ESFRI European Strategy Forum on Research Infrastructures

"Role of Research Infrastructures for a Competitive Knowledge Economy"

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Preface

The existence of and access to leading European large scale research facilities is and will remain a key determinant of Europe's competitiveness in both basic and applied research. Developing World Class Research Infrastructures is now one of the five pillars of an ambitious European Research Area (ERA)-Vision for the future.

Over recent years, the European Commission has been collaborating closely with the European Strategy Forum for Research Infrastructures (ESFRI) to optimise synergy in the creation of new European large facilities. Implementation of the first ever European Roadmap, the ESFRI Roadmap for Research Infrastructures, is now high in the national and EU research policy agendas.

Large scale Research Infrastructures have been a European invention since the time when scholars could access the libraries, collections and know-how preserved and enriched in the network of medieval abbeys. These large facilities act as centres of competence, which are open and attractive to the best world-level researchers.

Research Infrastructures can contribute in a unique way to both social and economic development; but never in a vacuum. Therefore, close cooperation and teamwork between the different sets of actors, such as, universities (fundamental research), research institutes (both basic and applied research) and industry (industrial research, development and innovation) has to be built up and combined with carefully thought out programmes of Public Engagement with Science and Technology.

Increased attention to the implementation of the 44 ESFRI Roadmap projects has led to increased attention to studies measuring the scientific, social and economic benefits deriving from these infrastructures. The aim of the seminar was threefold: (*1*) to take stock of actual & recent innovations stemming from European Research Infrastructures; (*2*) to reflect on the development of best practices to improve the innovation chain where Research Infrastructures are involved; (*3*) to identify gaps, needs and possible specifications for possible future impact and foresight studies.

This report is intended to support further reflection on impact assessment work of the different stakeholders, allowing hopefully for better management of the facilities as well as more efficient preparation of future actions.

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ESFRI Chair

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1. Executive summary

1. Introduction

Europe has taken a major step forward in the development of a more coordinated approach to policy making on new large scientific facilities. The establishment of the ESFRI in 2002 has facilitated the development of a strategic roadmap in the field of research infrastructures. With a view to increase support in the context of ERA and joint action by the European governments, ESFRI has released the first ever European Roadmap for Research Infrastructures in 2006.

The latest and updated ESFRI 2008 Roadmap includes 44 projects addressing some of the most important areas of research of European and global interest. At the same time, the European Commission has published the Green Paper on the future of ERA and has launched a widespread debate on the development of these new major facilities that none or few Member States might individually be able to afford.

Increased attention to the planning of new large scale facilities has led to requests for studies on the impact of research infrastructures. As well as bringing scientific benefits, funding bodies are increasingly interested to measure and maximise their economic and social benefits from their investment on large scale facilities.

2. Objectives of the Meeting

Held on the 29th and 30 of June 2009, this workshop brought together approximately 60 experts, drawn from a variety of specialities that are related to the role of Research Infrastructures for a Competitive Knowledge Economy.

The objectives of the seminar were threefold: (1) to take stock of actual & recent innovations stemming from European Research Infrastructures; (2) to reflect on the development of best practices to improve the innovation chain where Research Infrastructures are involved; (3) to identify gaps, needs and possible specifications for possible future impact and foresight studies (direct & indirect effects / social, economic and environmental issues at local, regional, national, European and global levels).

3. Conclusions

1) A number of participants expressed the view that with the ESFRI List, the FP7, the Structural Funds, and current national initiatives and resources, the EU has the basic instruments with which to maintain, develop and build successful new Research infrastructures.

2) No matter what framework is used to evaluate the relevance of Research infrastructures in the struggle for competitiveness, Science must continue to be the driving force behind, and the principal justification for research infrastructure. Their role in specialised programmes of Higher Education is also unique and efforts should be directed at developing this and sharing "good practice".

3) While their scientific impact can be measured using widely recognised metrics, a range of economic and social benefits often arises from the construction and operation of a large facility. However, these social and economic benefits are difficult to quantify and opportunities arising from knowledge transfer and spinout companies are inherently unforeseeable.

4) Although there is some material from impact studies available, this is mainly of an "anecdotal nature' and time might have come to provide more sophisticated evidence. This might require the definition of new methodologies to measure performance, impact and output of the new major facilities listed in the ESFRI Roadmap.

