European Science Foundation

Science Foresight to Advance European Research

A report by the ESF Member Organisation Forum on Science Foresight for Joint Strategy Development

European Science Foundation (ESF)

The European Science Foundation (ESF) was established in 1974 to provide a common platform for its Member Organisations to advance European research collaboration and explore new directions for research. It is an independent organisation, owned by 67 Member Organisations, which are research funding organisations, research performing organisations and academies from 29 countries. ESF promotes collaboration in research itself, in funding of research and in science policy activities at the European level. Currently ESF is reducing its research programmes while developing new activities to serve the science community, including peer review and evaluation services.

www.esf.org

Member Organisation Fora

An ESF Member Organisation Forum is an output-oriented, issue-related venue for the Member Organisations, involving other organisations as appropriate, to exchange information and experiences and develop joint actions in science policy. Typical subjects areas discussed in the Fora are related to:

- Joint strategy development and strategic cooperation with regard to research issues of a European nature.
- Development of best practices and exchange of practices on science management, to benefit all European organisations and especially newly established research organisations.
- Harmonisation of coordination by MOs of national programmes and policies in a European context.

www.esf.org/mo-fora

Authors

This report has been written by the Chairs of the ESF Member Organisation Forum on Science Foresight for Joint Strategy Development and by Thibaut Lery (ESF) and Anna Herou (VR, Sweden – seconded to ESF)

Acknowledgements

ESF is grateful to the Chairs of the MO Forum on Science Foresight for Joint Strategy Development – Andreas Trepte (Max-Planck-Society, Germany), Karel Aim (Academy of Sciences of the Czech Republic, Czech Republic), Jenny Nordquist (Swedish Research Council, Sweden), Claire Giry (French National Institute of Health and Medical Research, France), to the Members of the MO Forum, the special contribution of Thibaut Lery (ESF) and Anna Herou (VR, Sweden – seconded to ESF) as well as to Laura Marin (ESF) for the management of the Forum.

ISBN: 978-2-918428-97-8

Contents

1. Executive Summary

It is time for Europe to reinvigorate its long tradition of discovery and innovation. Indeed, in the context of the global financial crisis, the race for a global knowledge economy and the ensuing data deluge, research and innovation has become a vital and strategic cornerstone for the future of Europe. This necessary investment in science and research requires clear strategies for funding research, recruitment of researchers and the provision of research infrastructure. Pan-European science strategies for large-scale and long-term investments should be developed based on a clear process for selecting the most strategic and relevant scientific domains involving all stakeholders, i.e., researchers from both the private and public sectors, policy makers, governments, research funding organisations and research performing organisations. The process needs to build systematically upon the past in order to understand the future, to anticipate what might happen and to agree on how to promote research of the highest quality and knowledge expectation in the best interests of society. This is the core of *Science Foresight*.

Regardless of the proven strategic value of foresight, very little is done at European level to know how science and research is planned, designed, developed and delivered in real applications pertinent to governments, funding organisations, universities and industry. There is an urgent need for the coordination of science foresight and the standardisation of the corresponding data and indicators in Europe. For joint strategy development, prioritisations should relate to scientific areas, grand challenges or infrastructures, which require large-scale funding and collaboration. Specifying these aims will ensure that the tools are set up in an adequate way for optimal governance of the research system in Europe. The successful establishment of the European Research Area (ERA) requires open coordination of these visions for the future of science and society, as well as the use of science foresight as a systemic instrument.

The European Science Foundation (ESF) Member Organisation Forum on Science Foresight for Joint Strategy Development has identified key challenges and has issued the following recommendations.

A. **The creation of an EU Science Foresight Platform with institutional support.**
In order to continually track the evolution of established and upcoming scientific fields and the performance of scientific activities, it is necessary to coordinate the collection of data on policy input, research output and the societal, political and legal environment in which the research is being conducted. The Forum suggests the creation of a one-stop-shop online platform with an annual conference that would consolidate the foresight knowledge base by contributing to the development of a scientific reference system and exchange of experiences and reflections.

B. **The development of an EU Science Foresight Toolbox** that would include best practice, methodologies, guidelines, standards and examples. This would reduce the parallel efforts by all individual member state countries and maintain EU science intelligence.

C. **The preparation of an EU Science Foresight Roadmap.**
Since science foresight is a highly professional activity that requires independence and expertise (similar to what the ESF has provided with Forward Look activities over the last decade

and that Science Europe could take over), the Member States could prepare a European roadmap for science foresight. The roadmap would foster authoritative recommendations with broad acceptance in the respective scientific communities, and within national organisations as can be seen on other continents (USA, Japan…), and would help reduce fragmentation.

By following the above recommendations and combining the latest scientific evidence-based analysis with professional future studies, policy makers could access the relevant tools to tackle complex issues in planning strategies and priorities, with a better understanding of the potential opportunities and societal challenges that lie ahead of us. Science foresight can and must become a stepping-stone in the new renaissance of Europe.

2. Rationale

"I never think about the future,
it comes soon enough."
ALBERT EINSTEIN

Jointly charting the paths for scientific excellence to meet the scientific and societal grand challenges creates a basis for joint action of research organisations. Foresight provides a mechanism for this by developing a shared vision of the long-term research agenda. The ESF member organisations (research funding and research performing organisations) aim to develop science foresight and use its results as a basis for joint strategy development at the supranational level. This action addresses the need to develop an effective European research policy, capitalising on cultural, geographic and scientific diversity and to promote transnational funding, benchmarking of quality and shared scientific priorities for strategic research and researcher-driven programmes.

On 30 May 2010, the ESF Governing Council approved the launch of the ESF Member Organisation Forum on 'Science Foresight for Joint Strategy Development'. In taking this decision, ESF and its member organisations (MOs) confirmed the importance and potential benefits of positioning ESF together with its MOs as a strong actor in science foresight in Europe. The *EUROHORCs and ESF Vision on a Globally Competitive ERA and their Road Map for Actions* [1] identifies science foresight and the use of its results as a basis for joint strategy development to be of utmost importance for exploring forefront research and aligning regional, national and European long-term strategies in order to address the scientific and societal grand challenges.

1. http://www.eurohorcs.org/SiteCollectionDocuments/ESF_Road%20Map_long_0907.pdf

This Forum addresses the implementation of such an action by becoming a platform for ESF member organisations in defining science foresight, its possibilities and needs, and by giving recommendations on how science foresight can be used for developing research perspectives and strategic visions in scientific fields with pan-European importance in Europe.

This report addresses the objectives set by the group by developing recommendations to ESF member organisations, ESF and Science Europe:

- To outline the specific characteristics (e.g., principles, criteria) of science foresight;
- To map and identify good practices for science foresight (e.g., through publishers, scientific associations, MOs, other international institutions);
- To identify the needs of and gaps in science foresight at the European level;
- To identify the required tools, methodologies and data needed (in collaboration with the MO Forum on Evaluation of Publicly Funded Research);
- To identify mechanisms to engage and motivate the best scientists in the respective research field;
- To propose appropriate joint foresight processes/frameworks in science.

The European situation

While strategic planning and some foresight methods have certainly been practised, the use of 'foresight' in Europe, as a systematic method, was not established until the 1990s. Foresight has developed from reviewing the possibilities in technology development to be applied to other areas, such as science. In the past decade foresight has become a more important part of strategic planning in

Europe. And even more so, science foresight has been integrated with social policies, while social and environmental aspects, for example, have taken a more natural part of the foresight process.

