

THE GERMAN COUNCIL OF SCIENCE AND HUMANITIES
(WISSENSCHAFTSRAT) PROVIDES ADVICE TO THE GERMAN
FEDERAL GOVERNMENT AND THE STATE (LÄNDER)
GOVERNMENTS ON THE STRUCTURE AND DEVELOPMENT OF
HIGHER EDUCATION AND RESEARCH.

Science-driven Evaluation of Large Research Infrastructures for the National Roadmap – Pilot Phase

What are research infrastructures?

Research infrastructures serve to enable research in the broadest sense. The German Council of Science and Humanities distinguishes between four different types of research infrastructures: |¹

- _ Centralized and distributed research infrastructures, which provide instruments, for instance accelerators, observation stations or research vessels,
- _ information infrastructures, which provide various resources, like libraries or collections,
- _ information technology infrastructures, which could be indicated as service facilities and include for instance supercomputers, and
- _ social research infrastructures as meeting centres, like the Institutes of Advanced Study represent.

Why are research infrastructures important?

The importance of research infrastructures has been increasing. They have become indispensable in almost all areas of science for dealing with scientific research questions and for the promotion of young scientists. Besides the researchers themselves and the institutions they represent another supporting pillar of the research system. Along with their scientific importance also the challenges grow (financially and also with respect to the organization); financially, because they become more and more resource-intensive, and with respect to the organization, because the degree of complexity of the institutions or the networks increases.

|¹ Cf. therefor also earlier recommendations of the Wissenschaftsrat: Statement on nine large-scale facilities for basic scientific research and on the development of investment planning for large-scale facilities (Drs. 5385-02), July 2002; *Stellungnahme zu einer umfangreichen Forschungsinfrastruktur für die Grundlagenforschung: Tiefseeforschungsschiff (Nachfolge Forschungsschiff "Sonne")* (Drs. 9204-09), May 2009; Recommendations on a renewal and strategic realignment of the German fleet of research vessels – Extended Abstract (Drs. 10421-10), November 2010; Recommendations on Research Infrastructures in Humanities and Social Sciences (Drs. 10465-11), January 2011; Recommendations on Scientific Collections as Research Infrastructures (Drs. 10464-11), January 2011; *Übergreifende Empfehlungen zu Informationsinfrastrukturen* (Drs. 10466-11), January 2011.

What is the way to new research infrastructures?

The typical idealized life-cycle phases of a research infrastructure are illustrated in the following figure.



In the pilot phase of the roadmap process various research infrastructures of different stages of maturity went through the science-driven evaluation. But they were all in the phase before the implementation, hence in the preparation phase.

Which research infrastructures were evaluated?

In the pilot phase of the roadmap process the Federal Ministry of Education and Research (BMBF) nominated nine research infrastructure projects, on whose funding had to be decided, for evaluation to the German Council of Science and Humanities. They all fulfill the following criteria: they (1) are of national strategic importance, (2) are characterized by a long lifespan, (3) required more than EUR 15 million of investment and operating costs during the first ten years and (4) their access and hence their use is regulated via an evaluation of the scientific quality.

From the scientific area of engineering and natural sciences:

- _ Cherenkov Telescope Array (CTA)
- _ European Magnetic Field Laboratory (EMFL)

From the scientific area of environmental sciences:

- _ In-service Aircraft for a Global Observing System (IAGOS)
- _ Cabled Ocean Observing System Frontiers in Arctic Marine Monitoring (Cabled OOS FRAM)
- _ European Plate Observing System (EPOS)
- _ Global Earth Monitoring and Validation System (GEMIS)

From the scientific area of biological and medical sciences:

- _ European Infrastructure of Open Screening Platforms for Chemical Biology (EU-OPENSREEN)
- _ German Research Infrastructure of Imaging Technologies in Biological and Medical Sciences (German Euro-BioImaging – GEBI)
- _ Integrated Structural Biology Infrastructure (INSTRUCT)

What is a roadmap and which ones already exist?