5) It was felt that a pre-requisite would be the further development, driven by the EU Research Infrastructure action, of studies on the social and economic impact of the new large facilities. There is a need for a few well-elaborated methods and indicators, which may differ depending on the science goals of each RI sector. The next call for proposals under FP7 (closing 3rd December 2009) is an opportunity not to be missed.

6) Impact assessment of the large scale facilities must be placed in the context of the ERA objectives, which provide the reference framework for research and innovation policies in the EU. It was suggested that Narratives and Foresight could each make a valuable contribution to this goal. The assessment of Research infrastructures should include a structured debate among stakeholders of their contribution to these objectives, based on high quality analysis and descriptions.

7) While it will not be possible to find "one-size-fits-all" evaluation method for research infrastructures' evaluation, the presentations and discussions showed how important it will be to develop a systematic approach to the evaluation of research infrastructures' impact.

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Acknowledgement

The Rapporteurs would like to express their sincere appreciation to all of the Speakers and Participants who responded to his invitation to correct/comment on the early drafts of this Report. Their contributions have greatly enriched what would otherwise have been a rather dry summary of an intense and stimulating Workshop. Special thanks are also due to the EC Staff, in particular Mrs Christelle Alauzet, who organised the event.

2. Agenda of the seminar

Day one

14.00 – 14.20	**Opening address:** *RJ. Smits (EC) + C. Rizzuto (ESFRI)*
14.20 – 14.50	**Building World-class RIs as a source of new companies and jobs:** *Keynote speech by Prof. Andres Rodriguez-Pose (LSE)*
14.50 – 15.15	**Lessons learnt from the Evaluation of the Pertinence and Impact of the Community RI actions:** *H. Péro (EC)*
15.15 – 15.30	**Structuring Effects / Added Value of the RI actions at European level:** *DG Regio representative (P. Godin)*
15.30 – 17.00	**ESFRI Research Infrastructure Innovation Cases on bio-economy** *(V.Pike, Synthesis),* **health** *(K. Zatloukal, BBMRI),* **energy** *(A. Bredesen, ECCSEL),* **instruments** *(R. Ursic, Instrumentation Tech.)*
17:00 – 17:30	**Study of the Economic Impact over the past 25 years of the Synchrotron at STFC's Daresbury Laboratory** *C. Dougan, STFC's Knowledge Exchange manager*
17:30 – 17:55	**First conclusions:** *Debate moderated by C. Warden (IAC, RIFI)*

Day Two : Session Best Practices

09.00 – 09.45	**European RIs; impact on industry and society** *P. Bylander, K. Henjes (ERIDWatch), V.Gracz (Brainlogistics)*
09:45– 10.30	**Stimulating Public – Private Investment in and use of RIs** *D. Clark (EBI), H. Olbers (EIB)*
10.45 – 12.00	**Ensuring long-term Sustainability of Research infrastructure in the Knowledge-Based Economy** *C.Nielsen (Aaalborg), S.Gales (Ganil_Spiral2), U. Krell (DESY),*
12.00 - 12.45	**Which analysis to be performed to improve knowledge on impacts at local, regional, national, EU & global levels?** *Rémi Barré (CNAM) and L. Bach (BETA)*
14.00 – 15.00	**Developing Models and Methodologies** *P. Elias (Univ. Warwick), P. Valette (EC), A. Curaj (RIFI).*
15.00 – 16.00	**Roundtable discussion:** *moderated by C. Rizzuto & H. Péro*
16.00	**Conclusions for next actions – closing**

3. Role of Research Infrastructures for a Competitive Knowledge Economy

Introductory Session

Director Robert-Jan Smits opened the Workshop by mentioning the increased recognition Research Infrastructures are getting at political level. At recent meetings of the Competitiveness Council, Europe's Research Ministers have put the issue of Research Infrastructures on their agenda, thereby acknowledging the important contribution these large scale facilities make to: the generation of new knowledge, the training of the next generation of scientists, technology transfer and the generation of economic activity. He also mentioned that this increased recognition at political level of the role Research Infrastructures is largely due to the excellent work ESFRI has been doing with the preparation of the first European Roadmap for large scale facilities. Many Member States have increased their spending on research infrastructures and linked their national policies and strategies to the ones developed by ESFRI and the European Commission.