Strategies for research investments developed on regional, national, European as well as international levels also involve other public policies. As in a kind of evolution, science foresight exercises have developed to be more sophisticated, with a broader view of possibilities and threats. Through these methods, modern strategies can also take into account aspects within areas such as health, social development, the environment, safety and ethical concerns. Research strategies are now done in a more diverse process, involving actors and institutions in networks with a wide variety of competence and knowledge.[2] European science foresight practice has been influenced by traditions of technology foresight, sustainability planning and territorial prospective, but also by experiences from other countries.

The present use of foresight in Europe was established in the 1990s by way of experiences from the Japanese applied methods. In the same way that Japan adapted the methods of the military and space programmes of the US, the countries in Europe needed to adapt the Japanese methods to their conditions. Linkages between scientific research and industry were not as developed in Europe as they were in Japan at that time, which was one of the reasons why countries in Europe found that an inclusive and participatory approach to doing foresight was essential.[3] Traditional technology foresight, sustainability planning and a territorial prospective also influence European foresight. Some countries have a long history of future studies, and have of course used these experiences when developing foresight activities.

In 1974 national research councils, research performing organisations and academies in Europe established the ESF to link on their behalf with the scientific community at the European level. The ESF has now grown to an organisation with 67 members. One of the instruments related to the policy role of ESF is the *Forward Looks*. This instrument was introduced in the ESF Strategic Plan 2002-2006, with the aim of developing medium-term perspectives on future directions of multi-disciplinary research in Europe. The *Forward Looks* are an example of the development of foresight as an instrument for science and technology policy. Foresight developed in the 1990s from a new experimental policy instrument for national research policies into a practice being deployed in a range of R&D-related policy contexts. Interestingly enough, while in the earlier years foresight had clear linkages with governmental ambitions to improve allocation of research funding, including funding for basic science, the instrument has developed much more into an instrument for innovation policy. ESF *Forward Looks* have been enabling Europe's scientific community, in interaction with policy makers, to develop medium- to long-term views and analyses of future research developments with the aim of defining research agendas at national and European levels. Quality assurance mechanisms, based on peer review where appropriate, are applied at every stage of the development and delivery of a *Forward Look* to ensure its quality and impact through various phases such as scoping, implementation and reporting. In this document, the ESF member organisations summarise how science foresight in Europe could be further developed as a tool for strategic planning in the future.

2. Barré, R. (2001) *Strategic Policy Intelligence: IV Synthesis of technology foresight*.
3. Miles, I. (2004) *Three worlds of foresight*.

3.
Introduction to Science Foresight

3.1 Introduction

"Prediction is very difficult,
especially about the future."
NEILS BOHR

At a time when European countries are exploring the effects of globalisation and the need for research expense justification and impact, it is important to revisit how European research and innovation is funded, the process of selection of the most strategic and relevant scientific domains and the set-up of pan-European science strategies. Maximising the efficiency of expenditures on research and development is clearly important, especially in times of financial stringency. While science needs to be addressed in a competitive and transparent way, many possible benefits can be foreseen from coordinating strategic funding of research at a European level.

To meet the needs of the societal and scientific challenges in front of us, it is crucial to keep common objectives, including policy development, international cooperation and networking, and setting of scientific strategies and priorities. This will help us explore future opportunities for investment in science, demonstrate the vitality of European innovation, bring new actors into the strategic debate, and build new networks across fields, sectors and markets around common issues. Forward-looking activities are crucial to successful policy in science as in much else. To establish priorities for research one must try to understand the future, to anticipate what might happen and to agree how best to manage events to promote research of the highest quality and knowledge expectation.

If it seems obvious that we need forward-looking activities in Europe, then we need to learn more about them. This means going beyond merely the formal results of foresight exercises, in terms of what forecasts and analyses of future opportunities and risks have been developed, or what plans have been proposed and priorities targeted. We also need to learn how best to design and deploy foresight. Foresight and forward-looking activities are demanding of time and resources, and it is important to ensure that these are well used. We are confronting major challenges, and the quality of foresight will affect our readiness to address them. Let us first define the key concept that we will be dealing with, and then look at the best practices in Europe and finally present a set of recommendations for policy makers and science funders and performers.

3.2 A definition of Science Foresight

In this report, we refer to science in a broad sense, using the definition developed by the MO Forum on Science in Society Relationships[4] as follows:

Science may be considered as a broad field, which includes a body of publicly proved knowledge, still efficient and separated into specific fields (disciplines). But the main tension in the field of research is best defined as the exploration of new fields or new questions and, in a concrete view, as exploratory activities by scientists in search of new approaches, which contribute to understanding the world as well as to write/change the world. So Science will mean science or research, and will

4. ESF (2012) *Science in Society: A Challenging Frontier for Science Policy*, ESF MO Forum on Science in Society Relationships.

cover indifferently abstract and practical activities, and cover ALL sciences including Humanities and Social Sciences as well as Natural Sciences, Medicine and Engineering.

However, 'science' is driven by paradigmatic changes and currently contemporary research is being developed in a different manner; thus this definition should be complemented by an evolutionary and the revolutionary development of science through paradigms.

Scientific paradigm: "universally recognised scientific achievements that, for a time, provide model problems and solutions for a community of researchers"[5], i.e.

- ***What is to be observed and scrutinised***
- ***The kind of questions that are supposed to be asked and probed for answers in relation to this subject***
- ***How these questions are to be structured***
- ***How the results of scientific investigations should be interpreted***
- ***How an experiment is to be conducted, and what equipment is available to conduct the experiment.***

A foresight exercise aims at influencing present-day decisions in order to achieve the best possible future, e.g., for technological development, for society or for science. Thus, science foresight is the development of a science vision, providing a means of building, e.g., funding or recruitment strategies in order to prepare for future challenges or needs in science. Additionally, engaging researchers and other stakeholders in a science foresight exercise may be a goal in itself, improving communication and networking, and ultimately thereby improving future developments in science.

Science foresight is a systematic, participatory, prospective and policy-oriented, time-limited or permanent process aimed at actively engaging science stakeholders, e.g., researchers, funding organisations and the private sector, in the assessment of present science and the anticipation and recommendation of science futures based on inner-scientific, technological, economic, environmental, political, social and ethical constraints.

Nowadays, science foresight is based on key trends in scientific experimentation, theory and, more recently, in scientific simulations and the availability of big data sets. Science foresight contributes to the early identification of emerging needs, novelties and issues that could have far-reaching implications for European science and technology in the long run and to building stakeholder commitment to action. It helps analysis of changes in global research and innovation systems and the socio-economic context in which they operate.

In comparison to other types of foresight, science foresight as a concept has appeared relatively recently. The objective for using science foresight is to optimise research funding or to perform strategic recruitment; it is an important tool for identifying emerging patterns and new potential in disciplines, interdisciplinary fields, upcoming new topics, innovative research technologies or the availability of new facilities. The institutions organising science foresight include ministries, funders, universities, research institutes, etc. In general, the science foresight exercise itself should involve scientists since they are key stakeholders in the process.

In terms of methodology, science foresight is inclusive in the manner of being interactive and participatory. Most foresight activities involve many different research sectors and organisations, and create new channels of communication between them. Interdisciplinary approaches are needed to cover a diversity of factors for a wider knowledge foundation, and these approaches require sharing of different kinds of expertise. Network building is sometimes the main purpose of a science foresight activity because it allows for knowledge flows and system-wide learning, which increases the system's capacity for innovation. The interdependence of these networks creates an incentive to keep them active, and through that further develop the trans-disciplinary interaction. In some cases, the intention of science foresight activities is to have them institutionalised, creating permanent advisory boards and/or sustainable networks that stay active after the foresight activity is terminated.[6]

Science foresight is looking – in scientific disciplines, sub-disciplines or inter and/or trans-disciplinary fields – for upcoming new theoretical concepts, new empirical (data) resources, new methodologies, new instruments or innovative organisational environments in research. Its aim is to identify in which research areas exist the best relationship/ratio between opening new research opportunities and the availability of very creative talents in this field. Its forecasts and alternative trajectories help to formulate medium- and long-term roadmaps in scientific research, to optimise priorities in public research portfolios and to invest in the right people, topics and instruments/facilities in universities and research institutes. As a consequence, science foresight can stimulate the debate between the research world and society.

