pan-European infrastructures will, therefore require new legal and governance structures.

A legal framework for pan-European research infrastructures should meet some basic requirements:

- it must have a legal personality so that it can act in its own name;
- it must be recognised in all Member States;
- it should have a limitation in liability;
- it must be suitable for working with industrial/private partners and/or the European Commission;
- it should ideally provide some of those privileges and exemptions which are allowed at a national level for non-profit research.

These characteristics cannot be achieved by creating a 'national' entity and bestowing it with the above essential features. On the contrary among some partners (*i.e.* research groups or organisations) and in some Member States, there is a reluctance to enter into an agreement which ends up as a national legal framework.

One solution would be the creation of intergovernmental organisations, such as those which in effect already operate with success in some fields of science, *e.g.* CERN, EMBL, ESO, *etc.* Based on best practice experience with existing similar organisations, tailor made legal frameworks for new RIs can be set up. One major advantage of this approach is its flexibility. Very large facilities, distributed facilities, applied research facilities, basic research oriented facilities, *etc.* may require different legal forms. On the other hand the administrative and legal processes which typically have to be followed under such intergovernmental schemes may be lengthy, difficult and cumbersome.

An alternative solution could be the definition of a new easy-to-use legal framework at a European level (through an EC regulation) to make available a new type of structure which may be used by the interested research institutions throughout Europe. This framework would streamline and simplify the complex process of setting-up pan-European infrastructures. This could speed up the emergence of the many new facilities that are needed in the coming years.

This EC regulation should set out the main characteristics of the pan-European research infrastructures (legal characteristics, membership, staffing issues, liability, taxation, *etc.*). In addition it could describe the rules and procedures governing their establishment. In particular, the regulation should contain provisions on the application for the status of *pan-European research infrastructure* and procedures by which this status will be conferred by the legislator.

An important advantage is the fact that such a regulation would be applicable with immediate effect in every EU Member State. It could cover all the requirements mentioned above as a basic standard applicable to all research facilities. Complementing national or inter-governmental schemes, this regulation can provide a common and easy-to-use legal framework, leaving a high amount of flexibility to the individual consortia to set up the adequate rules for the specific infrastructure at European level.

The legal basis for this recommendation can be found in Article 171 of the EC-Treaty. This article gives power to the Community to set up joint undertakings *or any other structure necessary* for the execution of Community research. The article also empowers the Community to remove any legal and fiscal obstacles for research institutions to enable collaboration beyond borders.

RECOMMENDATIONS

- The European Commission should develop a legal framework for pan-European RIs, based on Article 171 of the EC-Treaty.
- This regulation should provide a common and easy-to-use legal framework, leaving a high degree of flexibility to the individual consortia to set up the adequate rules for the specific infrastructure at European level.

5. Management of and Access to RIs

"Management and access to RIs" includes a set of rules and procedures to optimise the use of a specific RI for a given community of users. Optimisation here refers to several factors:

- the quality of the RI and its users in order to guarantee international competitiveness through its scientific results;
- maximising the time of use by optimising or reducing maintenance or non availability periods and optimisation of time allocation for users according to predefined criteria;
- ensuring high quality of users´ support;
- optimisation of institutional criteria, e.g. quantitative indicators, internationalisation, technology transfer, industrial use, sponsorships, funding, etc.
- ensuring security of the operation of all aspects of the RI and adherence to appropriate ethical safeguards.

Management

Pan-European RIs will require professional management throughout their life-cycle (preparation, construction, operation and decommissioning). This entails a wide range of activities as RIs will not only provide services and access to highly sophisticated equipment; they will also train researchers and technicians, participate in technology development, and may be responsible for establishing standard operational procedures. These facilities, which may be located in a single site, distributed physically across many sites, or virtual, are expected to evolve constantly given the ever increasing multidisciplinarity of research. Accordingly, they will require a great deal of coordination by all the stakeholders to optimise their input and stimulate international collaboration and participation.

Therefore, management structures should be fully professionalised and operate within a governance structure capable of efficiently addressing common operational problems. Unfortunately, many RIs in Europe have inherited old managerial structures and, due to cumbersome legal procedures, they have chosen to live with them instead of starting a lengthy and uncertain process to modify them. In general, research facilities cannot all be managed in the same way as the procedures depend very much on the S&T domain, location, size, stakeholders. In order to respond to the needs of each particular RI, a flexible approach is required - rigid rules in both management and access policies must be avoided.

A basic management organisation with an additional ad hoc structure adjusted to the needs of a particular RI project will be needed. The possibility of developing general guidelines based on best practices should be explored. Such guidelines, covering the procedures required to establish appropriate management structures for RIs and recognising the need for flexibility, efficiency and quality of service, will be instrumental in the preparation phase of new RIs.

Access to RIs

The RIs included in the ESFRI roadmap should apply an 'open access' policy for basic research, i.e. be open to all interested researchers and based on competition and selection of the proposals evaluated on their scientific excellence by international 'peer-review'.

Effective access mechanisms not only benefit the end-users and society at large because of the knowledge gained, but also the infrastructure managers given the feedback on quality and potential spin-off that may arise. There are several questions and issues that have been raised and that should be considered by all parties when planning the access of future RIs. These questions are related to the management of access (access conditions for remote/virtual accesses and physical access, criteria for time allocation, development of 'support procedures', etc.), to the control and selection of access, to cost aspects, to the ownership of data and results, etc.

Large scale facilities, whether discipline specific or service oriented (information and availability of instruments and access), share common challenges and problems,

but each one is unique due to the diverse nature and complexity of their requirements, and as a result it will be necessary to tailor individual solutions. Tailor - made models for access can be based on best practice models developed by existing pan-European RIs. Similar to the management issues, the possibility of developing general guidelines describing various access models should be explored.

Funding of access to RIs

Sound mechanisms are needed to ensure sustainable financial management of RIs, including the prerequisite to guarantee long-term sustainability of open access at no cost to the researcher. Although national/regional R&D programmes provide funding for access to their facilities or facilities to which they participate (not only in their own country but also those located abroad) it is usually difficult to finance, without ad hoc international agreements, RIs located abroad.

Alternative models such as the provision of 'time slots for 'external' users' or the creation of 'associated partner' schemes could provide a solution to this problem. These models could facilitate the participation of regions or Member States for which a 'full' membership in RIs is not feasible due to financial reasons. The case of industrial users is particularly relevant and could require specific mechanisms to ensure confidentiality and consider cost coverage in a transparent manner.

At the European level, the Framework Programme currently provides funding on the basis of open competitive calls. However other multi-annual approaches seem to be required preferably based on open calls during the whole year to facilitate the use of RIs along the development of R&D projects.

The ERA-NET scheme should be further promoted as a valuable tool to manage common access to networking RIs located in several countries.

In addition, the synergy between *the Ideas, People, and Capacities* programmes in the Framework Programme should be improved in order to further stimulate the visibility of RIs as valuable instruments for science and technology programmes within the European system. This includes better coordination across programmes within the Commission and the creation of a more flexible framework for using funds coming from several specific programmes in a synchronised and more effective way. Such actions could be channelled through the 'strategic coordination mechanism' as mentioned in the previous sections. The related new concept in which the European Commission moves from its current role of *ad hoc* project funder to a strategic long-term partner and stakeholder in certain RIs would allow a better balance between the principles of real open access to RIs at the EU level and a sound financial management of these RIs.