Director Smits pointed out that this increased attention to large scale facilities also has led to requests for studies on the impact of research infrastructures. However, although there is quite a lot of material available, this is mainly of an 'anecdotal nature' and that the time has now come to provide more sophisticated evidence. This might require the definition of new methodologies and indicators to measure performance, impact and output. He said that this workshop should discuss these matters and come up with concrete suggestions for the next steps.

The ESFRI Chair, Prof Carlo Rizzuto, noted the need to marshal sufficient evidence for an adequate discussion base with the economists in Government Finance Ministries; who feel that the academic literature does not yet support the claim that Research infrastructures make a significant and quantifiable contribution to the business economy so as to justify major public investments in their creation and operation. Indeed most of the evidence in their favour is anecdotal and is linked to only a few Case Studies. Moreover, as major Research infrastructures are intrinsically long-term projects, longer than any Research project, they could serve as test beds in the study of the role of different economic, social and scientific influences on a given context or industrial sector.

Prof Rizzuto highlighted one of the challenges of the workshop as being the opportunity to examine the question, "Are the parameters in current use the right ones with which to evaluate the real economic benefits resulting from Research infrastructures?" He noted that it is easier to map the impact of public procurement during the construction, or major up-grading, of Research infrastructures, than those related to operational expenditure, far less the indirect benefits on Society and the Economy. However, he expressed the conviction that in the long run the latter are of much greater significance in the Economy. The issue is; "How do we know?"

Prof Rizzuto concluded by reflecting on the benefits accrued by both research infrastructures and their national user communities from Open Access. The use of a facility by international researchers on a peer-reviewed basis, according to excellence, impels the facility's management to continuously evaluate and improve the standard of the equipment and the quality of the service. It also incentivizes the "local" user community to improve the quality of their access research proposals - competing with the best proposers at international level - and this "benchmarking" in turn induces two important developments: a much wider improvement in the quality of research funded by their institutions and a greater effort to exploit and publish the outcomes of their use.

The decision process to choose the location most likely to achieve major socio-economic impacts

Professor Rodriguez-Pose presented the arguments in favour of placing major new Research infrastructures in those areas where existing clusters or special economic environments will facilitate both the ready supply of skills and services as well as an effective absorption of the high quality people and technological advances related to its construction and exploitation. He pointed out the challenges of holistic long-term development of a region, including those of its Higher Education (HE) sector, in order to reach the critical mass needed to achieve innovation impact. Knowledge spillovers need the right "catchment" areas to be effective and measureable.

He also introduced the comparative view in the sense that, for success in a knowledge economy, it is not only important what is done in one location/country, but also elsewhere and referred to the use of "narratives" as a valuable communication tool.

Among the conclusions presented by Prof Rodriguez-Pose were that although there can be no substitute for investment in R+D, the benefits are highly mediated by social factors, or "filters". He highlighted the important role of Education, and in particular HE, in fields that are relevant to the activity of the RI, or that can make use of similar technological advances and services. This requires targeted investments in skills, education and on-the-job training.

The management of opportunities to achieve major socio-economic impacts

The Research Infrastructures Head of Unit, Hervé Pero, noted that not all countries derive the same economic benefits on their contributions to infrastructure projects, considering for example the CERN national returns. This invites an evaluation of how to develop the complementary capacities within a country, or region that will facilitate such returns. He expressed his agreement with several previous comments in the sense that, among the Key Factors are the linkages and synergies between Research infrastructures, Universities, Industry and friendly socio-political policies. Therefore a systemic approach, calling on multi-disciplinary skills, is needed to effectively evaluate and manage the impacts of Research infrastructures. He also noted that the RI community faces the challenge of improving data collection and to develop new ways of exploiting the accumulated knowledge in the scientific databases.

In reply to the arguments in favour of continuing to concentrate Research infrastructures in those locations likely to maximise the returns, the representative of DG REGIO, Pierre Godin, highlighted that research and innovation are central to European growth and competitiveness. Therefore we cannot afford to limit R&D investment to only a few leading regions.
We need to achieve a good balance between fostering existing centres of excellence and enabling new ones to emerge. If we do not do this, we will reinforce disparities.
He referred to the large amounts of resources that have been earmarked for use in the development of projects, such as Research infrastructures, that have the potential to raise the socio-economic conditions in those areas that have been targeted for Cohesion Funds. The strategy is not to spread the money and to build the same major infrastructures in all regions. It is to distribute infrastructures having an impact on the regional development and offering access and links to other interested regions. Developing synergies between the different policies funding research and innovation is also essential and this needs to be done in cooperation with the relevant national and regional authorities and advisory bodies.