5. Kuhn, T. (1962) *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

6. Practical guide to regional foresight in the UK 2002

3.3 Diversity in foresight: Technology, Policy and Science Foresight

There is a diversity of forward-looking activities, foresight being one of them. But there is also diversity within the concept of foresight, the main variations being technology, policy and science foresight. One lesson from the last decade of foresight practice is that "one size does not fit all". Different problems and contexts require different actors and configurations of foresight approaches. In the boxes below these branches of foresight are distinguished from each other.

Technology foresight

Goal: Identify relevant broader topics for technological development

Focus: National organisations

Rationale:

- To increase competitiveness and sustainability
- To address market failure
- To identify priority research topics
- To strengthen the collaboration between science and industry

Participants: Industry, researchers, policy makers, consumers/end users

Technology foresights are commonly driven by the development of future products and technology, to guide investments in science and innovation, and for market strategy.

Policy and societal foresights

Goal: Identify research topics to address societal or socio-economic challenges

Focus: International organisations

Rationale:

- To identify research topics to address societal challenges
- To contribute to increased quality of life
- To increase competitiveness and growth
- To address system failure and strengthen national innovation

Participants: Policy makers, researchers, industry, research performing/funding organisations

Foresight exercises for policy (society-economy focus) aim to fill a gap in policy makers' understanding of an issue related to a certain policy, and to develop effective evidence-based strategies. Research results and other evidence are important for policy foresight, but the social issues are the drivers and the result is generally recommendations for policy on social issues.

Science foresight

Goal: Identify research topics with highest knowledge expectation and transformational/break-through potential

Focus: International and national organisations

Rationale:

- To promote high-quality research (international and translational focus)
- To promote highest knowledge expectation (revolutionary change/new paradigm)
- To develop visions and perspectives for research disciplines/themes/topics
- To improve programme design and focus (transformational)
- To improve institutional strategy/portfolio of a research performing institution
- To set priorities, strategies and coordinated action plans

Participants: Top researchers, scientific community, policy makers, research performing/funding organisations, ministries

In science foresight, social and environmental issues are not driving issues but are rather aspects amongst others in the foresight activities. In most cases the science questions are the drivers. For exploring alternative futures and identifying upcoming patterns and new potential in, e.g., disciplines, interdisciplinary fields, emerging topics, new research technologies or availability of new facilities, science foresight is a useful tool. It also allows for a longer-term vision, beyond normal planning horizons, especially in science foresight. This means looking at possible futures from five to twenty years, some foresight activities, e.g., for large research infrastructures, having a horizon of over thirty years. Even so, focus lies on emerging issues and refocusing the future development of established science issues. Despite the long-term focus, foresight is used to inform current decisions. Limited resources call for strategic decisions for investment, and in the context of research funding this involves choosing what areas to prioritise. Emerging issues may be difficult to fund, due to their inherent uncertainty, without the proper long-term vision. More risk-taking is important though to stimulate emerging fields and new paradigms.

In a typical science foresight initiative, the scoping phase is usually based on key questions that drive the set up and work plan of the foresight activities. For instance, what is the main question or problem that makes a foresight needed or appropriate? Is a foresight exercise suitable for this issue, the context and will it give the desired output? When approaching the issue, what resources (time, financial and human) are available? What are the different goals, political agendas and stakeholders?

This assessment should lead to a formal decision on a general level, opening up for the next steps of the foresight exercise. To select issues, the identifying of potential future issues, both threats and opportunities, new developments that could challenge established systems and assumptions, is essential. A prospective foresight exercise typically begins with an international review. Environmental scanning is a crucial background activity, which allows uncovering of weak signals; early indications of future changes, shifts in trends and systems. A continuous environmental scanning, involving systematic searches in online literature and databases (supported by text mining and bibliometrics for example)[7], provides necessary data to be analysed by expert panels proposing the focus and scope of a foresight exercise.

Minimum conditions for a foresight exercise

- Systematic/structured anticipation of long-term scientific, social, economic or technological developments and needs.
- Interactive and participative methods of exploratory debate, analysis and study involving a wide variety of stakeholders.
- Foresight activities create social networks; in some cases the building of links in the network is an output of equal importance as the reports or policies created.
- The foresight activities involve the creation of a shared vision, to which the participants can commit.
- The shared vision is based on the anticipation of possible futures, but comprises present-day decisions and actions.

7. Gordon, T.J. and Glenn, J.C. *UNU Millennium Futures Research Methodology* collection, Chapter 2: Environmental scanning

A French national Science Foresight: The national strategy for research and innovation in France (SNRI) 2009-2012

Goals, participants and timeframe

The strategy was a governmental project led by the Ministry of Higher Education in collaboration with other ministries. The objectives of the initiative were to define major orientations for France for the next four to five years, such as addressing environmental urgency and supporting the national economy, to identify key technologies and to put science back in the centre of society.

Methodology and output

The exercise was initiated by an identification of societal, knowledge and transversal challenges, which were validated by all ministries. The next step involved a SWOT analysis on a national and international level. The analysis was based on both qualitative and quantitative indicators, such as patents and bibliometrics, as well as an analysis of national and European policies (incentives, legal framework).

In a strategic reflection, other reports, e.g., from the OECD and IPCC were studied, together with an identification of potential uncertainties and breakthroughs. The findings from the first steps were discussed in expert groups, with the steering committee and with the Cabinet.

The next step was a public consultation process involving about 600 people (ministries, scientists, large companies, small and medium enterprises, associations).

A steering committee identified major challenges for the next four to five years, published in a strategic report with strategic analysis and proposals for actions. Besides a general report, the expert group of each identified challenge produced reports with thematic priorities and relevant cooperation instruments for each priority.

Impact

The steering committee was in dialogue with ministries throughout the process; for example, to check whether all ministries validated the identification of major challenges. The final results were presented to the government for implementation in the following years.

3.4 A diversity of approaches

Science and technology foresight activities have been conducted as early as in the 1950s. Some examples are think tanks, especially in the defence field, such as RAND, Hudson Institute, Institute for the Futures and the Futures Group in the USA, the Programmes Analysis Group in the UK or the FAST programme in Europe. During the 1960s, foresight was narrowed to anticipate new technology areas. The efforts were called forecasting and the activities were mostly concerned with the probabilistic assessment of what is likely to happen in the future. Applications were focused on the military and large corporations due to their interests in strategic analysis across technological problems. Later, due to the 1972 oil crisis, the future was considered as not an extension of the past, and the possibility of discontinuities must be allowed for. In the 1980s foresight was used to distinguish between single and multiple futures. Therefore, foresight started to be used to express a wider frame, to consider alternative futures and to create actions to achieve the desired goal. In this context the French approach *La prospective* was launched, focusing on the multiplicity of the future. Moreover, there was a shift from predictive forecasting towards a process-oriented and participative institutional foresight. However, towards the end of the 1990s there was a change in the S&T dominating focus on expert foresight to the recognition of the importance of broader social, economic and cultural factors as providing the context for the development and use of S&T.