RECOMMENDATIONS

- ESFRI, with the support of the European Commission and other relevant stakeholders should develop guidelines for the management of pan-European RIs, as well as general access policy criteria for pan-European RIs.
- The European Commission should improve the synergy between the Ideas, People, and Capacities specific programmes of the EU Framework Programme to further stimulate the visibility of RIs as valuable instruments for the S&T European system.

6. e-Infrastructure

The role of e-infrastructures

Continuous investments in e-infrastructures and ICT provide competitive European advantages and serve as excellent examples of how coordination and cooperation on a European level, paired with major research infrastructure advances, can dramatically change the way research work is being conducted.

High-performance communication networks such as GÉANT and its global extensions, distributed (Grid) computing, web-based data resources and virtual presence tools enable and accelerate the construction of collaborative communities of researchers. e-Infrastructures are both catalysts for scientific cooperation and act as integrating mechanisms, effectively providing what can be regarded as the 'glue' between the different scientific disciplines:

- Many research efforts require massive computing resources to tackle, for example, the environmental 'grand challenge' on global warming or research in the biosciences and bioinformatics, both of which must integrate research efforts across scientific disciplines
- Modern research is impossible without permanent access to high-quality e-infrastructure: computers, networks, on-line library resources, research data, the software tools to support collaborative research (known as middleware) and to find and access data, and applications to process and present research activity.
- Good access to and management of scientific data is a growing requirement. More and more data is created in digital format only and can be saved for future shared use. Eventually there will be a layer of scholarly and academic information resources, readily available to the research and education community (and much of it to the public at large). This will enable and facilitate cross-border, cross-institution and cross-discipline access to other researcher's data.

The e-Infrastructures are to a large extent financed by the Member States, and connected and interlinked together through powerful global networks that, together with computing and simulation facilities, enable and promote the use of virtual models to simulate, visualise and solve complex research problems. The European Commission support is essential for sustaining the advances in high-performance networking and computing, tools and applications to develop international research communities, and the management and creation of research information resources.

Defining the needs

The needs for 'e-infrastructure' capacity at European level include:

- *High-performance and high-capacity networks*. All Member States provide a National Research and Education Network (NREN) and, without exception, these networks are world class in terms of bandwidth and range of supporting services. The NRENs are linked, by a backbone network known as GÉANT. However, some very demanding applications require more bandwidth than is currently provided. Improvements are also needed to ensure universal mobile access and better video conferencing facilities to enhance the communication between research communities.
- *'Middleware'* to manage the authentication, access and shared use of networked resources. So far a limited number of countries have developed a national federated service to manage authentication and access to national shared online resources (whether content, high-performance computing, other computer resources, or research facilities and instruments).
- *Computer facilities and peripherals including high-performance computing (HPC)*. There are several reports over the last decade emphasizing the value of computational science or computer modelling as they often provide a more cost effective way to conduct experiments. In general there are adequate computer facilities in Europe to support research by generating, storing and preserving data. However, Europe does not have the top capabilities when

compared with other countries in the world, and this is partly due to the fragmentation of national policies. High-performance computing is still the realm of specialised communities of scientists and more efforts need to be invested to extend the benefits of HPC to new research areas. It is of high importance to develop and support a full range of computer facilities where the needed resources can be accessed when requested.

- *Online content* (research data, papers and journals, *etc.*): There are broadly two types of online content of direct interest to researchers: research outputs in the form of papers and journals, and research inputs in the form of data and primary sources. In both cases the management of these resources in terms of making them available online, cataloguing and describing them (through metadata), storing and preserving them (ensuring redundancy and reliability) and curating them (adding value for future generations) are expensive long term commitments.

The e-Infrastructure Reflection Group (e-IRG) contributed significantly through its recommendations both to the European Commission and the Member States by supporting of the creation of a political, technological and administrative framework for the easy and cost-effective shared use of distributed electronic resources across Europe. This steering and decision process is now recognised. It is however necessary to elaborate on the different responsibilities among the various stakeholders in the e-infrastructure landscape. Therefore it is of high importance to further intensify a productive collaboration between the research communities and the various e-infrastructure developing communities. At the same time, the interaction between e-IRG and ESFRI should be further strengthened.

e-Infrastructure provision must be underpinned by the following general policy principles:

1. Where funded by National or European funding agencies, e-infrastructure should be application neutral and open to all user communities. It should be multi-disciplinary and inclusive, *i.e.* it should not be discipline or project specific.

2. e-Infrastructure must remain state of the art, requiring investment in research into infrastructure technologies and close engagement between infrastructure providers and researchers.

3. Due to the increasing complexity of e-infrastructures and the need for researchers to exploit them effectively the research community needs adequate training and advisory services. Younger researchers may have a different perspective on, and requirements of, the research process due to increased familiarity and use of ICT, and the Internet in particular.

4. Software development and life cycle management needs improving and supporting. Open source software needs to be better supported and maintained.

5. Education and training is urgently required to be able to utilise the benefits from the investments in e-infrastructure. A thorough dissemination of already available e-infrastructure knowledge to a much wider workforce and potential user community is required.

6. e-Infrastructure provision must be directed by the needs of the research community and its requirements to carry major global research efforts.

Access to online content

Online content should be readily available to all researchers, teachers, students and society at large. The concept of Open Access (OA) is that the outputs of publicly funded research should be publicly available. Open Access is a complex concept that applies to: scholarly communication (journals, books, monographs *etc.*), research data and access to research infrastructures.

Data are seldom published or linked to research outputs such as journal papers and monographs. It is often difficult to verify conclusions and claims made in papers without access to the data. It should be noted that in the case of 'big science' (often carried out in international research infrastructure facilities) the data is an integral part of the research process and its management and preservation is considered in the planning stage. Similarly in areas such as the social sciences the creation and management of longitudinal data sets is an essential research resource. There remains, however, an enormous amount of data collected by small research teams, and individual researchers, where there is little motivation to preserve data and an inadequate infrastructure, skills or support, to facilitate such preservation.

Many research institutions and universities are recognising the need to take more strategic control of their information assets, including research outputs in the form of publications and the preservation of research data. This, if properly managed and joined up across the world, has the potential to provide a valuable layer of scholarly and academic resource that can be readily accessed by researchers, teachers, students and others. In the US the National Science Foundation is addressing this opportunity through its $100 million DataNet programme and some European countries (*e.g.* UK, Netherlands and Germany) have significant national repository programmes.

But there are few formal arrangements to promote and ensure the coherent management of on-line content, particularly research data, across Europe and other countries. The issues that need to be addressed include ownership of research data; guidelines and criteria for identifying which data needs preserving and archiving; agreement on metadata standards; ensuring interoperability of repositories; common search and retrieval tools; and professional standards for the management of repositories. While the responsibility for addressing these issues lies with the Member States there is an important role for the European Commission in providing leadership, co-ordination and assisting the development of interoperable repositories.

This activity also needs putting in the wider context. Repositories can hold all types of information and repositories of research data and research outputs can also hold, and must link to, cultural and educational resources.

Similarly subject based and institution based repositories must also link together. Sophisticated search tools are needed to exploit the rich but essentially unstructured layer of content that will become available through repositories. Management and funding policies are needed to encourage the deposit of research data, and for updating and deleting such data when appropriate.

