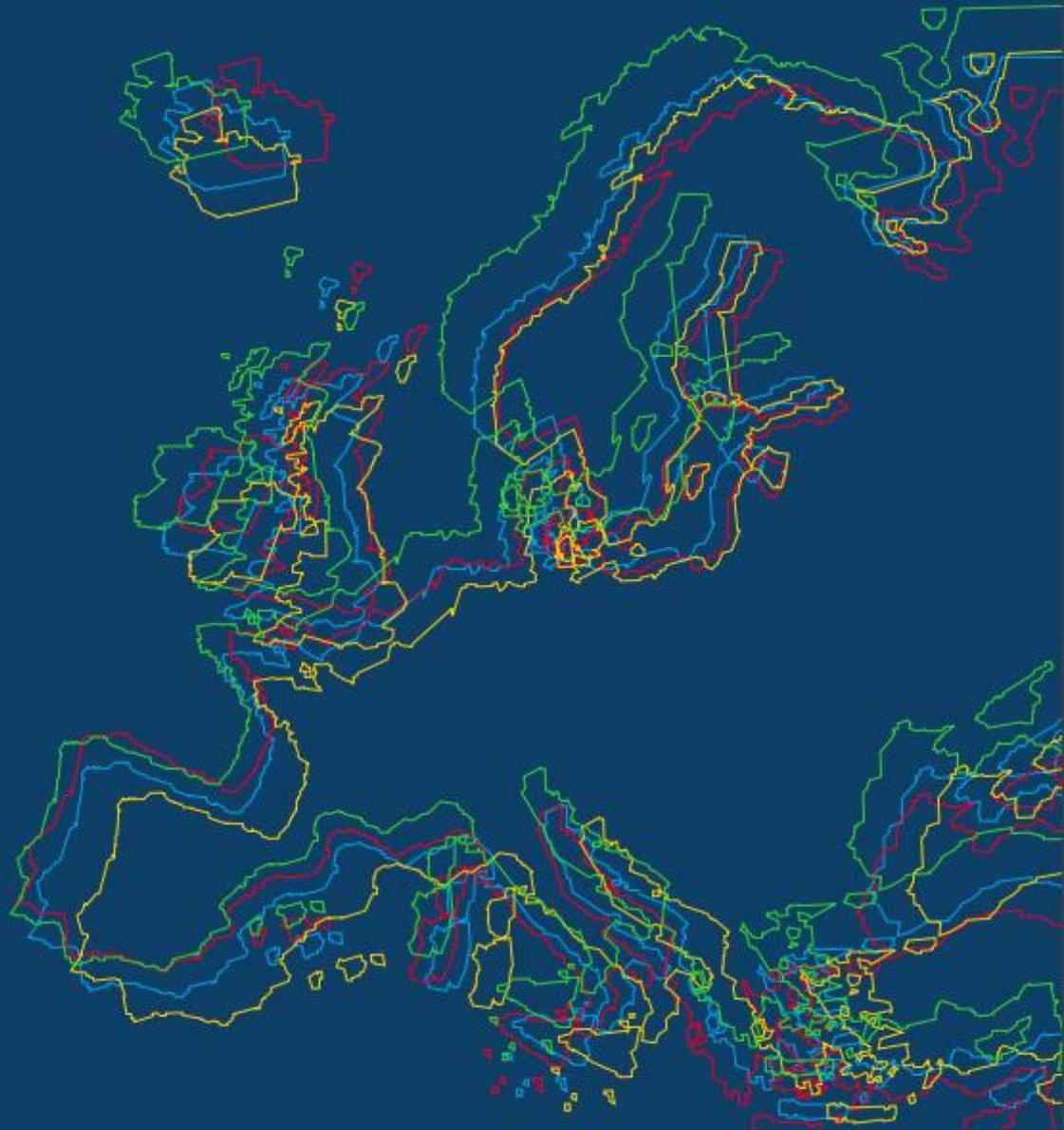




**InRoad**

synchronising research infrastructure  
roadmapping in Europe



# Good practices and common trends of national research infrastructure roadmapping procedures and evaluation mechanisms

(InRoad deliverable D3.3)



InRoad has been funded by the  
European Union's Horizon 2020  
Research and Innovation programme  
under grant agreement No 730928.

# GOOD PRACTICES AND COMMON TRENDS OF NATIONAL RESEARCH INFRASTRUCTURE ROADMAPPING PROCEDURES AND EVALUATION MECHANISMS (D3.3)

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Brussels, 10.12.2018



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## Executive summary

The InRoad Deliverable 3.3 describes and analyses national research infrastructure roadmapping procedures, as well as evaluations and monitoring processes in Europe. For this purpose, four case studies (Finland, Netherlands, Czech Republic and Sweden) of national roadmapping processes were conducted, from which good practices and key results were derived. Furthermore, a desk study was carried out to compare national procedures for the evaluation and monitoring of RIs and to identify additional good practices. On the basis of a cross-country analysis, the results of the consultation and survey (compendium) conducted in 2017 on national roadmapping processes were also evaluated and compared. The results of the different data sources as well as the good practices were the basis for the policy insights on coordination between national and European RI roadmapping processes and embedding RI roadmapping processes in national research and innovation systems formulated in the InRoad final report. In general the results showed a great diversity and heterogeneity in the respective national roadmapping processes, yet also some good practices were identified which could contribute to a better coordination of these processes.



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## List of Abbreviations

AC	Associated Countries
EA	Dutch Ministry of Economic Affairs
ECS	Dutch Ministry of Education, Culture and Sciences
ELIXIR	European Life Science Infrastructure for Biological Information
EPOS	European Plate Observing System
ERA	European Research Area
ERDF	European Regional Development Fund
ESF	European Social Fund
ESFRI	European Strategic Forum for Research Infrastructures
ESIF	European Structural and Investment Fund
FIRI	Finnish Research Infrastructure Committee
Formas	Swedish Council for Environment, Agricultural Sciences and Spatial Planning
FOM	Foundation for Fundamental Research on Matter
FORTE	Swedish Council for Health, Working Life and Welfare
GDP	Gross Domestic Product
HR	Human Resources
ICT	Information and Communication Technologies
IPR	Intellectual Property Rights
KNAW	The Royal Netherlands Academy of Arts and Sciences
MEC	Finnish Ministry of Education and Culture
MEE	Finnish Ministry of Employment and the Economy
MEYS	Ministry of Education, Youth and Sports (Czech Republic)
MS	Member States
NRIRMP	National Research Infrastructure Roadmapping Process
NRRI	National Roadmap for Research Infrastructures (Bulgaria)
NWO	Netherlands Organisation for Scientific Research
OP RDE	Operational Programme Research, Development and Education
OP RDI	Operational Programme Research and Development for Innovation
PRO	Public Research Organisations of Finland
R&D	Research and Development
R&I	Research and Innovation
RDI Council	Research, Development and Innovation Council (Czech Republic)
RFI	Swedish Research Council for Research Infrastructures (Rådet för forskningens infrastrukturer)
RI	Research Infrastructure
RIC	Finnish Research and Innovation Policy Council
RVO	Netherlands Enterprise Agency
SIA	Taskforce for Applied Research



SRC	Strategic Research Council at the Academy of Finland
STW	Dutch Technology Foundation
SUHF	Association of Swedish Higher Education Institutions (Sveriges universitets – och högskoleförbund)
UNIFI	Universities Finland
URFI	Universities' Reference Group for Research Infrastructures (Sweden)
VINNOVA	Swedish Agency for Innovation Systems
VR	Swedish Research Council (Vetenskapsrådet)
ZonMW	Netherlands Organisation for Health Research and Development



## 1. Introduction

The objectives of this InRoad Deliverable 3.3 (D3.3) are to describe common trends and good practices in national research infrastructure roadmapping procedures and evaluation in Europe. This should serve to clarify whether or not European Member States and Associated Countries coordinate with the European Strategy Forum on Research Infrastructure (ESFRI) roadmapping processes and what opportunities and constraints that presents in terms of coordinating RI from national to EU-level. The target group for this report are primarily actors in charge of coordinating national RI roadmapping processes, policy makers and funders.

The research interest of the four case studies follows the overall research interests of InRoad. To strengthen the sustainability of the Research Infrastructure (RI) landscape in Europe, InRoad seeks to define good practice in national RI roadmap processes in order to increase harmonisation and coordination across national processes and at a European level (ESFRI roadmapping process).

Based on this research interest, the case studies should contribute to identifying good practices and lessons learnt in terms of RI roadmapping at national level and their alignment with the ESFRI roadmap.

The main research questions were formulated as follows.

1. What are the detailed steps taken in the realisation of the national RI roadmap?
2. What are the mechanisms in place for coordination with other countries and with the roadmap process at European level (ESFRI roadmap)?
3. How do the relevant actors identify benchmark elements within a national RI roadmap processes that would contribute to better coordination with other countries and with the roadmap process at European level (ESFRI roadmap)?



## 2. Methodology

The identification of common trends and good practices in national research infrastructure roadmapping and evaluation in EU Member States/Associated Countries (MS/AC) was organised in four major steps: 1) Consultation, validated compendium, national roadmaps, 2) Case studies and desk studies, 3) Validation workshop, 4) Analysis and Discussion.

### 2.1 Consultation, validated compendium and national roadmaps

The data gathered from 27 EU MS/AC during the InRoad consultation conducted from May to June 2017 with its subsequent [consultation report](#) and the [InRoad compendium](#), formed the basis of the analysis. Moreover, national roadmaps and further national RI documents were used not only to assess common trends, but also to identify good practices in national RI roadmapping processes, and evaluation and monitoring procedures.

### 2.2 Case studies, desk studies and validation workshop

The unit chosen for the case study analysis is the entire decision-making process for one cycle of a national RI roadmapping process. This includes all relevant aspects at the system level, the process level as well as the actor level. In order to identify good practices, the selection of cases considered countries with more experience with national RI roadmapping over broad representation and therefore the selected national RI roadmapping process had to meet the following criteria:

- is based on previous RI roadmapping exercises (min. one roadmap update);
- includes an assessment of the European and national research landscape;
- includes a scientific and economic evaluation of new and existing projects;
- includes a business plan as an eligibility criterion;
- is linked to national research priorities in general;
- is linked to funding commitments;
- is coordinated with roadmapping at EU level.

Moreover, the selection of cases focused on relatively small European countries from different parts of Europe with particular demand for prioritisation of public funding for large-scale RIs and that participated in the InRoad consultation process. The selection matrix is detailed in Annex 1 of Deliverable 3.3.

Based on these criteria and preconditions, the following four countries were selected: Sweden, Czech Republic, Netherlands and Finland.

The analyses and results presented in this report are based on a total of 30 interviews conducted with actors involved in RI roadmapping processes in these four selected countries: representatives from ministries and funding agencies, advisers and RI representatives. The interview guide and list of interviewees can be found in Annexes 2 and 3 of InRoad Deliverable 3.3 respectively. The interviews provide detailed background information on the processes and actors in national RI roadmapping processes, and evaluation and monitoring procedures. The interviews were transcribed and good practices from these four countries were extracted.

Similarly, desk studies regarding Bulgaria, Czech Republic, and Ireland on the monitoring and evaluation in national RI roadmaps in Europe was carried out and corresponding good practices identified (see details in synthesis of country desk studies on monitoring and evaluation). Desk studies from a larger set of countries in Europe were used to derive common trends in monitoring and evaluation.



The identified good practices were generalised and potential recommendations developed. Together with the description of needs and first trends in the development of ESFRI roadmap processes, the recommendations were further described and structured in two thematic sections; 1) coordination between national and European roadmapping processes, and 2) embedding RI roadmapping processes in national research and innovation systems.