The first dedicated science foresight activities were initiated in the context of national science policies. In the early 1990s, governments articulated their responsibilities towards the science system more prominently. New policies and policy concepts like New Public Management, national systems of innovation and the knowledge society came with restrictions on the traditional budget streams, priority setting at the national level, new investments and funding instruments related to these national priorities and increasing pressures to improve the linkages between basic science and socio-economic benefits like innovation, health, environment, social cohesion, safety. This has led in many countries to a redefinition of the role of national governments and national funding bodies in the research systems.

National science foresight studies initiated at the governmental level still occur, but foresight has moved to other science policy levels as well, such as the intermediary level, the level of research institutes and within sectors. National science foresight studies are currently less focused on priority setting than the national exercises in the early 1990s.

The main aims of national science foresight activities are the development of a shared vision for actors in the national research system, and through such visions, the creation of better linkages between the different constituencies of the research system. For academic research, such exercises often imply the formulation of research areas that are of socio-economic and ecological relevance. At the intermediary level, such as the research councils, academies and technology agencies, science foresight studies often serve to set priorities for funding allocation (research programmes) and the selection of larger investments (centres of excellence, infrastructures). Sector-specific foresights often use science foresight to align strategies of heterogeneous actors who depend strongly on the health of the sector and, consequently, on each other. Science foresight may help to identify areas for strategic collaborations.

A Danish national Science Foresight: RESEARCH2015 and RESEARCH2020

Goals, participants and timeframe

RESEARCH2015 was initiated in 2006, to improve the basis for political prioritisation of funding for strategic research. Every four years a catalogue of especially promising themes for future strategic research is presented to the parliament by the Danish Agency for Science, Technology and Innovation. The subsequent catalogue, RESEARCH2020 presented in 2012, focuses on fewer themes with a focus on Danish and global social challenges and potentials.

Methodology and output

The exercise is a one-year process, starting with mapping of strategic research needs. The starting point of RESEARCH2015 was a broad mapping of the strategic needs created by societal and business development. The horizon scanning of 2007 by the OECD's International Futures Programme Unit was used as a foundation and inspiration for the mapping process. An Internet hearing that resulted in 366 proposals for strategic research themes from the general public, companies, researchers and organisations, followed.

In a second phase, an expert panel and a user panel workshop, involving a large number of stakeholders (ministries, research councils, universities, business associates and others) identified key themes. With this background a smaller number of proposals were identified as of higher importance, further narrowed down to the final 21 proposals through extensive dialogue with stakeholders in a third phase.

Impact

The result of the exercise is a catalogue, presented to the parliament, with a forward-looking basis for the political prioritisation of strategic research funds on the fiscal acts over the coming years. The parties of the settlement have recognised the catalogue as one of the major inputs for prioritisation of funding for strategic research, as well as for the preparation of a green research strategy, both part of the budget negotiations.

3.4.1 Diversity in science foresight outcomes: bottom-up versus top-down

There are various approaches to foresight with little interaction, often concentrated on a small group of experts. These approaches are top-down and close to future studies. The group of experts may use methods involving a wider community, such as Delphi methods, public meetings and seminars, but the study is kept within the smaller group of experts. In the bottom-up approaches, even the orientation and the design of the foresight activities can be interactive. These approaches stress interaction and participation; they involve people in the issue as well as in the process, which often creates legitimacy and a network around the issue. In science foresight, the input and the driving forces commonly come from the scientific communities and express their needs and requirements.

Foresight activities also differ in the dimension of focus on products or processes. When focused on products, the activities should produce practical and concrete outputs such as priority lists, reports, etc. Products can also imply background information for policy making, for example. Process-oriented foresight activities often focus on network building, development of foresight capabilities, and integrating foresight into organisations and with the stakeholders. These activities promote the exchange of knowledge, opinion and strategic thinking between experts and stakeholders, as well as developing the aptness of anticipating and responding to change[8]. This is especially true for science foresight where road mapping and lists of priorities are common practice.

8. Practical guide to regional foresight in the UK (2002)

Of course, real examples will show foresight activities that are a mix of the different approaches, rather than extreme cases of one or the other. The circumstances of an issue, such as resources, objectives or stakeholders, determine what mix of activities is best suited; there is no one foresight approach applicable to all issues.

3.4.2 Diversity in foresight: short- and long-term vision

In a discussion of short- or long-term perspective, it is relevant to make the distinction between the distance of the horizon in a foresight exercise, and the distance into the future in which we can see grand challenges or issues reaching, as it is not always the same. The horizon of future changes of a foresight exercise is not necessarily decided by the supposed future of a challenge or issue, but can be made shorter or longer depending on the objective (and resources) of the exercise. Generally, however, for changes that are already happening, a foresight of changes on a short- to medium-term is appropriate, while a medium- to long-term foresight is useful for anticipated developments in the future. Science foresights tend to call for longer-term horizons to guide R&D investments, compared to foresights on changes in socio-economic issues, for example, that more often look at changes in the short- to medium-term.

3.4.3 Diversity in methodologies

The primary framework for choosing the best-suited methods for a science foresight exercise is the context of the exercise; there is not a straightforward approach applicable to any exercise. The timeline and budget of the exercise will set the limits of resources, for example. Political agendas, expected

Figure 1. Methods for Science Foresight

outputs and goals have an important influence on the design of an exercise.

Another aspect not to be forgotten is the existing knowledge of methods. The expertise in specific methods that may be found within the organisation or be recruited can decide what is feasible, but so can the traditions or praxes of a region, country or area.

The national context of a foresight exercise provides both advantages and limitations, for example, structures and attitudes in the national culture. In the established democracies of Europe, actors are more comfortable with foresight methods that involve face-to-face forums such as workshops, and to discuss disputed or controversial futures, more so than in newer democracies where more anonymous methods are preferred [9]. The methodology should be mapped out early in the process, taking into account the specific objectives, resources (time, human and financial) and capabilities.

When putting together a mixture of methods, both in terms of type and number of methods, the choice often depends on the nature and capabilities of particular methods. The nature of a method is whether it gathers qualitative or quantitative information. Methods closer to creativity are influenced by imagination and are dependent on the inventiveness and ingenuity of individuals writing essays or the inspiration of a group engaged in a brainstorming exercise. Evidence-based methods focus more on facts and data, often rely on the expertise of individuals and are commonly used to support top-down decisions or make recommendations. Examples of evidence-based methods are Delphi, road mapping and key technologies.

In the other dimension, expertise methods focus on experiences and knowledge sharing, and depend on reliable documentation and means of analysis. This often involves quantitative methods such as benchmarking, bibliometrics and data mining. Interaction-based methods are more inclusive and emphasise discussions and knowledge exchange and include methods such as scenario workshops, voting, polling and citizen panels. These methods allow networking and multi-actor information flow but also promote legitimacy for the issue as well as the results of the exercise. The traditions and origin of praxes within the types of foresight differ, as do the needs and preferences of methods for the foresight exercises[10]. The figure above illustrates foresight methods in their context of the science foresight process (Figure 1).

9. EFMN Mapping foresight 2009
10. EFMN Mapping foresight 2009 and Popper, Rafael 2008 Foresight Methodology

An influential European Science Foresight: The Forward Look - The Nuclear Physics Long Range Plan 2010

Goals, participants and timeframe
The Nuclear Physics European Collaboration Committee (NuPECC), an expert committee of the European Science Foundation (ESF), initiated the Forward Look. About 6,000 scientists and engineers perform cutting-edge nuclear physics research at various large-scale and smaller national facilities, and at numerous universities and even hospitals. This science foresight exercise covered the next ten to fifteen years via a bottom-up process involving the entire nuclear physics community in Europe and input from international experts.