Research outputs and data should be made openly available, owned and controlled by the research community. It is essential that these research information resources are professionally managed and made readily available for the benefit of researchers and society. A coherent infrastructure of open repositories across Europe is therefore required. This will enable the full value of European research to be recognised and exploited.

Therefore, it is recommended that a programme of research and co-ordination is established by the Commission to help Member States address the issues of establishing, managing and joining up research repositories. This programme should be integrated within the broader approach of a strategic coordination mechanism for RIs as mentioned in previous sections.

RECOMMENDATIONS

In the advent of the digital era, Europe should reinforce an e-infrastructure strategy able to boost the creation of virtual collaborative communities of researchers, ensuring the inclusion and participation of students and researchers from all around Europe in the highest levels of the knowledge society.

To achieve this the European Commission, in close coordination with the Member States, must provide:

- A coherent and managed layer of scholarly and academic research resources (including research outputs and data) by bringing together Europe's research repositories and significantly increasing the number and quality of the knowledge resources available. The possibility to establish a programme of research and co-ordination to help Member States address the issues of establishing, managing and joining up research repositories should be explored.
- A world leading European Network with a global perspective: continued funding for GÉANT and its extensions to developing continents, whose research communities are an integral part of the solutions for global research challenges.
- A trustworthy management system to provide seamless access to shared resources of all types (computers, networks, data, instruments, applications, etc).
- An adequate and coordinated high-performance computing provision ecosystem with ready access to its services.
- Generic virtual presence tools able to facilitate virtual research communities.
- Education and training programmes should be put in place to accelerate the exploitation of the e-Infrastructures by younger researchers and to improve their availability to wider user communities.

To integrate fully this e-infrastructure strategy within an overall coherent RI policy strategy at EU level a productive relation between the research communities and the various e-infrastructure developing communities should be intensified and the interaction between e-IRG and ESFRI should be further strengthened.

7. RIs of Global interest

Most scientific fields address questions on a global scale and need international collaboration in order to succeed.

An increasing number of research infrastructures are now being developed at the global level. There are different reasons why certain research infrastructures require a global approach. In some areas of research, the cost and complexity of the needed infrastructure, or the existence of technical, administrative or political obstacles, requires collaboration on a world-wide basis. In other areas, it is the global scope of the scientific challenge, *e.g.* the better understanding of health or environment problems, which requires harmonisation of methods and standards. The size of the problem (or of the solution) may also require international collaboration to consider adequately the geographical dimension of the proposed research facility. The requirement for global collaboration is therefore growing, as is the need for RIs of a global nature supporting the international collaborative activities of researchers, including standardisation and integration of data collected in different countries.

An appropriate forum is therefore needed where global projects can be discussed and carried forward at an appropriately high-level. This could be a reinforced Global Science Forum (GSF) of the OECD or a new appropriate body to be created. Within such a forum European should speak with a common voice.

Within this framework, a good balance needs to be found between the support of the global research community and the protection of Europe's interests. Therefore, a set of strategic guidelines are required to help determine where European RIs need to collaborate in a global context whether as a leading role in partnerships, subsidiary partner or by inviting participation in a mainly European RI. In addition these guidelines should cover parameters to assess the benefits to European research. Parameters to consider in preparing such guidelines would include the scale of RI, funding, access to expertise, the global nature of their research requirement (*e.g.* research on atmospheric warming and astronomical research are intrinsically global issues), benefit to higher education, and the required needs of the developing world.

'Global' cooperation could also be stimulated through the creation of specific mobility schemes to enable researchers to engage with RIs outside Europe and vice versa (for non-European researchers).

The availability of e-infrastructures (*e.g.* distributed computing and data networks) for data collection and data availability is another essential element of international and global RIs. e-Infrastructures and digital repositories, cut across all disciplines, are embedded in the fabric of all facilities and are fundamental for the preservation and free transmission of knowledge. Institutional and governmental effort is focussing on the development of databases, digital repositories and interoperability standards, but regulation of the international movement of this knowledge will be needed. Thanks to GÉANT and the Grids, global virtual communities are also phenomena which are gathering momentum, with potential impacts much broader than their initial aims.

RECOMMENDATIONS

- Identify or create an appropriate forum where global RIs can be discussed and carried forward at an appropriately high-level and where Europe should speak with a common voice.
- A set of strategic guidelines should be developed to help prioritise European involvement in global RIs.
- The European Commission should stimulate the creation of specific mobility (access) schemes to enable researchers to engage with RIs outside Europe and vice versa (for non-European researchers).

Annex 1 - Analysis of responses to the public consultation

Public consultation: "ERA Green Paper: new perspectives" Research Infrastructures

The nature of the consultation

As part of the public consultation regarding future plans to develop further the European Research Area (ERA), an online consultation was conducted by DG Research between 1st May and 1st September 2007. The questionnaire used for this purpose covered the range of issues raised in the ERA Green Paper. The analysis presented here focuses on issues relating to the development of **research infrastructures** (RIs).

A total of 685 responses to the online questionnaire were recorded, with 31 percent (211 responses) replying on behalf of an organisation and 69 percent (474 responses) in an individual capacity. Of those replying on behalf of an organisation, the majority were from higher education institutions (18 percent) and non-governmental not-for-profit organisations not representing commercial interests (20 percent). While the majority of survey respondents were resident in Europe (the largest groups being resident in France (96), Italy (93), the UK (80) and Germany (70), replies were received from outside the EU, including the USA (14), Australia (3), Canada (2) and China (1).

In addition to the online consultation, organisations and individuals were invited to submit more detailed responses to the questions raised in the ERA Green Paper. A total of 63 such 'freeform' responses which made mention of research infrastructures were reviewed in preparing this report. At relevant places these have been integrated into the analysis of responses to the online consultation. Where comments are reproduced from individual responses on either the online questionnaire or from the 'freeform' submissions, these have been anonymised.

This report is presented in six sections, covering:

1. The European Research Area – views on **the importance of RIs within the ERA** and the most appropriate level at which actions should be taken to promote and develop RIs.

2. The European Strategy Forum for Research Infrastructures (ESFRI) – views on ESFRI leadership and **the need for a common approach to the identification of RIs through ESFRI.**

3. Views on **the need for a new legal framework or guidelines** to facilitate the creation and/or operation of RIs.

4. Public research funding and RIs – views on **types of science and technology programmes which should be funded via the public purse** and methods for funding.

5. Private research investment in RIs – views on **the role of the private sector** and suggestions for greater engagement of the private sector with RI funding.