4. Different approaches to impact analysis

It will not be possible to find a "one-size-fits-all" evaluation method. Although Research infrastructures' evaluation raises a lot of challenges it also opens up many opportunities to develop and use a variety of evaluation approaches, taking advantage of the specific features of each approach.

Different projects were presented with their "(to-be) success stories". Likewise different approaches have been used, some "narrative" (see below), some based on gathering of data, some more theoretical and based on foresight analysis. Although quite promising the BETA (Bureau of Theoretical and Applied Economics, French initials) approach, looking at indirect impacts and to be applied for the BBMRI project, is only one piece of the puzzle.

The discussions showed how important it will be to adopt a coherent approach to the definition and evaluation of impacts. This will require setting up a relevant evaluation framework (logic model, typology of effects, patterns of creation and diffusion of effects, and indicators…), right at the beginning of any evaluation study. It is also vital to be aware of the risks of the "indicator fallacy", where it is assumed that there is a single aspect that determines the success or effectiveness of the object under evaluation (e.g. quality of a researcher, department or institute based on a citation index).

- ***1st consideration***:

the need for a coherent approach could be illustrated by the "*cook-book*" analogy as a way to create the necessary (almost) new knowledge that should be the object of the next stages of the development of socio-economic impact assessment models:

- Courses:
  - Starter – pre-construction/planning,
  - Dish 1 (pasta) – construction phase,
  - Main course – runtime,
  - Desert – interval after runtime (may include de-construction or transformation[1]),
  - Coffee (or cognac) – final summary of assessment, integrating the different phases, recommendations for others (lessons learned),
- Each dish has a recipe:
  - Ingredients (factors, indicators) and where to buy them (methods/sources for data acquisition), and how to check for their good quality (pitfalls, where to be careful, what to consider when obtaining the data, etc),
  - instruments for processing (methods for analyzing)
  - step-by-step instruction (procedures, good practice, benchmarking, etc),
  - ways of presenting it "on the plate" – how to present, recommendations for structure of report, visualizations, different languages for different audiences, etc.

[1] e.g. the transformation of a major infrastructure into a public science park area with recreational facilities

- The "cook" should be able to link the different approaches to impact analysis, from "light meal" that covers basic ingredients to "vegetarian" which needs to be digested easily and has to reach different parts of the consuming body more or less quickly (distributed RIs).

➢ ***2nd consideration***:

There is a need for a succession of some *ERA net* activities, coordinating the development of national policy visions and actions:

- This could for example explore how an analysis of the network of influencing factors could be used to create a model, instead of assuming that the two most relevant factors are the R&D investment and technological progress. This would be an alternative to the approach (based on an historical example) mentioned by ERA text that no link can be detected between R&D investment and technological progress. In this both the democratic principles and Foresight come into play.
- Combine this with an intellectual capital (IC) approach to analyze the factors that contribute to sustainable success.

➢ ***3rd consideration***:

A complementary analogy of the roles that Research infrastructures play is that of the different branches of a tree, some of which are their role in the Life-Sciences (or Bio-Economy), the value of data to communities beyond those who produce it, the vital relationship with specialised programmes of Higher Education and some of the common "success" or "limiting" factors. Each of these is explored later in this report.

➢ ***4th consideration***:

Ideas to be explored for a "next generation" of projects:

- *Using models from other sectors*: a thought provoking example of how to go about analysing the probable degree of success in achieving sustainable economic impact by the development of the RI sector was presented in the form of the methodology and working tools of BLUES. This has been developed to enable the measurement of the future survival chances and current development progress of start-ups, primarily aiming at research spin-offs and technology start-ups. This methodology utilises previous research on the lifecycle of start-ups from Harvard Business School, as well as the practical experience of leading technology incubators and consultants. Besides the short term evaluation effect for both the start-ups and their financial supporters (technology incubators, science parks, public bodies, investors, banks, etc.) it could be considered as one of measurement tools for the long term effects of the RI related investments.
- *Building up the "stores"* where to Research infrastructures (or those intending to propose major new ones or upgrades) can "buy" the "ingredients" for impact analysis. Some recent software and data base analysis techniques can provide the right people with the inputs and statistics that they need to reach good decisions more quickly, and to equip them with the arguments they need to convince funding and other agencies to support major RI developments and the related innovation

and value chains, including spin-off ventures. However, during the Workshop several participants highlighted the fact that a crucial challenge/difficulty is getting the data. A data base will not solve this problem automatically, but makes the process of developing an impact analysis much faster at one point or another. The challenge is therefore to design, implement and fill data bases on an ongoing basis, as a way to provide data that can be used in preparing an impact analysis.