Methodology and outcome
NuPECC together with the ESF office organised several expert panels, workshops and working groups, a town meeting and a final conference. The report was based on surveys, interviews, literature review and SWOT analysis. The Long Range Plan was published via the Nuclear Physics News International, which is a European, US American, Canadian and Japanese journal issued by NuPECC. In addition, it was circulated to the community, funding agencies, lab directors, ESFRI, and national and European decision makers.

Impact
The previous long-range plan published in 2004 formed the basis of the NuPECC Large-Scale Facilities Roadmap submitted to the European Strategy Forum on Research Infrastructures (ESFRI) in 2005. In 2006 and 2008, ESFRI adopted the NuPECC priorities and identified FAIR, SPIRAL2 and three other projects in astrophysics and particle physics as the top nuclear physics projects in Europe. Similarly, the Long Range Plan was submitted to ESFRI, the European Commission, science ministries and the national funding organisations in December 2010 together with a science policy briefing and a video for the general public.

Member Organisation (MO) Forum survey on Science Foresight

In 2011 the ESF MO Forum on Science Foresight for Joint Strategy Development sent out a survey on science foresight to all member organisations of the forum. The survey aimed to map disciplinary, institutional and national foresight activities in scientific research (type, methods, structure, organisation, etc.). It was also to examine the Research Funding Organisations' (RFO) and Research Performing Organisations' (RPO) approaches to and needs for science foresight.

The survey was sent to 19 organisations and 14 responded. Many members expressed concerns or lack of experience/knowledge to reply. This, together with some of the answers received (below), we interpret to be an indication that science foresight is not a term generally used by ESF's member organisations, nor a method widely applied. However, many organisations state that they use elements of science foresight for their strategic planning.

Quotations from responses to the survey on science foresight

"We do not use the term 'foresight' for our work, but we have performed analyses and engaged researchers in a process which has led to the identification of areas for strategic research funding. The work contains many aspects and methods that can be related to foresight activities." *Vetenskapsrådet, Sweden*

"We don't really use the term 'foresight' to describe planning activities, although we do use several of the techniques that might form part of a 'foresight' process to inform our internal medium- to long-term strategic planning." *Wellcome Trust, United Kingdom*

"The necessity of opening a new research area and/or a major question on which we need to invest in the future." *Institut National de la Recherche Agronomique, France, on motivations for initiating a foresight project*

According to the (few) answers to the survey, bibliometrics, surveys and strategy planning are the most commonly used methods. Other methods frequently referred to in the survey were expert panels/commissions, but also SWOT analysis, stakeholder mapping, horizon scanning, brainstorming and scenario building.

Methods used according to the ESF survey on science foresight:
- Bibliometrics, SWOT analysis and surveys most common for identifying issues
- No one using Delphi, only few using trend exploration (explorative approach)
- Expert panels used by almost all organisations (creative approach)
- Brainstorming, mind mapping and scenario building used by some (creative)
- Critical technology and road mapping used by some (prioritisation)
- Other organisations' strategies taken into account

Organising foresight:
- Having no foresight unit is more common
- Commissioning foresight done by half of the respondents
- Corporate foresight officers within the organisation for half the respondents
- Foresight function most often located in strategy or evaluations department
- Most organisations do not have an established process for discussing results.

In summary, the survey shows that there is unfamiliarity and a lack of awareness of science foresight amongst the member organisations.

4. Key Elements Enabling Science Foresight

"The trouble with our times is that future is not what it used to be."
PAUL VALÉRY (French writer)

Performing science foresight requires many different kinds of data about the research system to build an evidence base into the process. This data can be divided into three larger categories: policy input, research output and the societal, political and legal environment in which the research is being conducted (Figure 2). These aspects are fundamental for governing a research system, and they serve as the knowledge base for science foresights.

4.1 Science input analysis

The science input analyses concern input into research, including researchers, research infrastructure, research funding, and research policy (strategies). Some typical data on inputs are European, national, regional or sectorial research policies or strategies, **human resources, research infrastructures and research funding** related to the foresight area.

Science input analyses are, for several reasons, difficult to perform on a European (or in many cases even national) scale today. First of all, there is currently no system for pan-European funding statistics or comprehensive statistics about research personnel[11]. Second, there is as yet no unified way of classifying research in Europe (and the rest of the world)[12]. In terms of disciplinary classifications, many countries collect 'input' statistics using classification systems based on OECD standard, but very few collect data which is classified according to what challenges the research attempts to address, or what research activity is involved. The need for such classification systems is great in that it would increase our understanding of the nature of the research, which is being funded and performed in relation to, e.g., societal challenges. The HRCS[13] is one very good example of such a classification system, which is specifically designed for health research but could serve as a model in developing similar systems for challenges other than health.

11. Also see ESF MO Forum on Research Careers
12. Also see ESF MO Forum on Evaluation of Publicly Funded Research

4.2 Societal, political and legal environment

The analyses concerning the societal, political and legal environment include analyses of research policy (strategies), the trends and novelties in the various scientific fields, research conditions and structural conditions. As with data for policy input analyses, this is information, which is not readily available in Europe, although there are national initiatives. For instance, a study of structural conditions may use national CV databases for researchers that are appearing in many countries. Such data will be of great value as a tool for analysing career development for researchers, thereby enabling the identification of bottlenecks in terms of competencies. But we also need structured ways of identifying, e.g., needs for large infrastructures. Such information is necessary for optimal governance of research systems, enabling truly strategic

13. Health research classification system

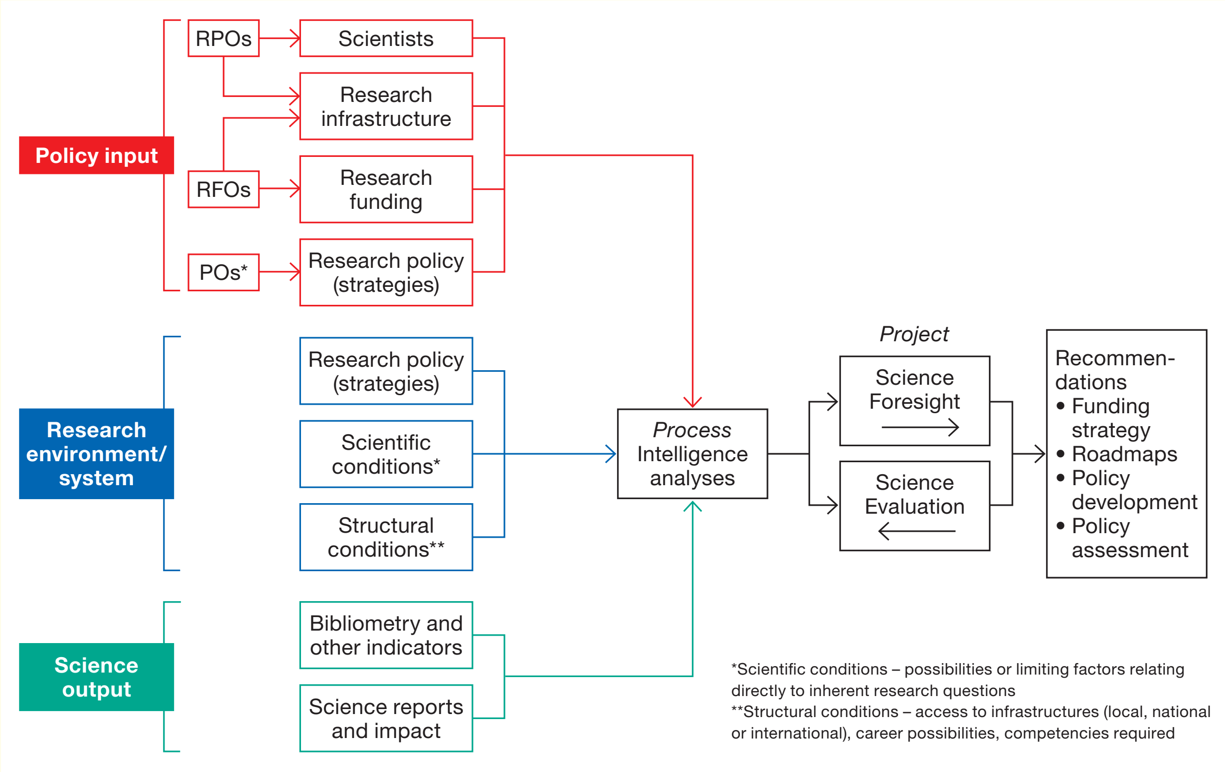

Figure 2. Science Foresight and evaluation process (RPOs: Research performing organisations, RFOs: Research funding organisations, POs: Policy organisations)

funding and recruitment. In order to have better informed strategies and evidence-based policy, it is also possible to use science foresight results to evaluate future priorities and develop new ways of thinking, highlighting the need for a systemic approach to both policy making and innovation.