6. The global nature of RIs – views on the need for structures which will facilitate **a more global approach to the development and use of RIs.**

1. The European Research Vision

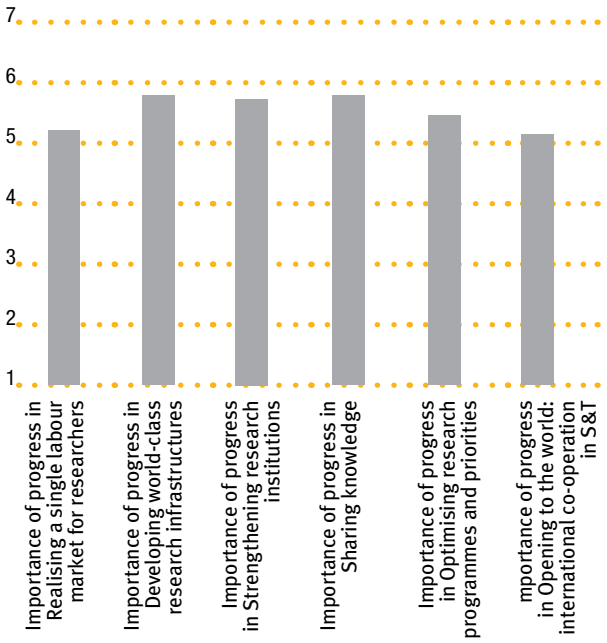
The ERA vision is presented in six areas in the ERA Green Paper. These are:

- Realising a single labour market for researchers
- Developing world class research infrastructures
- Strengthening research institutions
- Sharing knowledge
- Optimising research programmes and priorities
- International cooperation in science and technology

Respondents were asked to rank the importance of each of these areas in terms of the progress required for achieving the ERA vision. **Figure 1** shows the mean rankings attributed to each of these areas.

FIGURE 1

Mean ranking of importance in achieving progress in six areas (7 = highest rank and 1 = lowest rank)



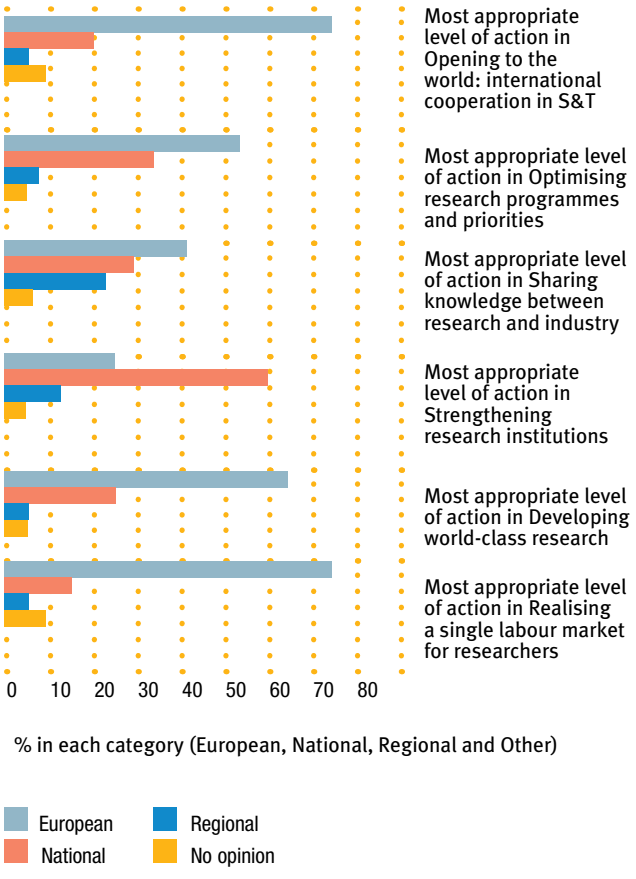
Source: Online consultation on the ERA, 2007

Progress in developing world class research infrastructures is ranked highly, on a par with the importance of progress in strengthening research institutions and sharing knowledge.

Respondents were asked to state the level (EU, national, regional) which they felt was most appropriate for requiring action to progress the ERA. **Figure 2** shows the distribution of responses, with two thirds agreeing that action on research infrastructures could most appropriately be taken at the European level.

FIGURE 2

Levels at which actions to progress the ERA are deemed most appropriate (all respondents)



Source: Online consultation on the ERA, 2007

2. The European Strategy Forum on Research Infrastructures

In 2005 the European Strategy Forum for Research Infrastructures (ESFRI) produced a roadmap for new and upgraded pan-European research infrastructures. Respondents to the consultation indicated whether or not they agreed that a common approach is required to develop the infrastructures identified by the ESFRI. They were also asked to indicate who should take the lead in such developments and how research infrastructures should be funded.

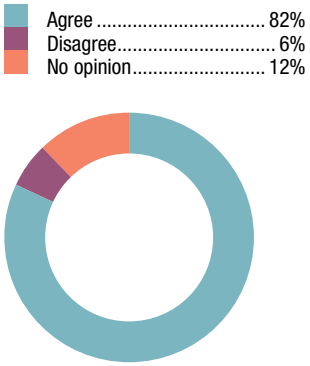
Figure 3 indicates that over four fifths of respondents agreed with the statement that a common approach for development is needed. Of those agreeing an overwhelming proportion stated that this should be done at the European level.

Separate analysis of the responses to this question from the respondents who were replying on behalf of an organisation is shown in **Table 1** below. Again, a strong measure of agreement is expressed for the view that a common approach is needed to develop the infrastructures identified by the ESFRI. A higher than average level of agreement is noted among respondents replying on behalf of: public sector research performers other than higher education; governmental bodies; higher education institutions; research funding organisations and large commercial organisations.

FIGURE 3

Leadership and the ESFRI

A common approach is needed to develop the infrastructures identified by the ESFRI



Source: Online consultation on the ERA, 2007

TABLE 1

Responses on the need for a common approach to the development of research infrastructures by type of stakeholders

Category of stakeholder	A common approach needed to develop infrastructures identified by ESFRI			Number of responding organisations in the category (=100%)
	Agree (%)	Disagree (%)	No opinion (%)	
Higher education institutions	85.7	2.9	11.4	35
Governmental bodies	100.0	0.0	0.0	8
Public sector research performers other than higher education	93.8	3.1	3.1	32
Research funding organisations	85.7	14.3	0.0	7
Non-governmental, non-profit bodies	78.3	8.7	13.0	23
Commercial organisations, 250+ employees	76.9	0.0	23.1	13
Commercial organisations, less than 250 employees	85.7	0.0	14.3	7
Associations representing commercial interests	50.0	0.0	50.0	2
Other	82.8	6.9	10.3	29
All respondents replying on behalf of an organisation	85.3	4.5	10.3	156

Source: Online consultation on the ERA, 2007

On this same issue (the need for a common approach to develop the ESFRI roadmap) the most common theme running through the majority of the freeform submissions is again one of support for the European Strategy Forum for Research Infrastructures (ESFRI) and the 2006 Roadmap. Most welcomed this initiative and thought it had done much to energise and galvanise a pan-European approach to thinking about the need for research infrastructures. Typical of such comments is the following:

> *'A step towards better planning and developing of research infrastructures at European level has indeed been achieved with the creation of the European Strategic Forum on Research Infrastructures (ESFRI) and the establishment of a coordinated European Roadmap'*
>
> **ASSOCIATION REPRESENTING COMMERCIAL INTERESTS**

Some queried the fact that, while ESFRI was run by Member States, certain Member States had done little to establish ways in which they could interact at the national level with the ESFRI and that the 'ESFRI process' was far from transparent:

> *'The ESFRI mechanism is presented as being a success of the ERA, even though there are no results at present which enable an assessment of its efficiency. Indeed, the process which led to the first roadmap was extremely complicated and little transparent.'*
>
> **PUBLIC SECTOR RESEARCH PERFORMER OTHER THAN HIGHER EDUCATION**

Respondents were asked to indicate who should take the lead in developing this common approach, selecting between the European Union, at Member State level or via some intergovernmental organisation. They also had the option of specifying some other level at which they felt it appropriate for the lead to be taken. **Table 2** shows the distribution of responses to this question for all respondents who replied to this question.