Finally, during the Validation Workshop (2-3. October 2018), the potential recommendations from the four country case studies were introduced to all participants in a plenary session. The potential recommendations were then interactively discussed during table discussions and broadly validated by the 73 participants coming from 21 different countries.

## 2.3 Analysis

Data was analysed based on the compendium indicators and information from national roadmaps and strategy reports. A trend is understood here to be either a certain development over time or a certain pattern of parameters that can be observed over a given time period. These common trends were interpreted with respect to their potential connection to ESFRI processes or other influences (regional, country or country internal influences), if evidence was available from the data. Common trends were also interpreted in terms of the direction of development, converging, diverging or stabilising, respectively.

The results were further discussed with respect to applicability in different country settings in Europe (e.g. countries with a small national budget for RI compared to countries with a larger RI budget). In summary, the positively tested recommendations and the set of good practices are presented as key findings.

## 3. Synthesis of cases studies on national RI roadmapping processes

The following case studies provide an overview of the national RI roadmapping processes of Finland, Netherlands, Czech Republic and Sweden according to the methodology described in the introduction. For each case study, the implementation of the roadmapping process is described, as well as the current roadmapping process and the actors involved. An analysis of the process (in terms of strengths and potential bottlenecks) is provided, and good practices are identified for each case.

### 3.1. Finnish Case Study

Chronology and future plans

2021	Planned next update of Finnish roadmap
2018	Finland's Strategy and Roadmap for Research Infrastructures 2014–2020. Interim review report 2018. Academy of Finland
2014	Finland's Strategy and Roadmap for Research Infrastructures 2014–2020. Academy of Finland
2009	National-level research infrastructures. Present state and roadmap. Summary and Recommendations. Ministry of Education



### 3.1.1. The Finnish R&I System

The Finnish governance system is quite centralised in terms of national guidelines, strategies and funding. Yet a mix of national and local administration allows regions to have a relatively high degree of autonomy in the design and implementation of regional policies. Regional responsibilities are especially focused on allocating structural funds. The Finnish R&I System is divided into four operational levels and the Finnish parliament and the Finnish government rule the highest level. In matters related to research, technology and innovation policy, the latter is supported by a high-level advisory body, the Research and Innovation Policy Council (RIC). The second level consists of the ministries, of which the Ministry of Education and Culture (MEC) and the Ministry of Employment and the Economy (MEE) play the main role in research and innovation policy. On the third level of the Finnish Innovation system, there are competitive R&I funding and the R&D funding agencies. The fourth level is comprised of organisations that conduct research (Halme et al. 2016, p. 19).

Figure 1 provides a graphical overview of the R&I system of Finland.

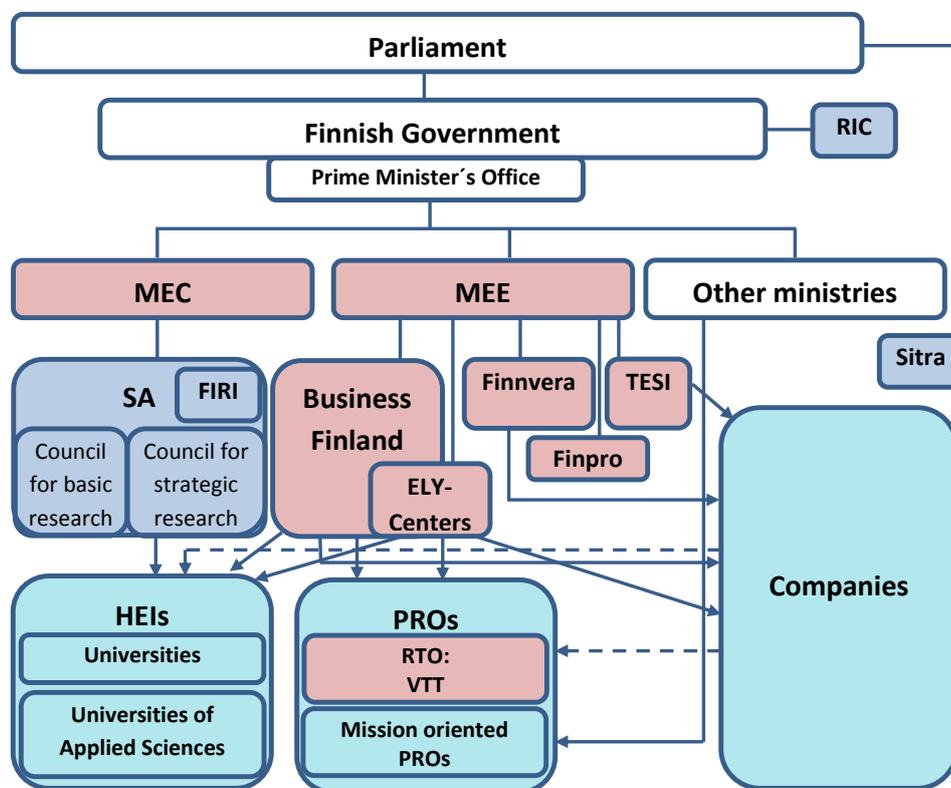


Figure 1: Overview of the Finnish R&I system (after Academy of Finland, 2013, p. 17)<sup>1</sup>.

<sup>1</sup> HEI: Higher Education Institutions (Universities, Polytechnics); ELY Centres: Centres for Economic Development, Transport and the Environment are responsible for the regional implementation and development tasks of the central government; Finnvera Ltd: Specialised financing company owned by the State of Finland and it is the official Export Credit Agency (ECA) of Finland; Finpro helps Finnish SMEs go international, encourages foreign direct investment in Finland and promotes tourism; PMO: Prime Minister's Office RIC Research and Innovation Policy Council; MEC: PRO: Public Research Organisations (Research.fi, PROs); SA: Academy of Finland; Sitra: The Finnish Innovation Fund; TESI: Finnish Industry Investment Ltd, a government-owned investment company; VTT: Technical Research Centre of Finland.

### 3.1.2. Embedment of RI in the Finnish R&I system

In the Research and Innovation Council's Vision and roadmap for 2030, Finland is committed to become the most attractive and competent environment for experimentation and innovation by 2030. In 2016, the Finnish public and private sector together invested 2.75% of the national gross domestic product (GDP) in research and innovation activities, having peaked in 2009, at 3.75%. This level remains among the highest in the EU despite the decline. In innovation, research and development, technology and competitiveness, Finland is ranked 10<sup>th</sup> in the Global Competitiveness Index 2017–2018; fifth amongst European countries, after Switzerland, the Netherlands, Germany, and Sweden. Achieving this vision for 2030 requires measures to provide a solid competence base and promote competence platforms, growth ecosystems and internationalisation (Research and Innovation Council, 2017).

The Finnish RI ecosystem is composed of 32 major national RIs, partnerships of Finnish actors in European RI (ESFRI), 27 international RIs that Finland has joined through state agreements or other agreements, and 344 local RIs denoted as significant by their host research organisations. In cooperation with the Open Science and Research Initiative, the [Finnish RI databank](#) describes and showcases RIs and their services in a unified manner with persistent identifiers (PID) to promote sharing and openness among researchers, RI service providers, and funders. The total funding of roadmap infrastructures from 2014 to 2016 was 483 M€ (excluding CSC RI, Finna, FinElib). Of this, 70 M€ was from the Finnish Research Infrastructure Committee (FIRI) and 413 M€ was from other funders. RI funders include FIRI, Business Finland, the EU, other domestic actors, companies, other foreign funders, ministries, and H2020. Regarding RI innovation and business from 2013 through 2016, 22 RIs developed 327 new technologies, 14 RIs produced 103 accepted patents, 13 RIs produced 274 invention disclosures, 13 RIs cooperated with 37 national companies, 6 RIs cooperated with 35 international companies and 12 RIs received 8.7 M€ corporate funding (Särkioja, 2018).

Finland's Strategy and Roadmap for Research Infrastructures steers the development of all parts of this RI ecosystem (Academy of Finland, 2014). Key objectives of this strategy are:

- Long-term development of all RI
- Improvements to the openness and collaborative use of RI
- Shoring up of the funding base of RI
- Provision of a firm basis, by the roadmap, for the methodical development of RI
- Evaluation of the impact and significance of RI

In order to achieve these goals systematically, short-term and long-term measures were developed for each objective. These measures serve to improve the clarity and coherence of the overall picture of national RI, as well as to promote the openness and scientific impact of such RI. The strategy and roadmap including its measures were monitored, publicly discussed, revised, and reported in Finland's strategy and roadmap for RI 2014–2020: Interim review report 2018 (Academy of Finland, 2018). Since these measures have great operational value in terms of achieving Finland's objectives to meet its 2030 vision, these can be regarded as good practices in themselves.

International RI are considered an integral pillar of Vision 2030 in terms of improving quality, impact and the renewal of Finnish science and research, especially with respect to the importance of international engagement in RI. This is further detailed in the Academy of



Finland's international policy for 2017–2021 (Academy of Finland, 2017). Therefore, the international merits of applicants for research funding is taken into account in proposal reviews.

### 3.1.3. The Finnish RI roadmapping process

#### 3.1.3.1. Implementation of Finnish national RI roadmapping process

Following the first ESFRI roadmap needs assessment to construct and update RIs at the European level in 2006 and the EU's Competitiveness Council recommendation on the preparation of national-level roadmaps to the MS, Finland prepared its first national roadmap which was published in 2009. The purpose of this first national roadmap was to identify RIs that would be required for the following 10–15 years to meet both national needs and international RI developments such as ESFRI.

For this roadmap, an intersectoral steering group including representatives from administration, scientific communities, funding parties and the private sector was tasked with:

- 1) Developing a proposal of procedures to identify and evaluate the needs for establishing new national RIs or for developing existing RI and the procedures for prioritising such projects;
- 2) Developing a proposal for a RI funding system including the division of tasks among financing parties with respect to common RIs associated with multiple organisations or different sectors of administration as well as international RI;
- 3) Conducting a preliminary inventory in collaboration with the Research Councils of the Academy of Finland and Tekes of significant national RI and to make proposals for their renewal and development (Ministry of Education 2009).

#### **Inventory of needs**

With funding from the Ministry of Education to carry out the inventory, the intersectoral steering group was appointed. The inventory and the preparation of the roadmap during 2008 was then conducted by the Federation of Finnish Learned Societies in connection with various parties that made additional proposals for participation in present or future international RIs.

The resulting Finnish roadmap published in 2009 covered the inventory of 24 existing projects of significant national-level infrastructures in Finland including information on their estimated operating costs and numbers of users in 2007, grouped according to thematic ESFRI categories. The roadmap also detailed Finnish involvement in significant international infrastructures, with information on membership fees in 2007 and the year of affiliation.

New national-level and ESFRI RIs with Finnish participation for the roadmap were listed including the estimated time of construction, estimated construction and operational costs for Finland and their connection with ESFRI. Additionally, national or international proposals that may develop into significant national RIs by the merging of particular projects in order to reinforce the national RI capacity or by meeting other requirements were detailed.

General recommendations as well as specific recommendations for each thematic RI area were described, based on the needs of the Finnish R&I system as a whole and for its contributing thematic areas. These recommendations cover issues such as clustering and interdisciplinary cooperation, funding and costs recording, internationalisation, digitisation, as well as the need for a RI policy, among others in a qualitative manner (Ministry of Education, Science and Culture 2009).