- *Review the roles of Research infrastructures* in the creation of new knowledge and the combination of existing knowledge.
    - *One of the key roles is in creating opportunities for further education*: In an ageing society, we might not only look at education for youngsters and at the beginning of their careers, but also take knowledge flows between generations into account. In concrete terms: design the exchange / involvement of young researchers with experienced staff. Research infrastructures can serve as an anchor/melting pot for such initiatives, which should be facilitated by knowledge transfer experts.[2]
    - *Another key role is in bridging knowledge generation and innovation*. These developments cannot be easily distinguished because innovation breakthroughs are sometimes "just" a new combination of existing methods/approaches. Therefore an effort should be made to elaborate on how to foster knowledge generation and development (rather than trying to distinguish these as two separate things). This, unfortunately, makes it much more complicated to identify the point at which it is sufficiently promising to attract/justify private investment.
- Therefore, *special PPP[3] models for RI should be developed* and these should be as explicit as possible. Such a project could explore the: Assessment of existing PPP models; analyze their transferability to Research infrastructures and propose Research infrastructure specific PPP models for investment, combining the establishment of a long term relationship with "quick wins", (something of special relevance when marketing the opportunity to potential investor or industrial sector).

[2] An analysis of educational effects would also have to take into consideration the societal age structure; it would not be easy to compare Singapore with Germany, for example. Clearly India and Italy face entirely different educational and occupational challenges.

[3] Public-Private-Partnership

5. Towards better visualisations of Research infrastructures

1. Intellectual Capital; Narrative and Analysis

Perhaps two of the most valuable contributions by the set of WS presentations to the development of our understanding of Research infrastructures' role in increasing the competitiveness of our economies, were those that focussed on the creation of **Narrative** and the use of **Analysis** to improve our understanding, communication skills and in general the pertinent knowledge of Research infrastructures.

The use of Intellectual Capital (IC) as a communication and managerial control and development tool has evolved into one where it is increasingly useful for accountability. In a company the Board is accountable for the development of the entities' IC and for developing the strategy that will grow and exploit it in a sustainable way, rather than only focusing on short term profitability. From the discussion it became apparent that there are many parallels between the use of IC in sectors as far apart as financial services and Research infrastructures.

The narrative of IC-based knowledge facilitates the circulation of a set of explanations that help the "reader", i.e. policy-makers, understand how intellectual capital works in the RI and thereby also why it is important to long-term value creation. The fact that the order in which different parts of the IC value chain are studied, reported and developed, and the ways in which they loop back into each other in a series of iterations, can provide a new insight into the whole debate on the development and operation of Research infrastructures. In turn a Research infrastructures' Value Creation Story could be used to measure its Business Model, as well as its Knowledge Narrative, and set out the relationship between its resources, actions and their effects. In this way the indicators can be used to quantify the Value Creation Story.

The Narrative can set the context where one can analyse the grey area between effects and impacts. Feedback loops also need to examine the unintended impacts, ranging from unforeseen environmental impacts, or unimagined societal challenges, to magnificent economic opportunities. Such loops need to be accompanied by mechanisms that introduce developmental or operational flexibility so that such impacts can be minimised or maximised, according to their degree of desirability.

One very important aspect of this debate is the focus on the fact that the Knowledge inside the heads of the owners, operators and users of Research infrastructures are in turn their greatest collective value. A value that has to be nurtured and shared through complementary initiatives, especially those related to Higher Education that can ensure their sustainable development well beyond the life-time of individual Research infrastructures.

This is a parallel to the way that in a start-up, the initial knowledge is of the highest value. But with the passing of time and the increasing organisational development, the know-how becomes more valuable than the original knowledge. It is once again the field of Higher Education that can provide the

finest nurture for the collective IC of Europe's unique collection of Research infrastructures. Many Research infrastructures are living examples of the way to keep key knowledge at the cutting edge through graduate training programmes and post-graduate research programmes, as well using each generation of technologists to train the subsequent generation, who in turn are capable of far greater achievements.