TABLE 2

Responses to statements about the level at which leadership should be taken for a common approach to the development of research infrastructures

	Agree (%)	Disagree (%)	No opinion (%)	N (= 100%)
Leadership should be at European Union level	81	9	10	494
Leadership should be at Member State level	49	37	14	419
Leadership should be at Intergovernmental organisation level	49	32	19	399
Leadership should be at other level	37	16	47	129

Source: Online consultation on the ERA, 2007

A clear preference is stated for leadership to be taken at the level of the European Union, with more than four out of five respondents agreeing with this statement.

A total of 60 respondents (43 of whom were among the 37 per cent <48 respondents> agreeing that leadership should be at some other level shown in Table 2) gave a written-in response to this question. These responses ranged from 'a combination of local/national', 'regional', 'research foundations' to 'discipline specific bodies', with the most common written in response being 'EU/ Member States' (11 cases).

Focussing on those respondents who were replying on behalf of an organisation, **Table 3** shows that agreement for leadership at the EU level is highest among higher education institutions, public sector research performers other than higher education institutions, research funding organisations and larger commercial organisations.

TABLE 3

Responses by type of stakeholders to statements about the level at which leadership should be taken for a common approach to the development of research infrastructures.

Category of stakeholder	Leadership should be at European Union level	Leadership should be at Member State level	Leadership should be at Inter-governmental organisation level	Leadership should be at other level	Number of responding organisations in the category
Higher education institutions	28	18	15	3	39
Governmental bodies	6	1	1	2	13
Public sector research performers other than higher education	25	16	10	3	34
Research funding organisations	6	3	4	3	8
Non-governmental, non-profit bodies	19	10	6	2	42
Commercial organisations, 250+ employees	10	4	5	2	14
Commercial organisations, <250 employees	6	5	3	0	11
Associations representing commercial interests	1	1	1	0	9
Other	20	9	8	4	41
All respondents replying to the question on behalf of an organisation	147	122	114	34	211

Note: (1) Categories are not mutually exclusive

Source: Online consultation on the ERA, 2007

A number of the freeform responses raised issues about the role of the ESFRI, particularly its status as a 'Member State' organisation (organised by Member States not the European Commission and reflecting the views of Member States). Most agreed that this was the most appropriate type of structure for the strategic development of RIs, because it was the Member States that would be called upon to provide the majority of funding. Others pointed to the existence of other European bodies which produced their own infrastructure roadmaps (*e.g.* CERN), arguing that a means should be found to ensure no duplication of effort arises between the activities of these bodies and the ESFRI.

Another common theme evident within the freeform submissions concerned the situation of small and medium scale RIs. Some felt that ESFRI had focussed unduly on the large scale facilities and had paid insufficient attention to the need to develop smaller RIs in those fields of scientific exploration where small-scale RIs were typical. A number of submissions raised this issue about the size of RIs in relation to their funding – with funding for smaller research infrastructures being more problematic and the fragmentation/inefficiency of having a disparate collection of small scale RIs across the ERA. The following quotes exemplify such views:

> *'The Green Paper does not pay sufficient attention to the importance of having both a procedure of the ESFRI type and of preserving (and developing) under the Research Framework Programmes the funding necessary to enable the networking or construction of smaller infrastructures or databases.'*
>
> **PUBLIC SECTOR RESEARCH PERFORMER OTHER THAN HIGHER EDUCATION**

'Whilst a variety of small or medium size infrastructures are properly the responsibility of individual EC Member States, the importance of infrastructures for frontier research and their enabling effects on the regional scientific community, institutions and industry, strongly argue in favour of a well distributed set of major infrastructures in Europe.'

EUROPEAN INSTITUTION

Related to issues about the size of RIs, there are suggestions in some of the submissions that a distinction could be made between 'hard' RIs and 'soft' RIs (*i.e.* between physical equipment based RIs and those relying more on electronic/digital databases), with different selection procedures involved. A significant number of submissions made reference to the fact that RIs will become increasingly dependent upon electronic communications, and that the development and implementation Grid-based technologies should be seen as integral to the construction of new RIs and the updating of existing ones.

In terms of the mechanisms used by the ESFRI to decide on pan-European research infrastructures, the principal of scientific excellence is strongly supported. Some submissions supported the idea that EU Structural Funds could be used to develop RIs, while others warned against any focus on methods of funding which may divert attention from the need for development to be driven by the excellence of the scientific ideas and the scientific needs. Typical of such comments is the following:

The key factor in deciding which infrastructures should be built and by whom should continue to be scientific quality; while there may be cases in which it would be appropriate to use funding form such sources as the Structural Funds to assist in the construction of a facility, the availability of such funding should not drive the decision making process.

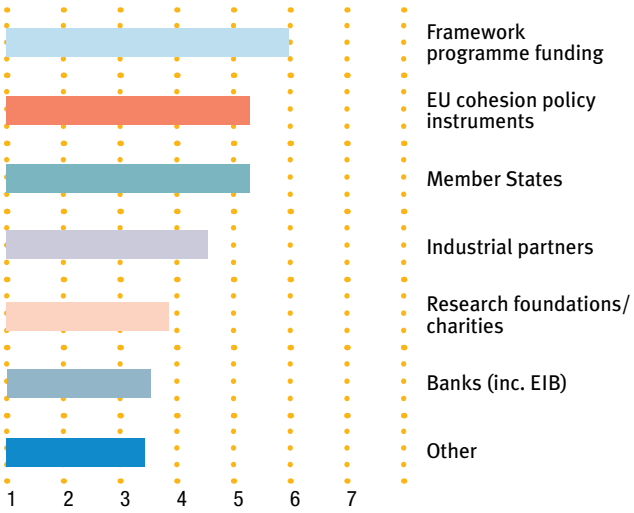
GOVERNMENTAL BODY

In response to a question about the potential sources for the main part of funding for research infrastructures identified in the ESFRI roadmap, Framework Programme funding was most highly ranked as the source which should provide the greatest amount of funding (see **Figure 4**).

FIGURE 4

Respondent rankings of funding sources for RIs identified by the ESFRI

Mean rankings by respondents, with 7 = greatest amount of funding and 1 = lowest



Source: Online consultation on the ERA, 2007

In the freeform responses, many raised the issue of sustainability of RIs and the funding problem. A number of suggestions were made, ranging from an increase in the EU contribution to 20 per cent of the total cost (not simply the preparatory costs, but all capital costs), the use of Structural Funds, to the development of a centralised mechanism to allocate funds from Member States. Examples of such responses are:

'The EU should provide a more important financial contribution than at present, otherwise only the big countries will have these infrastructures installed on their territory. There should be a balance between big and small countries, which could be achieved through a more important involvement of the EU and the strengthening of cooperation mechanisms.'

NON-GOVERMENTAL, NON-PROFIT BODY

'L'ESFRI, crée en Avril 2002, a défini une feuille de route pour des infrastructures de recherche paneuropéennes modernisées et renforcées. Quatorze milliards d'euros sur 10 ans seraient nécessaires pour concrétiser ce projet. Des sources de financement supplémentaires au financement européen seront donc nécessaires pour y parvenir.'