### 3.1.3.2. Current Finnish RI strategy and roadmapping process

The 2009 roadmap and its recommendations resulted in a broader discussion of Finland's RIs. Finland's Ministry of Education, Science and Culture assigned the task of administering the country's national RI policy to the Academy of Finland. The Academy established a broad-based committee of experts across disciplines, ministries and innovation partners, the Finnish Research Infrastructure Committee (FIRI-Committee), for this purpose.

Finland's Strategy and Roadmap for Research Infrastructures 2014–2020, published in 2014, includes Finland's first-ever RI strategy and an updated roadmap for 2014–2020. This RI strategy governs the Finnish RI ecosystem including major national RI, Finnish partnerships within ESFRI projects, memberships of other international RIs and research organisations' strategically significant RIs.

The Strategy and Roadmap for Research Infrastructures is a plan. It covers the national RIs to be developed and what will require renewal over the next 10 to 15 years. The 2014–2020 roadmap includes 31 national RIs, 18 of which are with ESFRI. The selection criteria include; RI importance to the Finnish scientific community and to the research strategies of the host organisations, the breadth of the user community, the need for funding and the long-term commitment of the host institutions (Academy of Finland 2014).

#### **Landscape analysis**

The Finnish roadmap includes a description of opportunities and challenges for the systematic development of RI in the hope that Finland will gain recognition for its internationally competitive science and high-quality RI, which would enable the renewal of learning, society and the business sector by 2020.

#### **Action plan**

In order to meet this vision by 2020, clear actions were described with respect to the long-term development of all RI, improvements of access to and collaborative use of RI, shoring up of the funding base of RI, the provision of a firm basis through the roadmap for the methodical development of RI and the evaluation of the impact and significance of RI. The selection process and criteria were described in a transparent way and published.

The plan is targeted to be useful to universities and research institutes in their development of research quality within their research environments, while strengthening the impact of research and promoting internationalisation. Additionally, the overview of the development phase of the RI ecosystem will support the work of the ministries, as well as innovation within the private sector (Academy of Finland, 2014).

In 2017, the Academy of Finland performed the mid-term evaluation of the Finnish strategy and roadmap and finished this process in May 2018. The steps for this process included a call for RI that were already on the roadmap, an evaluation, assessment of the fulfilment of the plan, and public seminars to report and discuss the results (for details please see below). The RIs included on the Finnish roadmap 2014–2020 are shown in table 1.



Table 1: RIs on the Finnish roadmap 2014-2020 and their grouping based on the interim

A: VERY ADVANCED 10	B: ADVANCED 14	C: PROMISING 4	D: UNDER OBSERVATION 4
<b>BBMRI Finland*</b>	<b>CESSDA Finland*</b>	<b>Aalto Ice Tank</b>	<b>EATRIS Finland*</b>
<b>Biocenter Finland</b>	<b>EISCAT-3D</b>	<b>FinBIF</b>	<b>FGCI</b>
<b>BIOECONOMY</b>	(Finland*)	<b>oGIIR</b>	<b>Finna</b>
<b>CLARIN Finland*</b>	<b>EPOS Finland</b>	<b>RAMI</b>	<b>MAXIV Finland*</b>
<b>CSC RI</b>	<b>ESS Finland*</b>		
<b>ELIXIR Finland*</b>	<b>Euclid Finland*</b>		
<b>EuBI Finland</b>	<b>EU-OPENSREEN</b>		
<b>FINMARI</b>	Finland		
<b>INAR RI**</b>	<b>FinELib</b>		
<b>PRACE Finland*</b>	<b>FMAS</b>		
	<b>INFRAFRONTIER</b>		
	Finland*		
	<b>INSTRUCT Finland</b>		
	<b>JYFL-ACCLAB</b>		
	<b>NaPPI Finland</b>		
	<b>NVVL</b>		
	<b>Otanano</b>		

review in Finland (Academy of Finland, 2018, p. 16) <sup>2</sup>.

<sup>2</sup> \*Membership of international RI;

\*\* Membership and headquarters (ICOS) in Finland;

Aalto Ice Tank: Aalto University multi-purpose tank to research physical phenomena related to ice, ships and waves; BBMRI: Biobanking and Biomolecular Resources Research Infrastructure; Biocenter Finland: Distributed national research infrastructure of five biocenters; BIOECONOMY: Bioeconomy Infrastructure; CESSDA: Finland Consortium of European Social Science Data Archives; CES RI: IT Center for Science Ltd; CLARIN: Common Language Resources and Technology Infrastructure; EATRIS: European Advanced Translational Research Infrastructure in Medicine; EISCAT\_3D: European Incoherent Scatter Facility, ISR radar system located in Kiruna, Sodankylä and Tromso; ESS: European Spallation Source; EUCLID: ESA cosmological mission to study dark energy; EU-OPENSREEN Finland European Infrastructure of Open Screening Platforms for Chemical Biology; EuBI: Euro-BioImaging, European Research Infrastructure for biomedical imaging; FinBIF: Finnish Biodiversity Info Facility; FINMARI: Finnish Marine Research Infrastructure; FGCI: Finnish Grid and Cloud Infrastructure; FMAS: Finnish Microdata Access Service; INAR RI: Integrated Atmospheric and Earth System Science Research Infrastructure; INFRAFRONTIER European Infrastructure for Phenotyping and Archiving of Model Mammalian Genomes; Instruct: Integrated Structural Biology; JYFL-ACCLAB: Accelerator Laboratory of the Department of Physics at the University of Jyväskylä; MAX IV: MAX IV Laboratory; NaPPI Finland: National Plant Phenotyping Infrastructure.



### 3.1.3.3. Finnish methodology to select RI for the roadmap

The Academy of Finland provides funding for RIs based on competition. This means that a RI that succeeds in a competition to be listed on the national Finnish roadmap is not necessarily guaranteed funding and must compete with others in further open calls on an annual basis. Academy of Finland funding is dedicated to upgrading high-quality RIs e.g. in order to proceed to international RIs like ESFRI and to cover some membership fees.

National roadmap RI proposals from research organisations are evaluated in a two-stage process by international panels of experts representing the specific proposal disciplines. The assessment criteria include general and specific criteria. The specific criteria include:

- Scientific quality and potential;
- Open access and utilisation, Finish and international users;
- Relevance to the strategies of the host institutions;
- National and international relevance;
- Feasibility.

Based on the assessment results, the FIRI-Committee decides which RIs to include on the national roadmap. The process is schematically depicted in Figure 2.

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NVVL: National Virus Vector Laboratory; oGIIR: Open spatial data research infrastructure; OtaNano: Otaniemi micro- and nanotechnology research infrastructure; PRACE Finland: Partnership for Advanced Computing in Europe; RAMI:RawMATTERS Infrastructure



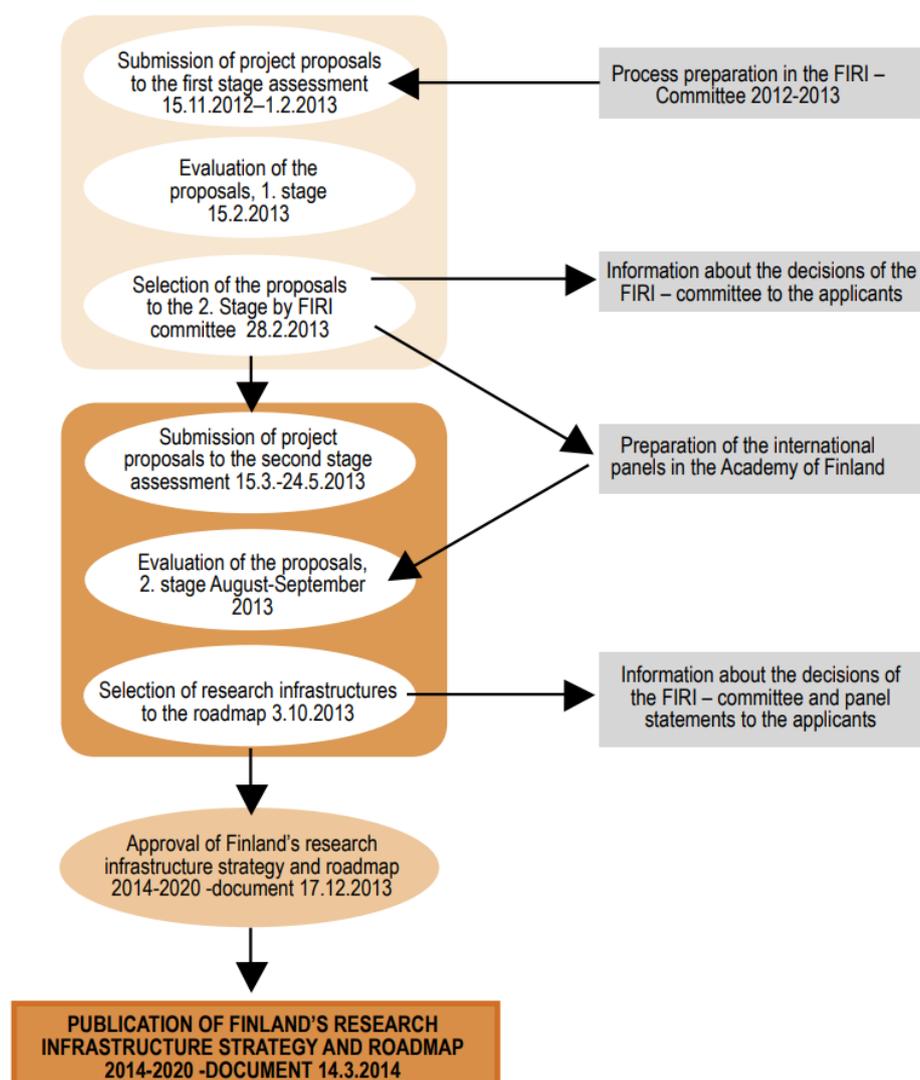


Figure 2: Process for selecting RI for the national roadmap in Finland. (Academy of Finland, 2013, p. 17).

#### 3.1.3.4. Finnish methodology to monitor existing RIs which are on the roadmap

In 2017, the Academy of Finland performed the mid-term evaluation of the Finnish strategy and roadmap and finished this process in May 2018. The decision to perform such an evaluation halfway through the period of roadmap validity was strategically planned in the 2014 roadmap. The steps for this process included a call for RI that were already on the roadmap, an evaluation, assessment of the fulfilment of the plan, and public seminars to report and discuss the results, as illustrated in the figure below.

The procedure for the mid-term evaluation is presented in the Figure 3.