4.3 **Output analysis**

Knowledge about research output is important for science foresight, and due to its forward-looking focus, the novelty aspect of the output is crucial. Output analyses have for a long time mainly focused on bibliometrics, largely because published articles are among the most direct outputs from research, but also because international data available through publishers enable benchmarking of research output between institutions or countries. As such, bibliometrics is a valuable tool for science foresight. The lag time until the value of an article can be assessed through citations can be a problem, but there are interesting attempts aimed at identifying new ways of rating the importance and use of publications, e.g., through peer review processes as the Faculty 1000 initiative (see below), direct online rating or number of downloads from online repositories[14]. Such initiatives may prove valuable for improving the use of bibliometrics in science foresight. Despite its many merits, the strong focus on bibliometrics for output analyses is somewhat criticised since it is an output indicator which does not fit all areas of science. As a result of this, many funders are now turning towards electronic reports as a way of obtaining a wider range of performance indicators to include in their evaluation schemes. Thus, databases of potential great value also for science foresights are now appearing all over Europe, but the respective funders are developing them locally. This means that their value as a complement to bibliometrics as a tool to benchmark research quality will be limited unless they are developed according to international standards and common data structures. The ESF MO Forum on Evaluation of Publicly Funded Research also recognises this potential problem and recommends such common standards.[15] We support their recommendations and further emphasise their importance in relation to science foresight, in which the output from one institution or funder is rarely in focus but rather a whole research area.

A good example of analyses concerning trends and novelties within scientific fields is the Faculty 1000 initiative,[16] which is a service for researchers

14. ACM digital library http://dl.acm.org/citation.cfm?id=1555449

15. For further information, see ESF MO Forum on Evaluation: Indicators of Internationalisation

16. http://f1000.com/

and clinicians, providing ratings of and commentary on research papers. The service acts as a filter, identifying and evaluating the most significant articles from biomedical research publications. A peer-nominated faculty of scientists and clinicians rate the articles they read and explain their importance. This shows the new participative approaches through new technologies and the development of new Internet tools that can benefit any science foresight initiative. Moreover, the accumulation of experience in using foresight tools and thinking actively about the future can stimulate other stakeholders or policy makers to conduct their own foresight exercises after being inspired.

4.4 Involvement and motivation of excellent scientists in science foresight

Long-term foresight strategy is as much skilled art as science, which needs to be reflected in attracting those experts capable of uncovering new emerging fields. Thus, aiming to have one voice for science in Europe, science foresight must be rooted in the community of scientists linked with true cooperation with the funding bodies that launch the funding schemes and the funding lines that can contribute to the further development of emerging fields. Bringing together key experts, knowledge and ideas enables us to look beyond normal planning horizons and to identify opportunities that could arise from new science and technologies and to explore the actions that we might take to help to realise those opportunities. To stimulate new and groundbreaking ideas, challenging paradigms and 'business as usual', it is also important to involve excellent young scientists in foresight exercises.

However, leading scientists must be involved in foresight exercises from a pragmatic point of view as "...a scientific contribution will have greater visibility in the community of scientists when it is introduced by a scientist of high rank than when it is introduced by one who has not yet made this mark." "For the development of science, only work that is effectively perceived and utilised by other scientists, then and there, matters,"[17] but also as a fundamental basis for the exercise as "not only do they have themselves achieved excellence, they have the capacity for evoking excellence in others." As "... cognitive material presented by an outstanding scientist may have greater stimulus value than roughly the same kind of material presented by an obscure one", it also then facilitates acceptance of the results of the foresight exercise by the rest of the scientific community.

The main issue that RFOs and RPOs face is how to attract the best available scientific talent to conduct science foresight. In order for the scientific community to accept the results, the outcome of the foresight, having leading scientists involved in the exercise is important. So how can science foresight attract the best available scientific talent? Organisational structures and practices of scientific organisations are the result of three interrelated phenomena: first, reputation requires that scientific organisations arrange themselves in ways that can attract eminent scientists; second, interaction requires adopting structures and practices that facilitate meaningful linkages and connections to other scientific organisations; and third, imitation entails that scientific organisations seek to emulate and learn from practices associated with other, leading scientific organisations.

Therefore, it is important to take into account the motivations for scientists to take part in science foresight activities. Their reputation, a potential reward, a spirit of service-oriented communities and the advocacy aim of the activities mainly motivate them. At the moment, finding the right experts and scientists is a difficult exercise since there is no central European institution that collects and distributes this information. It could be vital for Europe to develop such an institution to ensure quality assurance and monitoring of science foresight activities.

17. Merton, R.K. (1968) The reward system in Science – the Matthew effect. *Science* 159(3810), 56-63.

5.
Conclusions and Recommendations

5.1 Needs at European level

"My interest is in the future because
I am going to spend the rest of my life there."
CHARLES F. KETTERING (American engineer)

There is a need for coordination and standardisation of science foresight in Europe; we lack a common understanding and definition of science foresight. Through transparency and coordination, better-informed strategic decisions can be made, on a European as well as on national and regional levels. The science foresight exercises that are being done in Europe have very different characteristics, in size, profundity and quality of reports as well as participation of leading scientists. There is a difference in how and when the results are disseminated; they also have very different impacts and recommendations. There is no standardised way of doing foresight, nor is there an authority of European science foresight. Successful foresight exercises call for an understanding of the foresight processes as much as an informed and relevant selection of topics. The recruitment of leading scientists is essential to have a knowledgeable and legitimate outcome, which, as such, can have the desired impact.

Science foresight relies on the involvement of researchers and other experts in science, and the methods by which to involve them vary widely, from horizon scanning to questionnaires and Delphi. The common objective of these methods is to gain information about current and foreseen strengths, weaknesses, opportunities and threats in different scientific fields, and to build strategies for funding research or recruiting researchers based on this knowledge. However, in order to enable science foresight to be performed in an informed way, there is a need for data and tools to support the experts. There is an urgent need to organise data related to science foresight and indicators in Europe. And likewise, there is a need for European standards for collecting and classifying the data, and for these

Main challenges for science foresight in Europe

- To address fragmentation and duplication in science foresight exercises.
- To continually track the evolution of established and upcoming scientific fields and the performance of scientific experts (horizon scanning and intelligence).
- To define transformational topics and themes for European science foresight exercises.
- To identify 'leading scientists' on the basis of merit to form a 'European Science Faculty'.
- To organise and standardise the process of science foresight studies and to publish the results in an appropriate open manner.
- To have a European online platform to promote and disseminate standards, best practice and methodologies.
- To present necessary and sometimes controversial issues and possible developments to policy makers.
- To produce authoritative recommendations with appropriate acceptance in
  a. The respective scientific community, and
  b. Within national research councils and research performing organisations.

classifications to be harmonised with the prioritisations, which will most likely be performed, based on science foresights. For joint strategy development in Europe, these prioritisations should relate to scientific areas, grand challenges or infrastructures, which require large-scale funding and collaboration. Specifying these aims will ensure that the tools are set up in an adequate way for optimal governance of the research system in Europe.