Roadmaps, as the term is used here, present the need for research infrastructures of scientific communities and/or of a country. |² Decisions on the inclusion of new projects in the roadmap are generally supported by science- and quality-driven assessments. Hence the resulting published research or rather research political demand analysis and determination, can function as a basis for discussions between the responsible authorities of the infrastructure and the funding bodies and may strengthen the position of a country in international negotiations.

The European Strategy Forum on Research Infrastructures (ESFRI) |³, founded in 2002, massively accelerated the roadmap processes in Europe. Seven of the nine assessed research infrastructures are also listed there.

Since the first ESFRI Roadmap for Research Infrastructures was published in 2006 and regular updates |⁴ followed, many European states have started similar processes. The following table gives an overview of existing roadmaps in Europe.

Country	Year of publication of roadmap(s) and strategy paper(s) respectively
Austria	2009, 2010, 2011 strategy papers
Czech Republic	2010 roadmap
Denmark	2011 roadmap
Estonia	2010 roadmap
Finland	2009 roadmap
France	2008, 2012 roadmaps, 2010 strategy paper
Greece	2005, 2007 roadmaps
Ireland	2007 roadmap
Italy	2010 strategy paper (in Italian), 2011 roadmap (in Italian)
Malta	2006 strategy paper
Netherlands	2008, 2012 roadmaps
Norway	2008 strategy paper, 2010, 2012 roadmaps
Romania	2008 roadmap
Slovenia	2011 roadmap und strategy paper
Spain	2007, 2010 roadmaps
Sweden	2006, 2007, 2012 roadmaps
Switzerland	2010 strategy paper, 2011 roadmap
UK	2001, 2005, 2008, 2010, 2012 roadmaps

As of February 2013; this table is not exhaustive.

In the meantime also other non-European countries, like Australia, China, Japan or South Africa, publicly present their plans and need for research infrastructures by publishing a

|² In this context publications with a list of projects or precise needs for research infrastructures of one country or one large political area, like Europe, are defined as roadmaps. A publication, which deals with necessary developments and general scientific needs for the scientific landscape of a country, is described as strategy paper.

|³ Cf. http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri-background of 28 February 2013.

|⁴ ESFRI: Strategy Report on Research Infrastructures. Roadmap 2010, Luxembourg 2011.

roadmap. Additionally, there are roadmaps, which are specialized in one subject and therefore not necessarily limited to one country (an example is astroparticle physics |⁵).

What is new about the German roadmap and why is it necessary?

As a difference to the ESFRI roadmap or also the roadmap of the Helmholtz Association |⁶, the “Roadmap for Research Infrastructures” of the BMBF is not a mere “wish list” of research infrastructures, whose realization is desirable. With inclusion in the roadmap the BMBF indicates its willingness in principle to fund the implementation of the project.

Such a roadmap is important and necessary for Germany because

- _ it contributes to a long-term investment strategy with respect to establishing research infrastructures in Germany,
- _ it reacts on the scientific communities and contributes to synergetic effects,
- _ it contributes to Germany’s positioning in Europe and also globally, and
- _ Germany is taking on a pioneering role through announcing a willingness in principle of funding with the inclusion in the roadmap. Thus possibly further strengthening its influence on international developments of research infrastructures.