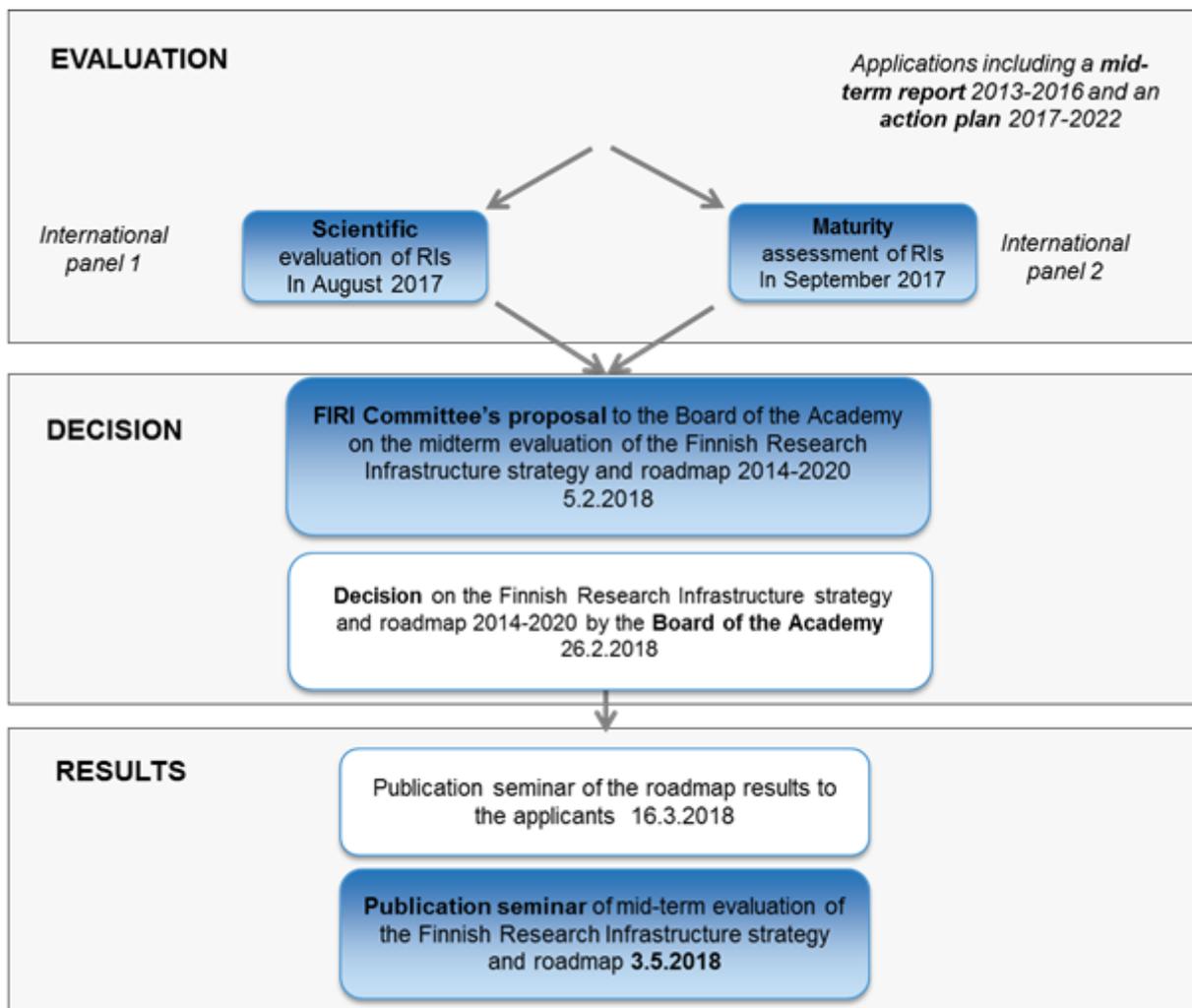


Figure 3: Finnish mid-term evaluation procedure (adapted from Academy of Finland, 2018, p. 15).

For this mid-term review, the Academy of Finland opened a call for RI mid-term evaluation to those RIs that were already on the roadmap and also those eight RIs that got funding outside of the roadmap from 2013 through to 2016. Based on the strategic plans of the Finnish research organisations and universities and their willingness to commit to funding these RIs for decades, they submitted 41 RI proposals altogether to the Academy of Finland (Academy of Finland 2018).

All of the proposals were evaluated by two different panels: the scientific panel and after that the so-called RI panel. The scientific panel evaluated all aspects of scientific relevance and the RI panel evaluated RI-specific issues such as governance, long-term sustainability, organisational and managerial issues, etc. The same criteria were used for all proposals irrespective of their specific scientific field by one evaluation panel, which required the selection of panellists with expertise that covered a wide range of areas. However, different evaluation criteria were applied in 2018 which were dependent on the specific RI lifecycle phase that was presented in the proposal, distinguishing RIs that are already on the roadmap from those that are not yet or those that belong to other international memberships. Likewise, there will be FIRI funding calls with respect to RI roadmap inclusion and categorisation (Table 2).

Table 2: Finnish roadmap evaluation criteria for RI on the roadmap 2014–2020, international memberships, and RI outside of the roadmap (Academy of Finland, 2018, p. 19).

<b>Review RI</b>	<b>RI on the roadmap</b>					
	<b>A: Very advanced</b>	<b>B: Advanced</b>	<b>C: Promising</b>	<b>D: Under Observation</b>	<b>E: Other intern. member- ship</b>	<b>F: Outside road- map</b>
<b>Level of advancement</b>	yes	yes	yes	yes	yes	yes
<b>Promotion of science</b>	no	no	yes	yes	no	yes
<b>Development needs</b>	no	yes	no	yes	no	no
<b>Funding in FIRI call</b>						
<b>Roadmap call</b>	eligible	eligible	eligible	eligible	eligible	in-eligible
<b>New initiatives call</b>	ineligible	ineligible	ineligible	ineligible	ineligible	eligible

All RI applications were evaluated on their specific level of advancement; however, RIs in the very advanced or advanced categories and international member infrastructures no longer needed to present the ways by which they have advanced scientific research in their applications. For these RIs, the results of the 2018 interim review are sufficiently convincing to be considered reliable until 2020.

Scientific advancement will continue to be evaluated annually for applications filed as promising RIs, RIs under observation, and RIs outside of the roadmap, including new initiatives. Future FIRI funding calls will also evaluate how RIs in the advanced category have been able to address the developmental needs identified in the mid-term review. As a prerequisite of continued FIRI funding, these development needs must have been successfully addressed. In the case of RIs under observation, if the identified developmental needs are significant, they must be addressed as a prerequisite to continued FIRI funding and the continued inclusion of the RI in the next roadmap. For the evaluation of RI proposals that are attempting to enter the ESFRI Roadmap, one crucial criterion that must be met is that there is a sufficient number of users for the RI in Finland.

The evaluation results of the two panels were submitted to the FIRI-Committee who then made the final decision on which RIs out of the 41 are to be taken into the roadmap for the next three years. Simultaneously, the mid-term evaluation fed into the development of a new RI strategy for the years 2017 until 2020 carried out by the FIRI-Committee, which was approved by the board of the Academy of Finland.

The results from the mid-term evaluation and the new strategy were published in two seminars to inform the wider public and to collect feedback with a view to further improvements. The first seminar (March 2018) with focus on the roadmap took place to



inform the RI managers who submitted proposals on the outcome of the evaluation, while the subsequent seminar included the presentation of the new strategy (May 2018) and presented the whole report to the wider public.

The evaluation criteria for RIs including eligibility, general and specific evaluation criteria are listed in the following (Academy of Finland, 2018).

### **Evaluation criteria for RIs**

**Eligibility criteria:** An RI to be included in the roadmap must:

- create international interest
- attract top-level researchers to Finland
- produce added value in their research, and
- markedly raise the standard of research in Finland in their respective field
- must also support the direction of scientific impact outside the scientific community to public services, culture, the economy, health and the environment.

**General evaluation criteria for RI.** An RI must:

- provide potential for world-class research and scientific breakthroughs
- be of broad national interest and enhance the international impact
- have a long-term plan for scientific goals, maintenance, financing and utilisation
- be used by several research groups/users for high-quality research
- be open and easily accessible for all researchers
- have a plan for access to and preservation of collected data and/or materials in spirit of open science and data policy.
- be extensive enough so that individual groups cannot manage them on their own
- introduce new cutting-edge technology (if relevant).

An RI can be national or international and single-sited, distributed or virtual. The development of research infrastructures involves several phases, from ideas, concept development, and planning to construction and operation, to occasional upgrading, and eventually to phasing out. These phases have different financing needs. To ensure that long-term research infrastructure needs are met, different types of support and financing are necessary. From a research infrastructure perspective, relevant types of funding include:

- planning grants for design studies and planning of construction or collaboration
- grants for investing in equipment or databases, used to construct national or international research infrastructures or a single research infrastructure that is nationally accessible
- grants for operational costs of maintaining the operation in the long term and
- grants for phasing-out the research infrastructure (when relevant)

A well-designed funding plan is important for the long-term design of a research infrastructure. The construction phase, mainly for centralised research infrastructures involving facilities and instrumentation, requires major, limited-time investment costs. The cost balance between construction and operation may be the opposite for distributed research infrastructures, where the greatest expense is seldom the investment cost, but rather the cost of ongoing work in standardisation, harmonisation and quality assurance of procedures and data.



Usually, RIs must be upgraded to maintain their competitive strength, necessitating the financing of new investments. Eventually, most research infrastructures will be phased out, which is associated with substantial costs of disassembling technical equipment and phasing out staff, etc. Hence, a phase-out plan should also be established prior to a decision to build a research infrastructure.

### **Specific evaluation criteria for RIs**

The RI projects evaluated may be at different stages in terms of their lifecycle. Some are in the planning phase while others might already be completely operational. For those research infrastructures that are in the planning phase, the evaluation is mainly based on anticipated future impacts rather than actual results. For existing research infrastructures, the actual results are evaluated.

The criteria used should be fair and equal, reflecting the international state of the art within the field in question. Major upgrades of existing research infrastructures or their reorientation require an evaluation of all criteria, the general and specific ones.

The evaluation of the research infrastructures is carried out in a process comprised of five different dimensions. Each research infrastructure is evaluated individually in each separate dimension as well as in comparison to the other infrastructures in all other areas of science. The dimensions are as follows:

- Scientific quality and potential
- Open access and utilisation
- Relevance to the strategies of host institutions
- National and international relevance
- Feasibility and sustainability

### **Scientific quality and potential**

The leading principle of evaluation is enabling scientific excellence through the RI. Specifically, the following issues must be addressed:

- The research infrastructure is of scientific significance, enables frontier research, is timely and provides added value at the national and international level;
- The research infrastructure is continuously used by excellent researchers and research groups;
- Existing research infrastructures shall provide an account of their activities, showing utilisation rate and impact, for example, in the form of publications and data methods;
- The research infrastructure participates in the training of researchers and students or is utilised for these purposes.

### **Open access and utilisation**

Research infrastructures have developed in many different ways. The use of research infrastructures has partly grown organically over time and partly been tailored to specific research needs. In many cases, new research infrastructures attract excellent user groups from other disciplines as well as researchers from abroad.

- There should be transnational open access to the research infrastructure. Access may require the approval of a research plan and reasonable user fees as compensation for the maintenance, user support and other services;



- The research infrastructure should have data policy that supports the Open Science concept, in which research methods, data and outcomes are all thoroughly documented and publicly accessible in an open manner. Therefore, the research infrastructure must have a data management plan that consists of information on data acquisition, computation, storage, and ownership of the data;
- The research infrastructure must have clear and well-functioning leadership and administrative structures, adequate personnel for the maintenance, services and user support of the research infrastructure;
- The research infrastructure should monitor its utilisation rate;
- The research infrastructure should demonstrate its contribution to training, e.g. provision of courses, professional guidance and science education.

### **Strategic relevance of the research infrastructure for Finland**

Building and operating a research infrastructure requires a long-term commitment from the research infrastructure itself and the host, as well as other contributing institutions. Therefore, the strategies and priorities of the host institution(s) will also be included in the evaluation.

#### National and global relevance

This dimension of evaluation relates to the added value the research infrastructure provides for the national and/or global research community, and how it contributes to the visibility, global attractiveness and the future development of the Finnish research environment.

- Strategic significance of the research infrastructure for Finland
- Added value of research infrastructure
  - for society, at large
  - for innovation activities, business and economy through global cooperation (e.g. mutual mobility) of Finnish research community.

### **Feasibility and Sustainability**

The feasibility and sustainability of each project proposal is assessed on the basis of the technical, institutional (e.g. form of ownership, terms of use or membership) and personnel requirements of the facility during the whole life cycle of the research infrastructure.