'OTHER' TYPE OF ORGANISATIONS

'The use of these (structural) funds is a national responsibility, but not all governments attach appropriate importance to research infrastructures (and to R&D in general).'

EUROPEAN INSTITUTION

3. Action at the European level to facilitate the creation and operation of RIs

In response to the question 'What action is required at the European level to facilitate the creation and operation of these new infrastructures identified by ESFRI?', there was a clear measure of agreement that a new European legal framework should be developed to support the creation and operation of new forms of RIs, and that guidelines should also be established to facilitate such activity. **Figure 5** shows that well over half of respondents disagreed with the statement that the current situation is sufficient for the creation and operation of new forms of RIs.

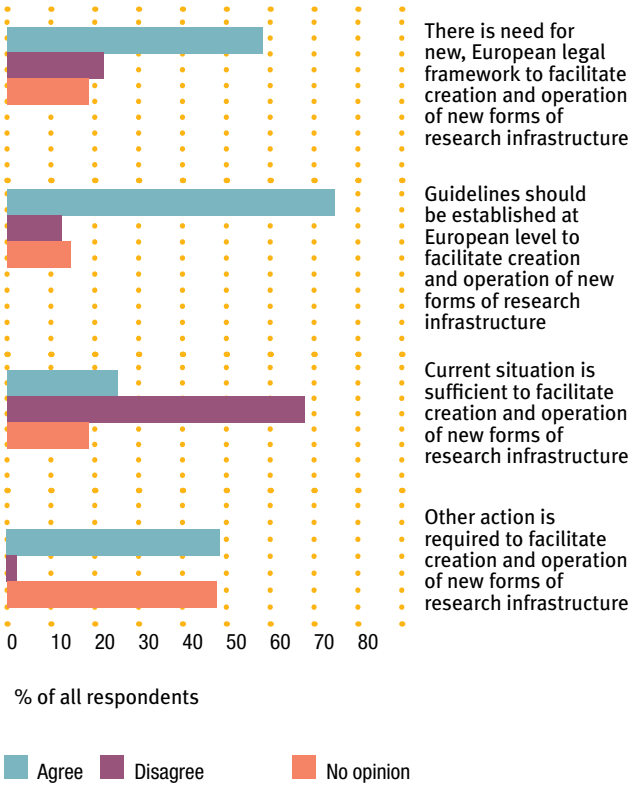
Of those stating that they felt that some other action was required to facilitate the creation and operation of new forms of research infrastructure (43 respondents), typical statements included:

- Reduce bureaucracy
- Implement networking to exchange information
- Increase the funding available for RIs
- Establish a central agency for RI funding

Examination of the responses to these questions for respondents who replied on behalf of an organisation (Table 4) shows a preference for guidelines over a new legal framework. Multiple responses were permitted to these questions (in other words, respondents could state that they were in agreement with the need for a new legal framework and could also indicate that they agreed that guidelines should be drawn up). The extent of this can be seen from the fact that there are 53 responses from Higher Education Institutions, but only 33 HEIs responding to these questions. Nonetheless, a clear preference for guidelines over a legal framework is apparent from most types of organisations, with the exception of governmental and non-governmental, non-profit bodies where views on the need for a new legal framework and for guidelines are fairly evenly split.

FIGURE 5

Responses on the need for actions required at European level for new RIs identified by the ESFRI



Source: Online consultation on the ERA, 2007

TABLE 4

Responses to statements about the actions required at the European level to facilitate the creation and operation of new research infrastructures by type of stakeholders.

Category of stakeholder	Need for new European legal framework	Guidelines should be established	Current situation is sufficient	Total number responding to the questions[1]
Higher education institutions	13	29	11	33
Governmental bodies	5	7	3	8
Public sector research performers other than higher education	14	28	3	31
Research funding organisations	3	6	1	7
Non-governmental, non-profit bodies	17	18	2	24
Commercial organisations, 250+ employees	4	7	4	12
Commercial organisations, <250 employees	4	5	1	6
Associations representing commercial interests	0	1	2	3
Other	19	23	4	29
All respondents replying on behalf of an organisation (= 100%)	79	124	31	155

Note: (1) Categories are not mutually exclusive

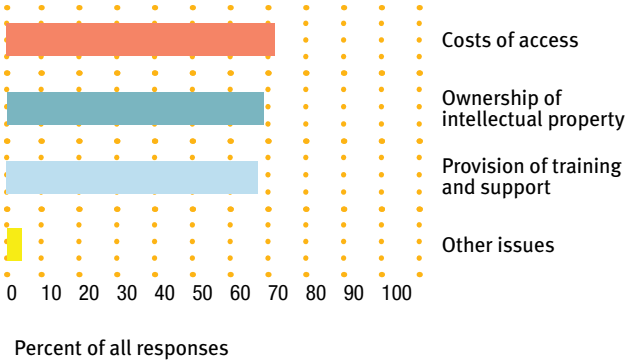
Source: Online consultation on the ERA, 2007

Figure 6 shows the distribution of responses to questions about the issues that a legal framework or guidelines should address, and views on how these should operate, to facilitate the creation and operation of infrastructures identified by the ESFRI.

Figure 6 groups responses into three broad categories; 'costs of access', 'ownership of intellectual property' and 'provision of training and support'. While all three broad groups are given strong support, it is 'costs of access' that predominates as the issue that a new legal framework or guidelines should address.

FIGURE 6

Issues that a legal framework or guidelines should address, and how, to facilitate the creation and operation of RIs



Source: Online consultation on the ERA, 2007

The small proportion of respondents who stated that some other issues should be addressed via a legal framework or guidelines raised questions about the interpretation of these questions, particularly the status of Intellectual Property Rights and ownership of IPR by a publicly funded body. Almost a quarter of the 49 respondents who gave 'Other issues' as their response to these questions stated that they felt that access should be free.

In discussing the need for a new legal framework, some of the respondents who submitted 'freeform' submissions were generally supportive of the need for a new legal framework governing the foundation and operation of RIs.

> *'An efficient and dedicated legal structure at European level should also be developed, in order to facilitate the management and operation of pan-European interest research infrastructures, including electronic infrastructures. This legal framework should address issues like the financing and coordination of research infrastructures, access rules, how to handle bioethics issues and regulatory aspects of innovation such as Intellectual Property Rights (IPR). '*
>
> **ASSOCIATION REPRESENTING COMMERCIAL INTERESTS**

Other freeform submissions stressed the need for flexibility in the development of such a framework, given the diverse nature of RIs. Some references are also made to the various instruments which could be used for this purpose. Few made any specific suggestions about how these legal instruments could be shaped for this task.

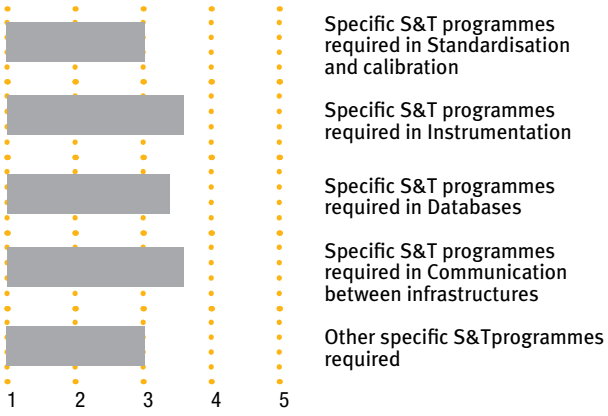
4. Public research funding and the long term improvement of RIs

Respondents were asked for their views on the ways in which public research funding could contribute to the long term continuous improvement of research infrastructures. They were asked to rank the importance of specific S&T programmes (at both European and Member State level) that might be required to support the improvement of research infrastructures

Figure 7 shows the mean rankings for specific S&T programmes (at both EU and Member State level) required to support the improvement of research infrastructures. This indicates that programmes to develop instrumentation, databases and communication between infrastructures were regarded as of almost equal importance.