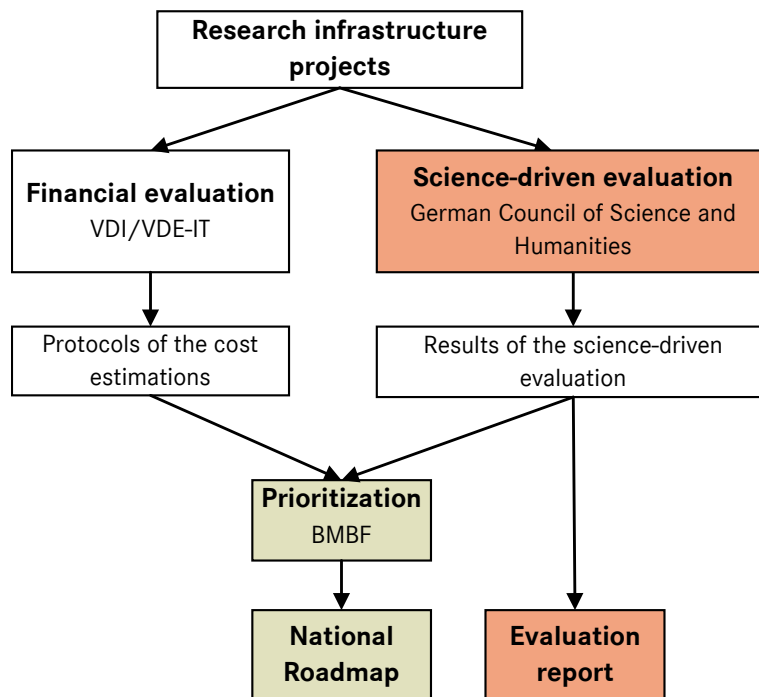
How was the roadmap-process organized in the pilot phase?

The science-driven evaluation by the Committee of the German Council of Science and Humanities and the economic assessment by the VDI/VDE Innovation und Technologie GmbH (VDI/VDE-IT) proceeded in parallel and independently of each other. The results of both processes constituted the basis for the prioritization of the BMBF, which decided on the inclusion of the research infrastructure in the roadmap by also taking its socio-political relevance into account.

|⁵ ASPERA (AStroParticle ERA-net): European Roadmap for Astroparticle Physics. Edition 2011.

|⁶ Helmholtz Association: Helmholtz-Roadmap for Research Infrastructures. As of 2011, Bonn 2011.

The figure gives an overview of the process as a whole.

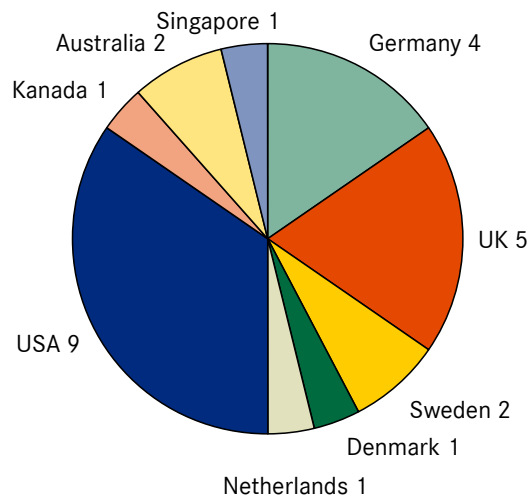


Who was involved in the science-driven evaluation?

For the science-driven evaluation the German Council of Science and Humanities established a mandated Committee in July 2011. This Committee consisted of 17 members, of which six are currently also members of the Council. Of the external experts three work in Germany, whereas the other eight are located in Switzerland (3), Austria (1), Great Britain (2) and the US (2). Each research infrastructure proposal was assigned to one Committee member who was close to the subject to function as rapporteur. Contrary to the general procedure of joint consultancy of science and politics in the Council, the federal government and the state governments (*Länder*) were not part of the Committee. As the Committee was mandated the evaluation did not have to be approved by the German Council of Science and Humanities.