The specific expenses considered during the evaluation include planning, investment, operational and decommissioning costs during the whole lifecycle of the research infrastructure.

#### Planning costs/investment costs

- Construction/building (incl. manpower)
- Acquisition of real estate
- Special technical equipment
- Supply/construction of devices and equipment

#### Operating costs

- Personnel costs (e.g. operation, maintenance, user support)
- Material costs (incl. membership fees or other payment of contributions to organisations)
- Costs of running the premises (rent, electricity)



- Other noteworthy investments (replacement purchases) required to keep the research infrastructure and equipment at an adequate level of function, reflecting the state-of-the-art

Decommissioning costs

- Costs of closing down the business and conservation of the resources developed

Ensuring sustainable funding during the whole lifecycle of the research infrastructure is essential, not only for the research infrastructure itself, but also for the user community at large. In the financial plan, investment and operational costs should be detailed explicitly as well as the associated sources of those funds. Flexible business models are essential to keep RIs sustainable in the long run.

### 3.1.4. Actors involved in the Finnish RI roadmapping process

#### **Government and its R&I advisory body**

The Finnish Research and Innovation Council (RIC) was established in 2009 and is the most important advisory body for the Finnish government on research and innovation. Finland's Ministry of Education, Science and Culture assigned the task of coordinating the country's national RI policy to the Academy of Finland in 2011. Finland's Ministry of Education, Science and Culture is also active in the Nordic Council of Ministers and its sub-organisation NordForsk helps develop RI collaboration at Nordic level and to promote linkages with European and global RI.

#### **Academy of Finland**

The Academy of Finland facilitates and supports scientific research through the provision of funding and through international cooperation. It also plays an important role in science policy development and implementation and provides other expert services as laid down by government decree or as prescribed by the Ministry. The Academy of Finland presently has four research councils: The Research Council for Biosciences and Environment, the Research Council for Culture and Society, the Research Council for Natural Sciences and Engineering and the Research Council for Health. After the merging of two of these, from January 1<sup>st</sup> 2019, there will be only three research councils in the Academy of Finland: The Research Council for Biosciences, Health and the Environment, the Research Council for Culture and Society, and the Research Council for Natural Sciences and Engineering. The research councils work alongside a number of other decision-making bodies within the Academy, that is, the Academy Board, subcommittees, the FIRI-Committee and the Strategic Research Council. In addition, the Strategic Research Council (SRC) at the Academy of Finland was built in 2014 and developed a reference framework for strategic research in Finland, and provides funding to long-term and programme-based research.

#### **The Finnish Research Infrastructure Committee**

The Academy of Finland established the FIRI-Committee in 2012. This committee was tasked with assessing Finland's RIs within the whole Finnish R&I system and to coordinate, follow-up and develop Finland's national RI policy, as well as draft proposals for the participation of Finnish RIs in international RI collaborations. The FIRI-Committee is comprised of a broad-based expert group with key actors in research infrastructure policy, such as representatives of the Academy of Finland; the Ministry of Education, Science and Culture; the Ministry of Employment and the Economy; the Ministry of Social Affairs and Health; Business Finland; Finnish universities; Universities Finland UNIFI; state research institutes; the Council of

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Research Institute Directors and the Rectors’ Conference of Finnish Universities of Applied Sciences. The chair of the expert group must be broadly representative of the RI field. The FIRI Committee also administers the funding of RI that comes from the state budget.

The table below summarises the role of the actors involved in the Finnish roadmapping process. This is a summary and not a comprehensive overview as, for example, the full list of stakeholders involved in the amendment procedure is not public.

Table 3: Composition and tasks of actors involved in the national RI roadmapping process in Finland.

<b>Actors</b>	<b>Composition</b>	<b>Tasks</b>
FIRI committee	<p>A broad-based expert group with key actors in RI policy, such as representatives of</p> <ul style="list-style-type: none"> <li>• the Academy of Finland</li> <li>• the Ministry of Education, Science and Culture</li> <li>• the Ministry of Employment and the Economy</li> <li>• the Ministry of Social Affairs and Health</li> <li>• Business Finland</li> <li>• Finnish universities</li> <li>• Universities Finland UNIFI</li> <li>• state research institutes;</li> <li>• the Council of Research Institute Directors and</li> <li>• the Rectors’ Conference of Finnish Universities of Applied Sciences</li> <li>• The chair of the expert group must be broadly representative of the RI field</li> </ul>	<ul style="list-style-type: none"> <li>• Monitoring and developing national and international RI operations</li> <li>• Proposing a long-term plan for RI to the Board of the Academy</li> <li>• Deciding on the selection of RI projects and the oversight of their progress</li> <li>• Attending to other matters concerning RI, as assigned by the Board of the Academy</li> </ul>
Two international expert panels	<ul style="list-style-type: none"> <li>• See Academy of Finland, 2018, p. 27</li> </ul>	<ul style="list-style-type: none"> <li>• One of the panels evaluates the RI for their scientific quality, potential for renewal and impact,</li> <li>• The second panel focuses on evaluating the organisational level of development of the RIs in terms of their ability to provide stated services</li> </ul>
Academy of Finland	<ul style="list-style-type: none"> <li>• The Research Council for Biosciences and Environment</li> <li>• the Research Council for</li> </ul>	<ul style="list-style-type: none"> <li>• Facilitating and supporting scientific research through the provision of funding and through international</li> </ul>



	<p>Culture and Society</p> <ul style="list-style-type: none"> <li>• the Research Council for Natural Sciences and Engineering and</li> <li>• the Research Council for Health.</li> </ul> <p>After the merging of two of these councils, from January 1<sup>st</sup>, 2019, there will be:</p> <ul style="list-style-type: none"> <li>• The Research Council for Biosciences, Health and the Environment</li> <li>• the Research Council for Culture and Society, and</li> <li>• the Research Council for Natural Sciences and Engineering</li> </ul>	<p>cooperation. It also plays an important role in science policy development and implementation and provides other expert services as laid down by government decree or as prescribed by the Ministry</p> <ul style="list-style-type: none"> <li>• The research councils work alongside a number of other decision-making bodies within the Academy, that is, the Academy Board, subcommittees, the FIRI-Committee and the Strategic Research Council</li> </ul>
Finnish Research and Innovation Council (RIC)	<ul style="list-style-type: none"> <li>• Prime Minister (chair)</li> <li>• The Minister of Education and the Minister of Economic Affairs (Vice-Chairs together with one more minister)</li> <li>• Five other members appointed by the Government</li> </ul>	<ul style="list-style-type: none"> <li>• Discussing key issues relating to the development of R&amp;I policy that supports wellbeing, growth and competitiveness</li> <li>• Advising the Finnish government on R&amp;I</li> </ul>
Ministry of Education, Science and Culture	<ul style="list-style-type: none"> <li>• Department for General Education and Early Childhood Education</li> <li>• Department for Vocational Education and Training</li> <li>• Department for Higher Education and Science Policy</li> <li>• Department for Art and Cultural Policy</li> <li>• Department for Youth and Sport Policy</li> <li>• Unit for Upper Secondary School Reform</li> </ul>	<ul style="list-style-type: none"> <li>• Actively engaging in the Nordic Council of Ministers and its sub-organisation, NordForsk, to develop RI collaboration at Nordic level and to promote linkages with European and global RI</li> </ul>



Strategic Research Council (SRC) at the Academy of Finland	Representatives from <ul style="list-style-type: none"> <li>• Ilmarinen Mutual Pension Insurance Company</li> <li>• Aalto University</li> <li>• University of Helsinki</li> <li>• Fortum Corporation</li> <li>• University of Tampere</li> <li>• University of Jyväskylä</li> <li>• VTT</li> </ul>	<ul style="list-style-type: none"> <li>• Developing a reference framework for strategic research in Finland, and to provide funding to long-term and programme-based research.</li> <li>• Responsible for project follow-up and impact assessment</li> </ul>
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### 3.1.5. Analysis of the Finnish case

From the beginning the Finnish RI roadmap process has been designed as a transparent national RI strategic plan balancing national RI needs with RI costs information and available research capacities towards a national vision. The tight integration of the RI strategy and roadmap in a plan is fully implemented and expressed in the last documents, '[Finland's Strategy and Roadmap for Research Infrastructures 2014–2020](#)' and its related [interim review report 2018](#). In order to fulfil this plan, intensive consultations with all national actors and international advisors involved have taken place. Structural changes were implemented, such as the establishment of the FIRI-Committee and the revision of the task distribution among the other involved actors. Concrete measures to implement the strategy and roadmap recommendations were setup for different time-frames and the progress and challenges have been continuously reviewed and publicly reported.

The perspective of the Finnish ecosystem integrates national, international and local RIs as elements of one dynamic system with respect to the RI lifecycle and synergies among RIs. Finland also recognised the need for core RIs that provide data and IT services for the whole Finnish RI ecosystem as all RIs have been providing more and more data and require similar services such as storage and retrieval. Through a continuous public engagement process and understanding of the Finnish RI ecosystem, the RI strategy and roadmap has been developed and mainstreamed nationally and internationally.

While the main elements of the roadmap process and the strategy were both established early, the Finnish internal and public engagement process has also been beneficial to foster collaboration and collect feedback in order to continuously further improve, fine-tune and adjust roadmapping elements to better fit to the Finnish R&I system and vision, as well as to promote the joint use, openness and funding base. For coherence between national RI strategies and the roadmap, related strategies and structures have been similarly adjusted in RI host and user organisations such as universities, research organisations, innovation and funding bodies, as well as education institutions.

The results of the first impact assessment of these steps seem promising and point to the overall soundness of the implemented measures at national level. One challenge is to more clearly identify actual RI users in the different disciplinary and interdisciplinary scientific, innovation as well as socio-economic domains, trace the RI impacts to these different users and get a more comprehensive assessment of the scientific, innovation and socio-economic impacts. This would again provide evidence for further improving the RI ecosystem, its supporting measures related to the RI strategy and RI roadmap processes. Furthermore, with that assessment, both users and also new funders could be more closely integrated to the RI ecosystem, thus further improving the overall Finnish R&I system performance.



### 3.1.6. Good practices from the Finnish case

- Finland has introduced a RI committee, staffed with highly qualified professionals from various thematic disciplines and different R&I organisations which are tasked with designing, developing and coordinating long-term RI strategies and processes in interaction with their respective state governments. This way national RI decision-making processes, strategies, budget allocation and prioritisation are streamlined and shaped by an established group of experts.
- Finland follows a systematic, integrated and cross-ministerial approach for the development of their RI ecosystem and has developed an overall vision and roadmap for its research innovation system. The 2014–2020 RI strategy specifies objectives and a program of interlinked short- as well as long-term measures for RIs. These measures are regularly monitored, discussed and adjusted if necessary. The longevity of infrastructure funding in Finland is achieved through collaboration. While the Academy of Finland provides funding primarily during the RI construction, the operating costs are paid by the RI host. To extend RI funding, opportunities and principles for cooperation at the national level and between RIs are pursued.
- In Finland, transparency and a feedback culture is practiced in the national roadmap process. For example, livecasting of seminars in Finland offered national stakeholders as well as stakeholders from other countries the option to participate in the public discussion of the interim review of the strategy and roadmap for Finnish research infrastructures 2014–2020. The discussions provided feedback to the Academy of Finland to improve the national RI roadmapping strategy and process and foster the linkages with national and international stakeholders.
- In the 'Finnish 2018 interim evaluation report on the Strategy and Roadmap for RIs 2014–2020', the Finnish Research Infrastructures Committee (FIRI-Committee) monitored and categorised all 32 RIs listed on their 2014 roadmap and classified them according to their level of maturity (lifecycle) and the fulfilment of predefined criteria into four different categories. Depending on their classification, the questions asked in future monitoring will be adjusted. RIs which were categorised as 'very advanced' and 'advanced' will be assessed more lightly for scientific advancement as they were sufficiently convincing in the 2018 interim review to be considered reliable until the year 2020. Additionally, the development of RIs can be tracked through regular monitoring according to RI categorisation into the different maturity levels. The Finnish RI categorisation provided for more transparency, efficiency and supports long-term decision making.
- In Finland, the national RI strategy and roadmap with implementation measures is a plan to contribute to a national R&I vision with clear targets and invites RI funders, hosts and users to align their strategies and capacities against this national plan. This creates coherence between different elements of the RI strategy: the long-term national plan, implementation and funding measures, RI roadmap and corresponding strategies, measures and roadmap elements at the host and user side.
- During the monitoring of the RI proposals, the same criteria were used for all proposals, irrespective of their specific scientific field, by one evaluation panel. The panel applied different evaluation questions according to the specific RI lifecycle phase presented in the proposal, distinguishing RIs which are already on the roadmap from those which are not yet or which are from other international memberships. Likewise, there will be FIRI funding calls for RI inclusion in the roadmap according to specific RI lifecycle phases.