The many elements of analysis provide a rich resource for our efforts to improve our knowledge of Research infrastructures and their multiple roles. Following these different paths requires creativity and greater efforts to develop studies dealing with the future of Research infrastructures, or better still on how to relate them to the ERA Vision 2020, developing the Knowledge Triangle, managing the pressures for structural changes and desires for cohesion as ERA's priorities evolve.

Clearly the key challenge in all of this is that of going beyond Open Coordination to the joint development and possible integration of national research policies in the field of Research infrastructures. This in itself would be a major ERA success story. All of which begs the eternal questions, "Just what is ERA and what is it for?" Never more pertinent than in the field of Research infrastructures!

2. Foresight and Policy

The use of Foresight – or Technology Foresight – methods cannot be limited to the exploration of the life span of a single Research infrastructure or to a sectoral cluster of them. Rather it has to be focussed first on the development of Research and Innovation policies. The context for such an exercise is the vision of the ERA, because this provides clear objectives for Research infrastructures. The document "ERA Vision 2020", adopted by the Council of 2nd December 2008, can be considered as a policy framework and states the following objectives:

a) key direct objectives for RI – to contribute to:

- *Excellence in science*
- *A research system with strategic capabilities*
- *Placing the ERA at the core of global research networks*
- *Attractiveness of Europe for carrying out RD*

b) key indirect objectives for RI - to contribute to:

- *The relationships between public and private RD*
- *The knowledge triangle in Europe*
- *Responding to the needs of citizens and businesses*
- *Trust and dialogue between society and S&T community*

Foresight can play a valuable role in the assessment of Research infrastructures by setting out in advance what should be expected as their contribution to these objectives. The evaluation process would therefore not mainly to "compute" impacts but provide frameworks for structured debates; in other words, the 'appreciation' of the contribution of a Research infrastructure to the objectives would consist of an interactive process among stakeholders, based on high quality analysis and descriptions.

6. Some more EU Research Infrastructure issues

During the course of the WS a number of important issues came to light. Some were complementary, others contradictory and many begged further research or discussion. By the conclusion of the day and a half of debate it was clear that the way forward would include the distillation of key messages, the identification of challenges and the drivers that could be harnessed to address these. The following are a selection, by no means exhaustive, of those that the author of this report feels to be especially relevant, without necessarily attributing them to individual speakers.

➢ The Life-Sciences (or Bio-Economy) versus more Fundamental sectors

A number of presentations highlighted the vital contribution of research infrastructures in sectors related to the Life-Sciences, to the training of researchers as well as fuelling economic sustainability. Even in the case of a distributed RI, such as BBMRI and other BMS projects, the highly coordinated development of the value chain can result in their playing a vital role. The clear examples of private-public partnerships in these sectors contrast sharply with those RI sectors where the object of the research is far removed from development and innovation. In the latter case it is mainly the technological development and innovation driven by the design of advanced instrumentation and construction techniques that have a major impact on industrial sectors. Such impact can be huge, estimated at about 10 B€ per year (see the result of the ERID watch study; www.eridwatch.eu). However it was noted that achieving a level playing field here required many complementary measures and efforts on the part of all of the relevant actors; Government Departments, Regulatory Authorities, the Scientific Community, RI developers and operators, Professional and Trade Associations and the enterprises themselves.

➢ The value of data

An interesting development is the increasing need for the development, management and accessing of huge quantities of data that have different owners from the RI that houses them. Also in this field the level of sustainable socio-economic impact can be greatly influenced by the decisions, both as to funding and exploitation, which are taken at its creation and as it develops. This field could well hold the key to many of the most valuable innovations and applications of our medium term future. However, there are some vital issues that need to be addressed and they should perhaps become the topic of specific research. For example, they involve a different business model with a special money flow. Whereas public money may be essential for their creation, the potential value of the data that is then feed into it from private and public sources could be many times greater. On the other hand they can benefit not only the "big" players of a sector but also many enterprises, who would otherwise have no possibility of creating and exploiting such data resources. Possibly the use of the inclusive methods employed in Foresight studies could be brought to bear very creatively in developing shared visions of their future and in preparing the way for new funding models.