FIGURE 7

Mean rankings for specific S&T programmes to support improvement of RIs

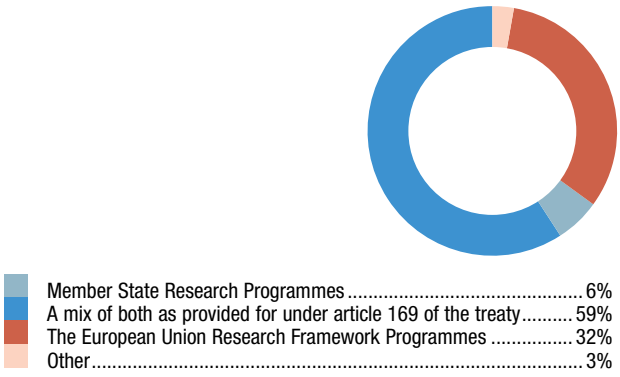


Source: Online consultation on the ERA, 2007

Of the four choices presented to respondents, the S&T programmes which received the highest rankings were those to develop instrumentation, database access and for communication between infrastructures.

FIGURE 8

Mechanisms for the support of specific S&T programmes for the long term improvement of RIs



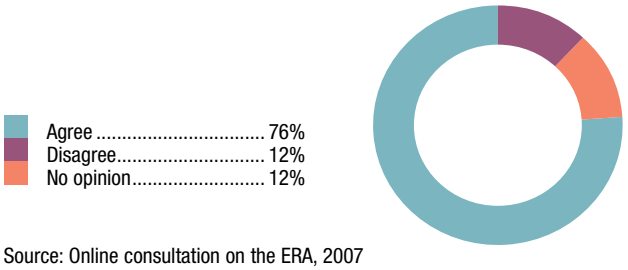
There is a clear preference stated by survey respondents for the use of Article 169 of the treaty as the preferred approach for the funding of S&T programmes to develop RIs. Almost 60 per cent selected this mechanism in preference to the Framework Programmes or Member State research programmes.

5. Private research investment in RIs

Respondents were asked for their views on private research investment in RIs. The first question posed was whether or not they felt that there was a lack of private sector investment in RIs. **Figure 9** reveals that a strong measure of agreement with this statement was recorded.

FIGURE 9

Responses to the statement on whether or not there is a lack of private sector investment in RIs

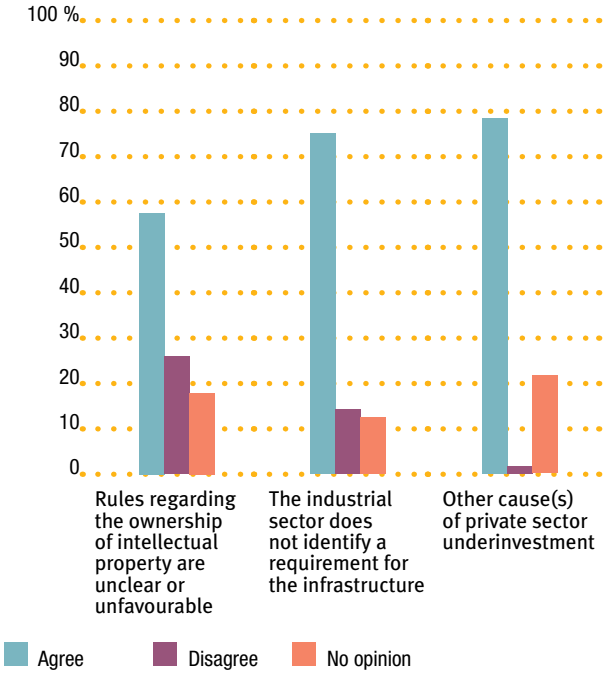


Source: Online consultation on the ERA, 2007

Those in agreement were asked to express their agreement/disagreement with statements relating to the causes of such underinvestment. The responses are illustrated in **Figure 10**.

FIGURE 10

Responses to the statement on the causes of private sector underinvestment in RIs



Source: Online consultation on the ERA, 2007

Nearly three quarters of respondents replying to this question stated their agreement with the view that the private sector does not identify a requirement for research infrastructures. A considerable number of respondents (N=73) wrote in their view as to why there was underinvestment by the private sector. Many of these responses stressed the lack of any framework for public/private sector partnership. Some questioned the view that the private sector should identify a need for RIs, given that these were essentially 'public goods'.

'The private sector will only invest in new infrastructure when it sees a likely return and where the risk of investment (the risk of failure) can be balanced appropriately with the potential gains from success. If business in the EU is 'under investing', then the reasons for this need to be explored in more detail. Business operates on the global scale and the EU must make itself attractive to one-off research infrastructure investments that firms could place almost anywhere in the world. EU-level incentives for private research and innovation infrastructure investment should be considered where there is high potential for spill-over effects from this investment to the EU economy.'

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6. Developing RIs that serve a global function

In the final part of the 'Research Infrastructures' section of the online consultation, respondents were asked 'How can infrastructures that serve a global function best be developed and how should Europe be involved?' **Table 5** shows that almost two thirds of respondents replying to this question agreed with the statement that there should be an international forum to coordinate the effort of creating research infrastructures addressing global needs. Of those expressing this view, nearly three quarters were agreed that European views in this forum should be represented through the OECD Global Science Forum. However, the greatest measure of support was for a mixed EU/Member State representation from the ESFRI.

TABLE 5

Responses to the statement on the development of RIs that serve a global function and European involvement

	Agree (%)	Disagree (%)	No Opinion (%)	Total
An international forum is needed to coordinate the effort of creating research infrastructures addressing global needs	65	19	16	513
Of those agreeing: European views in this forum should be represented at the level of:				
···: Member States, through:				
The OECD Global Science Forum	74	18	9	258
The G8	29	57	14	213
···: European Commission (representing EU Member States)	72	21	7	230
···: Mixed EU/Member State representation from ESFRI	87	8	5	271

Source: Online consultation on the ERA, 2007

A number of the freeform responses addressed this issue. Compared with the online responses there was more' equivocation over this suggestion. Most of the responses that addressed the issue were supportive, stressing the need for Europe to 'speak with one voice'. Others pointed to existing fora, particularly the OECD Global Science Forum as the appropriate setting for a European discussion about the development of RIs, though some pointed out that this excluded countries such as China and India.

'(Our government) welcome(s) the establishment of a broader platform for large-scale research facilities alongside the ESFRI and the OECD Global Science Forum, including with non-OECD countries such as China and India.'

GOVERNMENTAL BODY

Some argued against the idea of a global forum, on the basis of it being overly bureaucratic and duplicating such bodies that already exist for this purpose:

'Setting up such a forum would duplicate the work already being done by the OECD's Global Science Forum which offers the most promising basis for international coordination of research infrastructure needs and can if necessary create dedicated sub-groups to deal with specific issues or the needs of individual sectors.'