Depending on their classification, the questions asked in future evaluations will be adjusted and RIs that were categorised as 'very advanced' will be assessed more lightly. Additionally, the development of RI will be tracked through regular evaluation and categorisation into different maturity levels.

- Finland assesses its RI strategy together with the RIs on the roadmap. Finland has produced a report on the interim review of its roadmap. The report investigates the topicality of the RI strategy and its procedures, as well as assesses the progress, in terms of scientific quality and organisational development of RI that are included on the roadmap or are not included but have received funding from the FIRI Committee.
- The Finnish RI-service offers persistent identifiers (PID) for each RI it contains descriptions for. The PID is assigned to the object for its entire lifecycle. It allows each RI to be identifiable in a unique manner. This facilitates the stock-taking of each RI both within and between organisations and evaluations and allows academic merit for RI service providers. PID are used for automated data transfer between information systems and organisations thus improving interoperability between data systems. PID complement and link research information such as scientific publications, research datasets and researchers themselves that already have a PID which facilitates assessing scientific and socio-economic impact of RIs.

The following measures serve as additional good practices (Academy of Finland, 2018):

- Long-term development of all RIs:
  - The FIRI-Committee has drafted principles for identifying and prioritising key RIs. The principles have been further specified in the evaluation of FIRI applications.
  - In cooperation with various actors, the FIRI-Committee has advanced the development of RI activities and their integration as part of the strategic planning of research organisations.
  - Seminars organised by the FIRI-Committee have discussed the importance of RIs and their development together with RI operators.
  - In cooperation with various actors, the FIRI-Committee has carried out situation assessments to expand the overall picture on the Finnish RI field:
    - Assessment of university RIs, carried out in consideration with the State of Scientific Research in Finland 2014 review
    - Participation in the RI report for universities of applied sciences
    - Participation in the report on the use of public RI and development platforms by companies
    - RI assessment of university hospitals in cooperation with the Ministry of Social Affairs and Health and the National Institute for Health and Welfare
- Improvements to the openness and collaborative use of RI
  - The FIRI-Committee has encouraged cooperation between RIs in connection with the annual funding calls.
  - The FIRI-Committee has introduced the openness of the RI' usage policies as part of its evaluation.
  - The FIRI-Committee requires that the development of RI data policies comply with the principles of open science.
  - In cooperation with the Open Science and Research Initiative, the FIRI-Committee has designed and developed the open-access RI Database.
- Shoring up of the funding base of RI



- The FIRI-Committee has organised annual funding application rounds.
- The FIRI-Committee has emphasised the crucial role of host organisations in terms of strategic planning in funding applications (hosts prioritise their RIs).
- Provision of a firm basis through the roadmap for the methodical development of RI
  - The FIRI-Committee has made information related to RI in the roadmap 2014–2020 or funded by the FIRI-Committee openly accessible in the RI Database.
  - In the annual funding calls, the FIRI-Committee has directed a significant portion of its funding to RI be included in the roadmap.
  - The FIRI-Committee has conducted an interim review of the strategy and roadmap for Finnish RI.
- Evaluation of the impact and significance of RI
  - The FIRI-Committee has organised industry- and discipline-specific discussion panels.
  - The FIRI-Committee has adopted the monitoring of scientific impact and significance as part of the RI reporting process.



### 3.2. Dutch Case Study

#### Chronology and future plans

2020	Next update of the roadmap envisaged
2019	Current update of the Dutch roadmap
2016	Most recent update of the National Roadmap Large-Scale Scientific Infrastructure. Netherlands Organization for Scientific Research (NWO)
2013	First Roadmap update: Uncharted Frontiers: the Netherlands' Roadmap for Large-Scale Research Facilities, Ministry of Education, Culture and Science
2008	First 'Netherlands Roadmap for Large-Scale Scientific Infrastructure', Commissie Nationale Roadmap Grootschalige Onderzoeksfaciliteiten

#### 3.2.1. The Dutch R&I System

The R&I structure in the Netherlands is relatively centralised. However, while the Dutch central government remains the main financing body for large international facilities like CERN and ESA, policy choices and focus areas are gradually becoming more regionalised. Additionally, direct support to business R&I and funding of RIs is also increasingly provided at the regional level. The main policy actors in R&I are the Dutch Ministries of Economic Affairs (EA) and Education, Culture and Science (ECS). The EA and ECS share responsibilities for enterprise policy, which includes innovation policy. The ECS is responsible for science and education policies and the allocation of institutional funding to the universities. The main R&I policy implementation bodies are the Dutch national research council (NWO) and the Taskforce for Applied Research (SIA), which are both part of the NWO, the Royal Netherlands Academy of Arts and Sciences (KNAW), and the Netherlands Enterprise Agency (RVO). Non-profit organisations and foundations do not play a significant role in funding R&I in the Netherlands. The funding of RIs on the level of the National Roadmap as well as the regional level is mandated to the NWO. (Janssen et al., 2016, p. 8.)

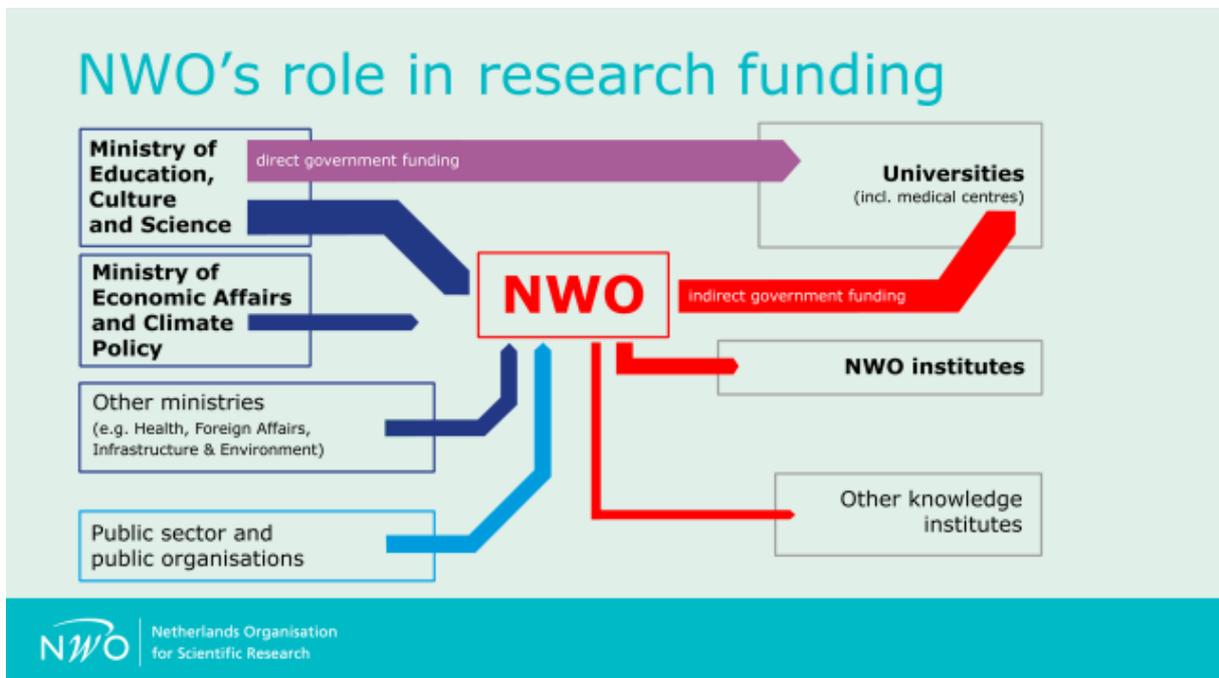


Figure 4: The NWO 's role in research funding (NWO, 2018).



According to the Dutch government, high-quality equipment and state-of-the-art research facilities are crucial for technological and social innovation in the Netherlands and therefore play a central part in the Dutch R&I-system and corresponding strategies. In its recent strategy for the period 2019-2022 the NWO sets a special focus on an accessible and sustainable scientific research infrastructure. Furthermore, the NWO acknowledges the importance and advantages of international cooperation for the quality and impact of Dutch RIs and research as well as the benefits for the Dutch society. RIs are not only perceived as the physical machinery and facilities, yet also as an opportunity for giving technical support and creating a professional work environment for scientists. (NWO, 2018)

The NWO and KNAW are the main actors when it comes to embedding RIs and international research priorities in a national competitive scheme working on behalf of the Dutch Ministry of Education, Culture and Science. In mid-2015, the NWO appointed a "Permanent Committee for Large-Scale Scientific Infrastructure". The committee currently consists of a chairman and twelve members from the Netherlands with various scientific backgrounds as well as representatives from industry. It has permanent character to maximise the long-term and optimal use of investment opportunities in scientific RIs in the Netherlands (opposed to the previous tradition of ad-hoc committees) and to maintain the balance between creating the scope for new RIs and the continuity of existing ones. Since its introduction, the strategic committee has been tasked with developing the national strategy for large scale RIs independently, but in close consultation with the Dutch ministries as well as coordinating the investments made in RIs in Dutch research institutes, applied research organisations and governmental agencies.

The Permanent Committee generally considers that harmonisation of national priorities with international priorities is important for the Netherlands in order to prevent duplication. For this, the Permanent Committee aims to harmonise the Dutch Roadmap with the ESFRI processes. Thus, if a facility in the Netherlands is in the same field as an ESFRI RI, it will only be incorporated on the National Roadmap when it becomes part of the ESFRI RI.

### 3.2.2. The Dutch RI roadmapping process

A first 'Netherlands Roadmap for Large-Scale Scientific Infrastructures' was published in 2008 and has been developed as a direct response to the development of a European roadmap for RIs by ESFRI. In 2011, the State Secretary for Education, Culture and Science requested that the NWO organised a review of this roadmap at the beginning of 2011. A new funding round emerged from this process in 2012 followed by an additional funding round over the period of 2013/2014 using NWO's funds for large-scale RIs. In 2013 and 2016, the NWO published updates to the Dutch roadmap. The next roadmap update is expected to be published in 2019.

#### 3.2.2.1. Implementation of the Dutch roadmapping process

The following chapter describes the implementation of the current RI roadmapping process in the Netherlands, its individual steps and main actors involved. The chapter concludes with an analysis of the process and identifies good practices applied in the Netherlands. This overview is based on a desk review of relevant documents related to RI roadmapping, as well as qualitative interviews with key actors involved conducted in early and mid-2018.