5.2 Conclusions

"As for the future, your task is not to foresee it, but to enable it."
ANTOINE DE ST EXUPÉRY (French writer)

5.2.1 Key results

Amongst policy makers, there is a clear lack of awareness of science foresight, in addition to a perceived lack of time and funding to be dedicated to such an activity within organisations. This is partially due to the insufficient skills locally available to conduct science foresight successfully. This perception is becoming more problematic at a time when the level of expectations from both the public at large and the funders is increasing. It is natural to ask for better justifications for funding based on impact, return on investment for society and focus on grand challenges. It appears that science foresight is mainly taking place at the beginning of funding calls and rarely during or after the funded activities, which raises the question of transparency of the evaluation process and the next round of funding. Indeed, research and innovation policies are necessarily based on visions of the future of science, technology and society, and need more systemic instruments to manage the increasing complexity of dynamics of scientific, societal and economical changes. Hence, the successful establishment of the European Research Area (ERA) requires open coordination of these visions of the future of science and society, as well as the use of science foresight as a systemic instrument.

5.2.2 Needs and recommendations

A. **The creation of a EU Science Foresight Platform with institutional support.** In order to continually track the evolution of established and upcoming scientific fields and the performance of scientific activities, it is necessary to coordinate the collection of data on policy input, research output and the societal, political and legal environment in which the research is being conducted. The Forum suggests the creation of a one-stop-shop online platform with an annual conference that would consolidate the foresight knowledge base by contributing to the development of a scientific reference system and exchange of experiences and reflections. It would help applying foresight practices to gather anticipatory intelligence in specific policy fields and the impact of foresight on policy.

B. **The development of an EU Science Foresight Toolbox** that would include best practice, methodologies, guidelines, standards and examples. This would reduce the parallel efforts by all individual member state countries and maintain EU science intelligence. Basic elements, such as expert panels, project team, sponsors, reporting and recommendations, would be complemented by adapted specific elements, including methodological sophistication, degree of participation, budget, timescales, organisational configuration, etc. Access to all the data should be based on an open access policy.

C. **The preparation of an EU Science Foresight Roadmap.** Since science foresight is a highly professional activity that requires independence and expertise (similar to what the European Science Foundation has provided with Forward Looks activities over the last decade and that Science Europe could take over), the Member States could prepare a European roadmap for Science Foresight. The roadmap would foster authoritative recommendations with broad acceptance in the respective scientific communities and within national organisations as can be seen on other continents (USA, Japan...), and would help reducing fragmentation. It would also be important to maintain a 'faculty' of science foresight professional experts and of 'leading scientists' based on merit, who may participate in science foresight activities.

Annexes

Annex 1. **Bibliography**

ESF MO Forum on Science in Society Relationships (2012) *Science in Society: A Challenging Frontier for Science Policy* (http://www.esf.org/activities/mo-fora/science-in-society-relationships.html)

ESF MO Forum on Evaluation of Publicly Funded Research (2012) (http://www.esf.org/activities/mo-fora/evaluation-of-publicly-funded-research.html)

ESF *Forward looks* (http://www.esf.org/activities/forward-looks.html)

Keenan, Michael (2006) Technology Foresight: An Introduction

Barré, Rémi (2001) Strategic Policy Intelligence: IV Synthesis of technology foresight

Miles, Ian (2004) Three worlds of foresight

Miles, I. and Keenan, M. (2002) *Practical Guide to Regional Foresight in the United Kingdom, European Commission.*

Health research classification system (http://www.hrcsonline.net/)

Gordon, T.J. and Glenn, J.C. (2009) *UNU Millennium Futures Research Methodology collection, Chapter 2: Environmental scanning*

EFMN Mapping foresight (2009) (http://ec.europa.eu/research/social-sciences/pdf/efmn-mapping-foresight_en.pdf)

Georghiou, et al. (2008) the Handbook of Technology Foresight, Edward Elgar, Cheltenham.

Merton, R.K. (1968) The Matthew effect in science – the reward and communication systems of science are considered, Science vol. 159 No. 3810.

The national strategy for research and innovation in France (SNRI) 2009-2012

The Nuclear Physics Long Range Plan 2010 (http://www.nupecc.org/index.php?display=lrp2010/main)

The EC Expert group Global Europe 2030-2050 report, State of the art of international Forward Looking Activities beyond 2030 (http://ec.europa.eu/research/social-sciences/fwl-experts-groups_en.html)

Selected examples of science foresight initiatives:

European Foresight (http://forera.jrc.ec.europa.eu)

France, INRA, l'*Institut national de recherche alimentaire – Agrimonde: Scenarios and Challenges for Feeding the World in 2050* (http://www.international.inra.fr/content/download/2596/49543/version/2/file/INRA-CIRAD2009-AgrimondeSummary.pdf)

Organisation for Economic Co-operation and Development (OECD) – International Futures Programme (http://www.oecd.org/dataoecd/37/54/42332642.pdf)

Chinese Academy of Sciences (CAS) Science and Technology – Roadmaps to China 2050 (http://www.alphagalileo.org/PrintView.aspx?ItemId=61845&CultureCode=en)

ESF Member Organisations (MOs): Refers to ESF member organisations, which are Research Performing Organisations (RPOs) and Research Funding Organisations (RFOs).

ESF MO Forum: an output-oriented, issue-related venue for the member organisations, involving other organisations as appropriate, to exchange information and experiences and develop joint actions in science policy.

Evaluation: (Ex-Post) evaluation is the description, analysis and assessment of projects, programmes processes or organisational units. It is performed in the course of, or after, an intervention.

Funding scheme: funding programmes or funding instruments distribute funding based on explicit requirements and often with an explicit objective, e.g., to promote scientific careers, to enable research collaboration.

Output data: Information on tangible and quantifiable research output (research findings) such as publications or patents.

Research Funding Organisation: A governmental agency or private organisation, which funds research.

Research infrastructure:[18] a European Research Infrastructure is a facility or (virtual) platform that provides the scientific community with resources and services to conduct top-level research in their respective fields. These research infrastructures can be single-sited or distributed or an e-infrastructure, and can be part of a national or international network of facilities, or of interconnected scientific instrument networks.

Research Performing Organisation: An institute or other organisation, which is itself realising research and employs active researchers.

18. As defined by MERIL (http://www.esf.org/activities/science-policy/research-infrastructures/meril-mapping-of-the-european-research-infrastructure-landscape/what-is-meant-by-research-infrastructures.html)

Most common foresight methods (from ForSociety Transnational Foresight ERA-Net[19])

Bibliometrics: statistical analysis of books, articles, or other publications, taking into account the prestige/impact factor of journals and the number of citations of the article.

Brainstorming: can be used for supporting the generation and development of new ideas in a group process. The tools aim at focusing the thinking, getting beyond the obvious ideas and structuring ideas. It supports creative, exploratory thinking.

Delphi: The Delphi method is a structured survey exploring the opinions, experience and knowledge of participants (mainly experts) and confronting and comparing these with the opinions, experience and knowledge of other experts, thereby emphasising the development of a mutual consensus by forcing the participants to explain the reasons for their views in the face of the opinion of others.