The long term importance of contacts with Higher Education

Without doubt one of the elements most often cited as playing a key role in both the successful development and exploitation of Research infrastructures as well as in their contributing significantly to sustainable and long-term socio-economic development, is that of complementary, sustained efforts in the field of Higher Education. This has to be approached with long-term commitment where priorities are set by realities and not by the academic preferences of powerful individuals with little regard to their relevance in the city or regional context. Whether the example considered is that of technologies for the Energy Sector (e.g. through the ECCSEL presentation), or the historic development of Grenoble (which has become a model of what can be achieved and how real benefits can be reaped when the synergies are fully exploited).

The fact that Education is an integral part of the Innovation Process was emphasised. In this context the very interesting remark was made, "You can achieve long term results beyond current flights of fantasy". This focus on higher education in the field of RI development should involve long term multi-disciplinarity, because it is the ability of people to comprehend a variety of techniques and scientific principles that will facilitate their unlocking complex or "wicked" problems. They can also become effective "boundary spanners", able to comprehend the two different value systems and cultures that have to blend together if scientists and industrialists are to form programme partnerships, instead of just project collaborations. This supports the view that, "people make a difference", because they can stand behind an idea, motivate others and see it through to success.

Success and limiting factors

Another aspect that really stood out in the discussions was the difference between potential impacts of Research infrastructures and what often proves to be their actual impact. The need to clearly identify both the "enhancing" and the "dampening" factors, as well as the need to develop the complementary policies and concrete actions must be addressed. This will require the review of existing good practice and the development of effective methods, the training of the right people in their use and the necessary scientific and political support for their implementation.

There was a critical discussion of the fact that presenting unanticipated benefits, when discovered, as evidence that proves the success of a RI is not seen to be legitimate in all cases. Although the attempt to do this may be understandable from a marketing point of view, it seems doubtful for the ex-ante evaluation of Research infrastructures, e.g. for deciding the site of proposed new installations.

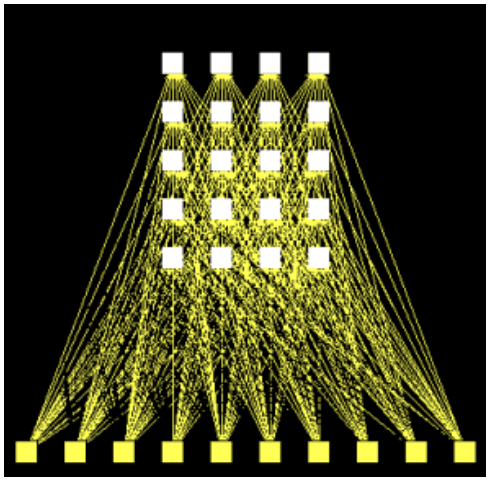
One current challenge is turning the perception that Research infrastructures contribute strongly to innovation and local development into the kind of story that Politicians need. Retaining the strong interest of local and national politicians is fed by the general publics' positive perceptions, and this combination ensures sustainable funding. At the same time, the fact is that different communities have different expectations of the results of major

spending programmes on R+D and on Research infrastructures. They do not necessarily all want to hear the same arguments by those promoting Research infrastructures. The officials in Government Ministries of Finance are usually pretty forthright in expressing their view of what constitutes a convincing argument!

Some participants also expressed the view that, until such undertakings become a reality, the ESFRI Road Map is not an exercise that will have a radical impact on the decisions taken by individual member states in this field. In fact, funding decisions by individual Member States continue to be taken on an ad-hoc basis and not always for the "right" scientific or technological reasons. However, several Countries are developing their national roadmaps, and in doing this they are prioritizing, within the national budgets, between the Pan-EU and the "national" ones: this process is happening at government level and is correcting the tendency of the funding agencies, which tend to be more conservative in their choices.

➢ Developing complementary / improved funding models

In some cases the RSFF (Risk Sharing Finance Facility) can go beyond classic "gap financing", addressing those major peaks in the cost flow of a major development that have increasingly become a salient feature of the huge and very ambitious Research infrastructures being planned or already under construction. However, from some quarters there are increasingly loud calls for a much greater funding role by the EU on behalf of the entire community of member states. This really calls into question to what extent European leaders really believe that investing in Science and Technology, and in the major Research infrastructures proposed in their ESFRI Road Map, is a key element in developing the dream of a competitive knowledge based Europe. In this regard many feel that an ideal scenario would be, apart from any EC contribution to the original cost, an important Community contribution of the Research infrastructures' annual operating costs. Another important aspect that cannot be overlooked is that of the decommissioning costs.