#### **Landscape analysis**

In 2016, the Permanent Committee for Large-Scale Scientific Infrastructure conducted a landscape analysis in which it reviewed 164 existing facilities and identified a total of 113 RIs of interest in need of future funding. However, the Permanent Committee stated that the



demand for RIs in the Netherlands is considerably higher than the financial budget available and investments are often needed over a long-time period which requires agreements with the various stakeholders concerning sustainability, collaboration as well as prioritisation of needs. (NWO 2016)

The Permanent Committee used the following selection criteria for identifying suitable RI during the landscape analysis.

Table 4: RIs selection criteria for the landscape analysis (NWO, 2016, p. 6).

<p><b>1. Facility meets the definition of large-scale infrastructure and the type of infrastructure it involves</b> (national/international, single sited/distributed/virtual, hardware/e-infrastructure/data/collection)</p>
<p><b>2. Cohesion between the various facilities</b> (Uniqueness overlap and cohesion, affiliation with ESFRI, cooperation and selectivity in the field)</p>
<p><b>3. Affiliation with strategic developments</b> (Affiliation with the Dutch National Research Agenda (NWA); strategic goals and priorities of institutions, scientific fields, top sectors)</p>
<p><b>4. Participation and use</b> (The facility's national and international target and user group)</p>
<p><b>5. Facilities' significance to science and society</b></p>
<p><b>6. Status and maturity level of facility</b> (Phase of lifecycle, support, governance and organisational structure, substantiation of the investment plans, institutional commitment, long-term funding)</p>

Additionally, RIs under investigation had to meet the financial lower limit (€10M) for large-scale research facilities and shouldn't have been included into or be part of an existing landscape analysis. Moreover, an open access policy for researchers is a key requirement for the RI to earn a spot on the national roadmap.

### Strategic prioritisation

The NWO continuously monitors the quality and complementarity of different national research funding streams to align them to their national RI strategies. This coherence between funding and prioritisation strategy is intended to maximise both the synergy and impact of the various research funding streams where RIs are embedded and connected in the national and international R&I ecosystem. However, this may imply that occasionally the priorities of researchers or RIs cannot be financed if they do not align with national strategies. Moreover, the NWO is planning to develop a national investment agenda in cooperation with the Dutch universities and the Royal Netherlands Academy of Arts and Sciences (KNAW), to which all parties involved contribute.

### Clustering of facilities to promote cooperation

While performing the landscape analysis and overviewing the landscape the Permanent Committee concluded that many facilities were needed for the same research fields and that identical equipment was needed. Consequently, the Permanent Committee decided to encourage facilities with similar RI needs or complementary thematic focus to form a cluster and submit joint applications. Moreover, cluster members were asked to develop a long-term investment agenda as well as a business plan, to guarantee the infrastructure's long-term



financial sustainability and were also invited to set priorities in view of the limited resources available. Per predefined thematic areas, which were identified while conducting the landscape analysis, only one joint application was accepted for the 2016–2020 roadmap per such an area. Furthermore, applicants were asked for a commitment of funding the RIs'. Regarding the operation costs, the Permanent Committee decided to fund up to 50% of the operation cost during a period of maximum 10 years under the condition that the hosting institutes are obliged to fund the other 50%. (NWO 2018)

### Selection of proposals for the national roadmap

The Permanent Committee first selected 32 RIs, of high scientific priority to be included on the current 2016–2020 national roadmap. Eventually the national roadmap consisted of 32 facilities including 15 individual RIs and 17 facility clusters of the three scientific domains listed in the following table.

Table 5: Dutch single RI and facility clusters included in the 2016-2020 National Roadmap for Large-Scale Scientific Infrastructure by domains (derived from NWO, 2016).

Medical and Life Sciences	Science and Technology	Humanities and Social Sciences
BBMRI (cluster)	ATHENA	CLARIAH-PLUS (cluster)
Bioimaging AM (cluster)	Ruysdael observatory	ODISSEI (cluster)
BSL3	DUBBLE	
ELIXIR-NL (cluster)	E-ELT	
ISBE	EPOS-NL (cluster)	
MCCA (cluster)	ESS	
MRI and Cognition (cluster)	ET	
MRUM	HFML/FELIX (cluster)	
NEMI (cluster)	KM3Net	
NIEBA (cluster)	LHC detector upgrades	
NL-OPENSREEN	NanoLabNL (cluster)	
NPEC (cluster)	NC2SM	
UNLOCK (cluster)	RV Pelagia/ NMRF	
uNMR (cluster)	SKA	
X-omics (cluster)	Solar Cells (cluster)	

Every two years, the NWO organises a competition for funding RIs on the roadmap. The Permanent Committee decided that every research field should receive grants for establishing RI in case the quality is high enough. Therefore, the Permanent Committee decided based on



historical data to make 45% of the budget available for the science and technology domain, 45% for the life sciences domain and 10% for the domain of social sciences and humanities. The Permanent Committee is also recommending using the ratio for upcoming national roadmap calls.

By mid-2017, 21 of the selected RIs submitted a funding proposal. The NWO appointed an independent international selection committee to assess these proposals. This international selection committee consisted of experts with a broad knowledge of scientific developments and experience considering large-scale scientific RIs. Each application was sent to at least 5 international reviewers and the applicants were given the opportunity to send in a rebuttal on the peer's comments. The selection committee selected 14 proposals for interviews, which were held in the beginning of 2018. Based on interview performance, the selection committee compiled a ranking which was submitted to the NWO executive board for the final granting decision. (NWO 2018)

The following evaluation criteria were used for the assessment of the RIs' funding proposals by the international selection committee:

1. Science and excellence
  - The RIs' importance for science and the potential to attract researchers,
  - The embedment of the investments,
  - The urgency of the investment for Dutch science.
2. Innovation and strategy
  - The RIs' importance for society and industry and the connection with current societal developments,
  - National strategies and interests.
3. Technical, business and management issues
  - Technical feasibility,
  - Information and Communication Technology (ICT) infrastructure,
  - Organisation and governance,
  - Accessibility (open access),
  - Financial aspects,
  - Risk analysis.

### **Funding of facilities included in the roadmap**

Usually, the NWO has an annual budget of €40M available for funding of RIs included in the roadmap, yet for the competition in 2017-2018 the NWO was able to use an extra €90M through an additional budget of the ECS and savings from earlier years. Additionally, the Permanent Committee will also provide the possibility of allowing limited additions to the recent 2016 national roadmap in urgent situations prior to its planned formal update in 2020 (NWO 2016).

### **Methodology to evaluate RIs to be included in the national roadmap**

As of November 2018, the development of evaluation and monitoring criteria for RI included in the national roadmap by the Permanent Committee is ongoing and will be decided upon early in 2019. These will include the evaluation of the present facilities as well as the facility clusters. In preparation for the evaluation, the Permanent Committee decided to ask the RIs currently receiving funding for annual progress reports and is planning to conduct site visits at the granted facilities.



### 3.2.3. Actors involved in the Dutch roadmapping process

#### Role of the government

The Dutch government and especially the ECS and the EA are mainly responsible for the specification of the RIs strategic framework as well as the provision of the budget for applied research facilities as well as international facilities. Moreover, the Executive Board of the NWO consults with the ECS and the EA on which RIs are to be included on the national Roadmap before making the final decision on which ones to include.

#### Netherlands Organisation for Scientific Research

In 2017, the Dutch national research council (NWO) has been reorganised to be more flexible and responsive to developments within science and society. The NWO currently consists of a board of directors, a separate organisation for its research institutes, and the four thematic domains: Science; Applied and Engineering Sciences; Social Sciences and Humanities. The Netherlands Organisation for Health Research and the former Technology Foundation (STW), the Foundation for Fundamental Research on Matter (FOM) and the Netherlands Organisation for Health Research and Development (ZonMW) have been integrated into the new NWO organisational structure. (Van den Broek et al., 2018, pp. 5-6)

#### The Permanent Strategic Committee for Large-Scale Scientific Infrastructure

The Permanent Committee is one of the outcomes of the Dutch Cabinet’s 2025 Vision for Science and was appointed by the NWO in July 2015 on behalf of the Ministry of Education, Culture and Science. The ministry’s request to the committee was to develop a national strategy for investments in large-scale research facilities. One of the committee’s key tasks was to submit a proposal for updating the National Roadmap for Large-Scale Scientific Research Facilities. The first step was to itemise all the large-scale research facilities in the Netherlands that are accessible for researchers. The eleven-member strong Permanent Committee also determines the need for new facilities, both for fundamental as well as applied research. Together, the existing facilities and proposed new facilities are the basis for the National Roadmap for Large-Scale Research Facilities. The Permanent Committee is also exploring the possibilities for public–public and public–private partnerships in the development of new facilities as well as the use of existing facilities. (NWO, 2018)

Table 6: Composition and tasks of actors involved in the national RI roadmapping process in the Netherlands.

Actors	Composition	Tasks
Netherlands Organisation for Scientific Research (NWO)	Four science divisions allocate subsidies and grants, the divisions have their own budget, Council Board and Council Executive Committees. The NWO is also a research performing organisation. It has eight research institutes that make strategic contributions to university research. Furthermore, it incorporates	Planning and setting the strategic guidelines for RI in cooperation with the Ministry of Education, Culture and Science; Publication and administration of Call for the roadmap; Supporting the Permanent Committee in the inventory and landscape analysis, mapping of infrastructures and eligibility check;

	three Task Forces which have a semi-permanent status.	Decision the funding of RI, based on the advice of the independent selection committee.
Strategic Committee for Large-Scale Scientific Infrastructure (advisory body of the board of the NWO)	Currently 14 members including a chairman. Recently two members were added with specific expertise in the field of ICT infrastructures.	Planning and setting the strategic guidelines for RI; Performing the inventory and landscape analysis, mapping of infrastructures and eligibility check; Performing the evaluation for establishing the roadmap.
Ministry of Education, Culture and Science	The ministry is headed by a secretary general and a deputy secretary general, who head a system of three directorates general: <ul style="list-style-type: none"> <li>• Primary and Secondary Education;</li> <li>• Higher Education, Professional Training and Sciences;</li> <li>• Culture and Media.</li> </ul> Additionally, the ministry oversees nine autonomous agencies and councils	Has tasked the NWO with the establishment of the Permanent Committee and to define the Terms of Reference.
International selection committee	13 international experts from various scientific backgrounds	Assessment of proposals for RI for the roadmap funding scheme.

### 3.2.4. Analysis of the Dutch case

The introduction of a Permanent Committee responsible for large-scale scientific infrastructure has replaced the former ad-hoc committees responsible for roadmapping processes in the Netherlands. Contrary to practice in many other European countries, the Dutch Research Council, NWO, and its Permanent Committee are almost solely in charge of designing the roadmapping process and deciding on strategic prioritisation and selection criteria, thus streamlining the decision-making process and creating the foundation for long-term strategic planning.

A limiting factor for the roadmapping process in the Netherlands is the imbalance between available funding resources and needed investments for RIs, which makes harmonisation and long-term financial planning challenging. A first key action taken by the Permanent Committee was the clustering approach, which forces facilities with similar or compatible thematic backgrounds to submit a joint proposal for each predefined thematic cluster and to develop an investment agenda considering the strategic prioritisation of the respective research field. A second key step taken was allocating the available budget for RIs to three research domains.