GOVERNMENTAL BODY

Others supported the idea but warned about the difficulties it could generate if internal disputes surfaced within such a forum:

'While it would be an ideal to strive for, the task of establishing a global forum on research infrastructures should not be underestimated. Even within one country there are often fragmented policies and funding streams that can lead to duplicate, redundant or incomplete infrastructure projects. Seeking consensus across the EU and internationally about research priorities will be a major challenge.'

ASSOCIATION REPRESENTING COMMERCIAL INTERESTS

Annex 2 - Members of the Expert Group

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Mario Campolargo and **Wim Jansen**: *e-Infrastructures*

Annex 3 - Terms of references of the Expert Group

Overall objective

These are the Terms of Reference for an Expert Group set up by DG Research of the European Commission in the context of the follow-up of the Green Paper on 'The European Research Area: New Perspectives' adopted by the Commission on 4 April 2007.

The overall objective of the Expert Group will be to identify and define possible measures and actions concerning the following dimension for the Development of the European research Area (ERA), as spelled out in the Green paper: 'World Class Research Infrastructures', taking account of existing expertise and of the major elements stemming from the debate launched by the Green Paper.

Via a combination of collective and individual work punctuated by several meetings, the group will prepare all necessary material for discussing the key issues and for drawing its conclusions. In particular, it will include in its work an analysis of the relevant responses to the on-line consultation as well as the relevant parts of other submissions received from Member States and stakeholders. At the mid-point of its work, the group will prepare an interim policy option paper in a format which will be the basis of a presentation and material for discussion at a Portuguese Presidency conference to be held from 8 to 10 October 2007. In its final report, it will formulate and suggest concrete options for policy makers, and will substantiate these policy options with relevant background analysis and findings of the group's work.

Number, identification and selection of experts

The expert group consists of up to 10 members (including one chairperson and one Rapporteur), to provide a variety of views and approaches while keeping the size of the group manageable. During the work of the expert group additional experts can be added to the group either to replace members who withdraw or to address new specific tasks.

Experts are identified from a list, continually updated by an open-ended call for applications (*OJ C 305 of 14.12.2006*), for the constitution of expert groups assisting the Commission's services for tasks in connection with the seventh RTD framework programme: (https://cordis.europa.eu/emmfp7/). The members of the group are selected on the basis of their competence, and the requirements of each topic, with an emphasis on different institutional and national/regional viewpoints, and a good mixture of academic, industrial and policymaking backgrounds and professional experiences.

Overall mandate

The expert group will:

TASK 1: provide an overview of recent initiatives, current challenges and existing trends regarding research infrastructures;

TASK 2: analyse the issues identified in the Green paper regarding research infrastructures and propose a number of policy options, with their impact analysis, to address these issues.

TASK 3: draw upon relevant previous studies and undertake, in particular, the analysis of the results of the public consultation questionnaire launched in the context of the Green paper.

Issues to be addressed

The expert group will address, in particular, the following specific issues:

1. How could the EU, on the basis of identification of needs by ESFRI, effectively decide on pan-European research infrastructures and their funding – the latter involving the Community (including possible synergies with EU cohesion policy instruments), Member States, industry, the EIB and other financial institutions?

2. Should a European legal framework be developed to facilitate, in particular, the emergence and operation of new forms of research infrastructures of pan-European interest, including electronic infrastructures? What other policy and legal changes are necessary to encourage the private sector to invest more in research infrastructure?

3. Is there a need to define common and transparent principles for the management of, and access to, infrastructures of European interest?

4. How can the longer-term continuous improvement of research infrastructures be ensured, e.g. through S&T programmes associated with them and European electronic infrastructures?

5. Should a global forum on research infrastructures be created, involving third countries and international organisations, where Europeans could speak with one voice (as they did in the ITER project on nuclear fusion research)?

In its work, the Group will need to take fully into account the international dimension, in particular the consequences of the globalisation of R&D. The expert group may also address, as relevant, any other issues that it considers important for Research Infrastructures in Europe.

Selected reference documents

- Main ERA Communications and reports http://ec.europa.eu/research/era/index_en.html
- FP7 documents on Research Infrastructures (7th EC Framework Programme, 'Capacities' specific programme, Work Programme 2007 for research infrastructures http://cordis.europa.eu/fp7/capacities/research-infrastructures_en.html
- European Roadmap for Research Infrastructures http://cordis.europa.eu/esfri/roadmap.htm
- 2007 Hamburg Research Infrastructures Conference documents www.ecri2007.de
- 2005 Nottingham Research Infrastructures Conference documents http://www.nottingham.ac.uk/ecriuk/
- 2002 Trieste Research Infrastructures Conference documents
- 2000 Strasbourg Research Infrastructures Conference documents

More information on ERA…

The ERA Green Paper consultation has generated a substantial response mobilising different groups of stakeholders - individual citizens, universities, research performing and funding organisations, NGOs, industries and businesses, associations representing commercial interests and trade unions. The consultation closed definitively on 31 December 2007. The following extracts represent some of the major challenges:

ERA VISION: Stakeholders express strong support for the ERA vision and for action on all ERA dimensions highlighted in the Green Paper. Most groups of stakeholders place 'knowledge sharing' and the 'infrastructures' dimensions on top in terms of importance. Moreover, the 'researchers', 'international cooperation' and 'infrastructures' dimensions are deemed to be the most important in terms of need for action at EU level.

STRENGTHENING RESEARCH INSTITUTIONS: A majority of respondents agree that the excellence and competitiveness of EU research institutions can be reinforced through better links between institutions, enhanced inter and trans-disciplinarity to better address societal needs, improved coordination and effectiveness of financing instruments. Over 60% of the on-line respondents agree that sustainable partnerships between research institutions and industry as well as the sharing of research and knowledge management activities between research institutions - both at European level - are the best avenues to creating European world-class virtual (and not only) centres of excellence.

SHARING KNOWLEDGE: Developing communities of knowledge is deemed a sine qua non for a well grounded European Research Area. Over 80% of respondents call for open access to scientific data and publications. Over 70% of respondents expressed the desire to see EU-level databases and initiatives developed.

OPTIMISING RESEARCH PROGRAMMES AND PRIORITIES: The majority of respondents agree (77%) that addressing complex resource-intensive scientific challenges requires cross-border cooperation between public authorities. The identification of future challenges and opportunities (through foresight) and the evaluation of publicly funded research proposals by peer review are suggested by more than 80% of the respondents as the most important areas for closer EU-wide collaboration. Joint foresight can be crucial for common prioritisation. The suggested shared principles include striking the right balance between collaboration and competition and between bottom-up research initiatives and top-down strategic guidance. Concentration of efforts in European level programmes is recommended (74% of the responses), as well as joint public programmes with variable geometry (72%) and ERA-net type coordination (71%).

OPENING TO THE WORLD: INTERNATIONAL COOPERATION: More than four fifths of respondents support the idea of the EC and Member States working together to define common European priorities, to enhance coherence of their programmes and to promote exchanges and synergies. A large majority of respondents favour Europe taking a more active approach to define the global S&T agenda in multilateral fora, with 75% expressing the wish that Europe should 'speak with one voice'.

More information can be found under the following web site: http://ec.europa.eu/research/era/

European Commission

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