7. The way ahead

As far as impacts are concerned, a major challenge will be the development of a systemic view, which could invoke the analogy of a "cook book" with different projects proposing to focus on specific aspects so as to ensure a coherent overall development of the tools that can be used to evaluate Research infrastructures and their expected or achieved socio-economic impacts.

In policy, a key issue is the need for a structured debate. Foresight methods could be used to prepare this and the participation of the relevant actors in such an exercise will in turn prepare them for these debates. What is clear is that the impacts of RI must be assessed with reference to the objectives of research and innovation policies – and not in terms of generic and abstract goals ('competitiveness', 'economic growth'…); those are the over-arching goals to which the sectoral policies (such as research and innovation) all together contribute. Research infrastructures are generally planned and exist within a sectoral policy and have to be assessed in that context.

Nevertheless, no matter what framework is used to evaluate the relevance of Research infrastructures in the struggle for competitiveness, **Science must continue to be the driving force behind, and the principal justification for, Research infrastructures.** Their role in specialised programmes of Higher Education is also unique and efforts should be directed at developing this and sharing "good practice".

The recognition of these aspects at the close of the WS led to a call for the preparation of a report that could be debated further and improved as a result of the proposed follow-up WS to be held at the end of the year. Such a report could contain a first draft analysis of the measurement instruments of impact, and the modelling of inputs and outputs as well as relationships and interactions (see the different presentations in annex).

It was noted that the RIFI Project (Research Infrastructures, Foresight and socio-economic Impacts), as well as new projects to be launched in the next months, intend to show how Foresight can be used to wire up the development process of decision-making in Research infrastructures. The initial formulation of methods to evaluate the socio-economic impacts of Research infrastructures should be available in time for their informal discussion at the proposed follow-up WS.

It was also suggested that the next generation of projects could contribute to the development by of the proposed "Cook-book"; which could offer something similar to the Oslo Manual by setting out **a variety of recipes for impact analysis**, as well as comments of their respective strengths and weaknesses in different contexts. In this way it could form part of an overall decision support system that would also contemplate the effective and balanced use of Structural Funds. In turn this should be complemented by parallel initiatives in programmes of **Higher Education** and the development of the relevant **absorption capacity of local / regional enterprises**.

8. Conclusions

1. A number of participants expressed the view that with the ESFRI List, the FP7, the Structural Funds, and current national initiatives and resources, the EU has the basic instruments with which to maintain, develop and build successful new Research infrastructures. However it was also felt that a pre-requisite would be the further development, driven by the RI Unit, of studies on the social and economic impact of Research infrastructures. There is a need for a few well-elaborated methods and indicators, which may differ depending on the science goals of each RI sector. The next call for proposals under FP7 (closing 3rd December 2009) is an opportunity not to be missed.

2. The view was also expressed that the impacts of RI should be assessed with reference to the objectives of the research and innovation policies of the EU – and not in reference to generic and abstract goals (e.g. 'competitiveness', 'economic growth'…); those are the over-arching goals to which the sectoral policies (such as research and innovation) all together contribute; the creation and operation of Research infrastructures take place within a sectoral policy and have to be assessed in that context.

3. Research and innovation policies must be placed in the context of the ERA, which provides them with objectives. It was suggested that IC Narratives and Foresight could each make a valuable contribution to this goal. The assessment of Research infrastructures should include a structured debate among stakeholders of their contribution to these objectives, based on high quality analysis and descriptions.

4. To achieve the potential impacts, Europe needs to create multidisciplinary teams, which are brought together to realize a long-term vision in fields of major importance. This will in turn increase the innovation and value creation resulting from Research infrastructures and the R+D carried out with them immensely; really "teaming up" the knowledge triangle.

5. The participants in the WS warned that decision makers also need to develop complementary initiatives and regulations (towards a more favourable environment for Research infrastructures at European level). Moreover, they recommend that the results of complex impact assessment studies should be used to really influence policy priorities and spending decisions, counterbalancing the tendency of the major EU Countries to use the size of their financial contribution to an individual project to ensure that it would go to the area that best suits their own interests.

9. Annexes

Annex 1: List of contributors and attendees

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Annex 2: Presentations

2.1 Overviews

2.2 Projects

2.3 Case Studies

2.4 Other schemes than RTD