Expert panels: one of the most frequently used methods in foresight. The method aims at eliciting existing expert knowledge. The panels are typically groups of 12-20 individuals who represent different disciplines and who are given 3-18 months to deliberate upon the future of a given topic area, whether it be a technology, an application area or an economic sector. The methods do not provide direct guidance for the implementation. It provides a flexible framework and other methods like scenarios and participatory facilitation methods are typically used as a part of the process.

Horizon scanning: Systematic examination of potential threats, opportunities and likely future developments that are at the margins of current thinking and planning. May explore novel and unexpected issues, as well as persistent problems or trends. Early warning system.

Scenario building: The method helps the decision maker or any other potential user to consider a range of plausible futures, to articulate preferred visions of the future, and to use what is learned during the scenario process in informal or formal strategy making and decision making. It may also help to unleash the creativity of

19. http://forlearn.jrc.ec.europa.eu/index.htm

participants and encourage them to challenge conventional wisdom. Good scenarios stimulate participants to take the long view.

SWOT analysis: A technique that is widely used to identify and categorise significant internal (Strengths and Weaknesses) and external (Opportunities and Threats) factors faced either in a particular arena, such as an organisation, territory, region, nation or city. It is a tool that synthesises expert knowledge and results of more detailed studies. In addition to just listing the factors, their importance for the future can also be analysed.

Lead Organisation to 'Develop Science Foresight and Use its Results as a Basis for Joint Strategy Development'

Mandate of EUROHORCs to the European Science Foundation (ESF)

Background

In April 2009, the EUROHORCs General Assembly approved a joint EUROHORCs/ESF policy document entitled *EUROHORCs and ESF Vision on a Globally Competitive ERA and their Road Map for Actions.* The document lists **10 vision points**, which are necessary to reach a globally competitive European Research Area (ERA) as well as 10 **actions** to implement these visions. Action 3 **'Develop science foresight and use its results as a basis for joint strategy development'** is intended to address the need to develop an effective European research policy, capitalising on cultural geographic and scientific diversity and to promote transnational funding, benchmarking of quality and shared scientific priorities for strategic research and researcher-driven programmes.

The ESF Strategic Plan 2006-2010 introduced the Forward Looks (FL) as the flagship activity of ESF's strategic arm. Forward Looks enable Europe's scientific community, in interaction with policy makers, to develop medium- to long-term views and analyses of future research developments with the aim of defining research agendas at national and European levels. Forward Looks are driven by ESF's member organisations and, by extension, the European research community. Quality assurance mechanisms, based on peer review and consensus building where appropriate, are applied at every stage of the development and delivery of a Forward Look to ensure its quality and impact.

In January 2007 a short ESF report *Looking beyond the Endless Frontier*, produced by a group of experts in the field, summarised the main criteria and methodological approach to develop successful FLs. From this report a first set of guidelines were issued about how to design and execute FL activities in the best possible quality assurance approach. In April 2007 these guidelines were officially presented to the ESF Governing Council.

Mandate to the European Science Foundation

The General Assembly of EUROHORCs mandates the European Science Foundation as the Lead Organisation to "Develop science foresight and use its results as a basis for joint strategy development".

Goals

The following actions are proposed to position ESF as a key organisation for coordinating Science Foresight in Europe and promote Joint Strategy Development:

- Develop ESF Forward Looks into a **high-quality foresight instrument** across all fields of research.
- Ensure that the ESF Forward Looks will have **greater impact**. A great proportion of the Forward Looks managed by the scientific committees have originated from scientists, and lately some ESF Member Organisations have commissioned ESF to develop specific foresight studies. As foresight aims at the long term, its outcome should not be formulated in terms of expected results to be obtained but in terms of 'Grand Challenges', the big questions to be **answered** starting initially with the questions that researchers themselves would like to address and ending with the questions that society would find relevant.
- Ensure that ESF studies will include the **three components of foresight** in science, i.e., analysis of the knowledge generation and dissemination, of the needs for infrastructures and research centres and of the socio-economic context and impact. **It is necessary** to move away from one-size-fits-all approaches and give foresight an enhanced role in policy design tailored to particular context, national, regional, local or sectorial.

Actions

In order to position ESF as a science foresight provider for its member organisations, there is a need to:

1. Launch a Member Organisation Forum. Items to be addressed by the MO Forum:

- Debate about the choice of science topics that could benefit from foresight as a basis for joint strategy development and joint programming.
- Define the scope of the desired foresight study and propose the best approach to up-grade the current FL methodology.
- Consider additional synergy with instruments like 'Exploratory Workshops' for scoping purposes, 'Science Policy' for reaching policy makers and 'Conferences' for additional impact.

Annex 3. MO Forum Mandate

- Identify (1) resources within member organisations to constitute a community of practice between member organisations and ESF, (2) key potential partners both at a European (e.g., European Commission and EIRMA) and an international level, and contract the *ad hoc methodological support and/or strategic alliances.*
- Implementation: Submit a proposal to the April 2010 Governing Council.

2. Revisit the current guidelines to produce a more ambitious business model fit for the purpose of running foresight studies in science adapted to joint strategy development.
Implementation: Analysis of the impact of ESF FLs and writing new procedures to be approved by the April 2010 Governing Council.

3. Design the corresponding training modules to accommodate the needs of the Science Advisory Board, those of the Science Officers within our member organisations, and those of ESF Science Officers responsible for running the activities.
Implementation: Contract with consultant(s) and organisations (e.g., IPTS, Seville)

4. Agree on the best work plan and financial support to implement the above approach.
Implementation: Approval at the EUROHORCs General Assembly in October 2010.

Annex 4. **List of MO Forum members**

Country	Organisation	Member
Belgium	Research Foundation – Flanders (FWO)	Hans Willems
Czech Republic	Academy of Sciences of the Czech Republic (ASCR)	Karel Aim (Co-Chair)
Finland	The Academy of Finland	Paavo-Petri Ahonen
France	National Centre for Scientific Research (CNRS)	Charles Hirlimann
France	National Institute for Agricultural Research (INRA)	Isabelle Albouy
France	French National Institute of Health and Medical Research (Inserm)	Claire Giry (Co-Chair) Thierry Damerval Richard Salives
Germany	German Research Foundation (DFG)	Daniel Bovelet
Germany	Max-Planck-Society (MPG)	Andreas Trepte (Co-Chair) Christoph Ettl
Ireland	Science Foundation Ireland (SFI)	Roisin Cheshire Stephen Simpson
Italy	National Research Council (CNR)	Anna d'Amato Giuseppe Martini
Lithuania	Research Council of Lithuania	Jurgita Stonyte Aiste Vilkanauskyte
Norway	Research Council of Norway	Ellen Veie
Poland	Polish Academy of Sciences (PAN)	Jacek Kuciński
Spain	Council for Scientific Research (CSIC)	Juan José Damborenea
Sweden	Swedish Council for Working Life and Social Research (FAS)	Erland Hjelmquist
Sweden	Swedish Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS)	Vikoria Halltell
Sweden	Swedish Research Council (VR)	Jenny Nordquist (Co-Chair) Anna Herou
Switzerland	Swiss Academies	Stefan Nussbaum
Turkey	The Scientific and Technological Research Council of Turkey (TÜBITAK)	Serhat Çakir
Forum management		
	European Science Foundation (ESF)	Thibaut Lery Laura Marin

ISBN: 978-2-918428-97-8
Printing: Ireg Strasbourg

European Science Foundation
1 quai Lezay-Marnésia • BP 90015
67080 Strasbourg cedex • France
Tel: +33 (0)3 88 76 71 00
Fax: +33 (0)3 88 37 05 32
www.esf.org

April 2013 – Print run: 1000