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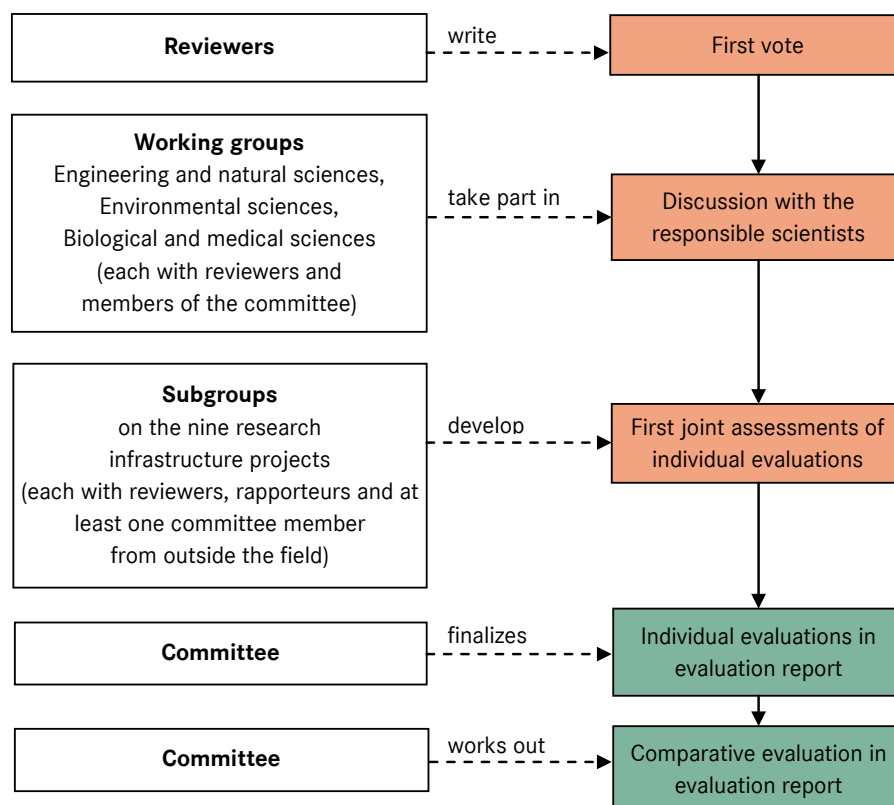
Furthermore for each research infrastructure projects three reviewers were consulted. |⁷ Their countries of origin (with respect to the institutions) can be seen in the following figure.



|⁷ One reviewer assessed two projects, which showed an overlap, at once so that in total 26 reviewers were involved in the process.

How did the science-driven evaluation proceed in detail?

The procedure of the science-driven evaluation is depicted in the figure below. It should be noted that, between the receipt of the research infrastructure proposals at the Head Office of the Council and the delivery of results to the BMBF, little more than nine months were required for the evaluation. |⁸



Both, the individual evaluation and the comparative evaluation follow four evaluation dimensions:

- _ Scientific potential (amongst others the development of new research fields, extension of existing fields, existence of competing and complementary research infrastructures),
- _ Utilization (amongst others the size and origin of user groups, regulation of the access to research infrastructures),
- _ Feasibility (amongst others the technological requirements, institutional and personnel requirements of the hosting institution),

|⁸ Cf. Wissenschaftsrat: Concept for a Science-driven Evaluation of Large Research Infrastructure Projects for a National Roadmap (Pilot Phase) (Drs. 1766-11), Cologne December 2011.

- _ Relevance to Germany as location of science and research (amongst others relevance of the research infrastructure proposal to Germany's role and interests, impact on the visibility and attractiveness of German science).

Which challenges do research infrastructures have to face?

The increasing relevance and the diversification of the types of research infrastructures generate challenges, which were identified during the roadmap process. For the optimization of the establishment of research infrastructures they should be analyzed in more detail and hence realized according to best practices.

- _ The elaboration of governance-structures is often neglected in favour of work on the scientific question of a research infrastructure, although they are in many ways critical for its success.
- _ The relevance of data management of a research infrastructure, i.e. the challenges associated with the data collection and archiving, the access to data and data processing are often underestimated.

The financing of research infrastructures is complex and unclear. The actual challenge lies within the sustainable financing of the entire lifespan and of the utilization of research infrastructures.