Furthermore, the NWO guarantees taking over 50% of the operational costs for a period of 10 years under the conditions that the facilities applying for funding commit to paying the other half of the operational costs. In addition, all other costs incurred will be funded. The mentioned steps ensure that new RIs of high priority can continue to be included in future national roadmaps, even though funding is limited. Initial feedback by the RIs suggests that the clustering approach was positively received in the Netherlands. Moreover, funding decisions on RI in the Netherlands are linked to strategic priorities. As a result, RIs need to orient themselves stronger towards national priorities.

### 3.2.5. Good practices from the Dutch case

- For the roadmap proposal, the NWO asks for a ten-year budget for the full costs of an RI. Additionally, in the Netherlands 50% of the operational cost are funded during a period of 10 years under the conditions that the facilities applying for funding commit to paying the other half of the operational costs. For the proposals, the hosting organisations are asked to submit a letter of intent in which they commit to financing half of the operational costs for 10 years. This way, the NWO ensures that the applicants deal with a business plan and financing strategy while applying for the roadmap.
- In the Netherlands, the Permanent Strategic Committee for Large-Scale Scientific Infrastructure was introduced in 2015. It reviews and visits RI sites during the Dutch landscape analysis to identify potential for clustering of RI facilities. By visiting the facilities, the Permanent Committee can better assess the demand and thematic focus of the Dutch RIs.
- The imbalance between available and needed investments for RI in the Netherlands is limiting funding of new RIs. By forcing RIs with similar or compatible thematic backgrounds to submit a joint proposal to apply for the National Roadmap, redundancies with regard to equipment can be avoided and synergies can be used. Moreover, funding decisions on RIs in the Netherlands are linked to strategic priorities. As a result, RIs are required to orient themselves more strongly towards national priorities.
- The NWO continuously monitors the quality and complementarity of different national research funding streams to align them to their national RI strategies. This coherence between funding and prioritisation strategy is intended to maximise both the synergy and impact of the various research funding streams where RIs are embedded and connected in the national and international R&I ecosystem. However, this means that sometimes the priorities of researchers cannot be financed if they do not synchronise with national strategies.



### 3.3. Czech Case Study

#### Chronology

2015	Roadmap of Large Infrastructures for Research, Experimental Development and Innovation of the Czech Republic for the years 2016–2022.
2011	Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic, May 2011 Update.
2010	Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic. Ministry of Education, Youth and Sports.

#### 3.3.1. The Czech R&I System

The Czech R&I system is characterised by relatively centralised decision-making at governmental level with fragmented implementation, as illustrated in the figure below. The central coordination role for R&I policies and programmes lies with the Council for Research, Development and Innovation (RDI Council), an advisory body to the Czech government. The RDI Council is composed of experts from science and industry and is headed by the Prime Minister. It plays a central role in defining R&I policies in the Czech Republic. The RDI Council cooperates with the Ministry of Youth, Education and Sports (MEYS) on the definition of national research policies and the elaboration of national priorities, and has the important task of preparing the state budget expenditures for R&D. The Ministry of Industry and Trade is responsible for innovation. At the governmental level, the RDI Council, the Minister for Education Youth and Sports, and the Minister for Industry and Trade assume the most important roles in national R&I system decision-making.

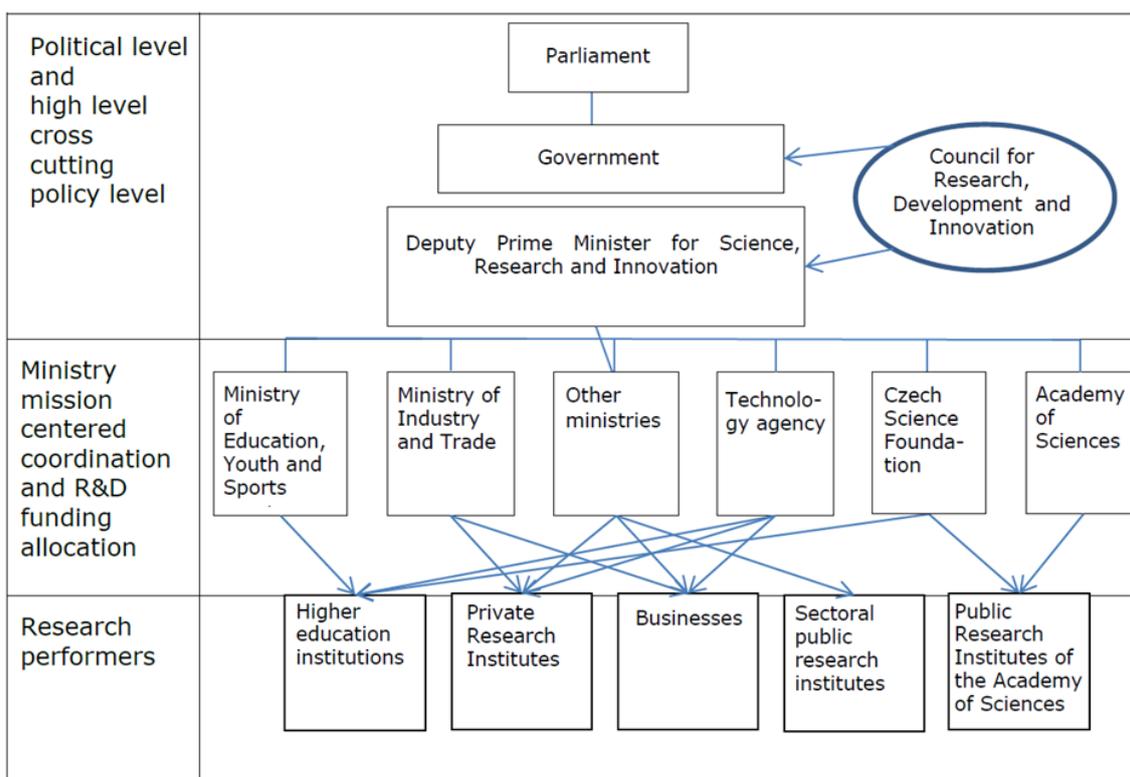


Figure 5: Structure of the Czech R&I system (adapted from Srholec and Szkuta 2016, p. 17)



The MEYS is responsible mainly for RI, international cooperation in research, higher education institutions and operational programmes. Strategies and decision-making for RI are mainly developed within the department of R&D. This department is divided into two distinct units: the European Research Area unit, and the RI unit. The RI unit, in collaboration with the Head of department for R&D, prepares the national RI roadmap.

The national R&D budget is divided into two main funding pools: Targeted Support and Institutional Support. Institutional Support mainly funds research institutes of the Academy of Sciences and other research organisations, according to their results in the previous budgetary period. Targeted Support serves to fund specific goals and programmes run by the MEYS, the Technology Agency or the Ministry of Trade and Industry. One such programme targets large RI projects and is under the responsibility of the MEYS. However, membership fees to ERICs and international organisations are funded with Institutional Support.

The European Regional Development Funds (ERDF) is another highly important source of RI funding in the Czech Republic, which provided funding for RI investment via the Operational Programme Research and Development for Innovation (OP RDI) from 2007 to 2015. Over the present programme period, funding from the ERDF was also made available through the Operation Programme Research, Development and Education (OP RDE). While the operational costs of Large Infrastructures continue to be mainly funded by the MEYS, investment costs for further RI facility technological development is funded through a special call as a part of the implementation framework of the OP RDE (MEYS 2015).

Around 29% of public spending for R&D in the Czech Republic originated from abroad over the 2012–2015 period, primarily from ESIF outlays for the construction of several major R&D centres and RI projects (Eurostat 2017 in Srholec & Sanchez-Martinez 2018). The figure below shows the EU budget for RDE in the Czech Republic over the period 2014–2020 by theme and source of funding. The EU budget for this programme is approximately €2.8B from the ERDF and European Social Fund (ESF), with a national contribution of €670M (€3.4B total budget).

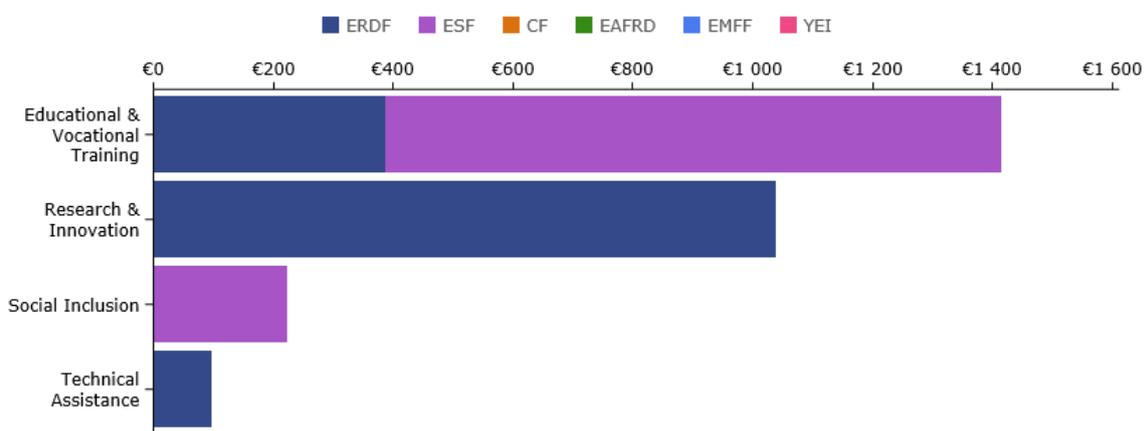


Figure 6: EU Budget by Theme: Research, Development and Education - CZ - ESF/ERDF, EUR million (EC, 2018)

Information on RIs and RI projects that received ERDF funding between 2007 and 2015 for construction or upgrades is available in the 2015 Czech RI roadmap. Furthermore, it details the main previous source of funding (state budget and/or ERDF) in the list of all RIs included in the roadmap.

### 3.3.2. The Czech RI roadmapping process

The following pages describe the implementation of the RI roadmapping process in the Czech Republic, as well as its current design and methodologies. The primary actors active in the process and their functions are identified. Finally, the analysis identifies good practices and explores remaining bottlenecks in the Czech RI roadmapping process. This overview is based on a desk review of the documents related to RI roadmapping in the Czech Republic, as well as interviews with key actors involved in the process.

#### 3.3.2.1. Implementation of the Czech RI roadmapping process

The first Czech roadmap for RIs, the 'Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic', was published by the MEYS in 2010. The first roadmapping process was largely inspired by discussions taking place within ESFRI, and by the ESFRI roadmapping process itself. An advisory body for RIs, the Council for Large Infrastructures for Research, Experimental Development and Innovation (hereafter Council for Large Infrastructures), was set up and contributed to forming working groups. Those working groups included Czech experts from six scientific domains: Social Sciences and Humanities, Environmental Sciences, Material Physics and Space, Informatics/e-infrastructure, Energy and Biomedicine. They worked on the first landscape analysis of RIs in the Czech Republic. International experts were also invited to provide advice.

The roadmap was defined as *"a strategic document for development of large infrastructures for research, development and innovation. [...] The document aims to describe the situation and significance of large research, development and innovation infrastructures within the Czech Republic, as well as the European Research Area, opportunities arising from financing of these types of facilities from the Structural Funds, and participation of the Czech Republic in projects under the so-called ESFRI Roadmap"* (MEYS 2010, p. 7). Key strategic elements of this first roadmap include: the Czech Republic in the context of the ERA, the role of ESIF in funding RIs, and the involvement of industry.

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#### **The 2011 roadmap update**

A roadmap update was produced in 2011. This update intended to include information on the new funding frameworks for RIs in the Czech Republic, the targeted support for RIs and the ESIF. Previously, large RI projects located outside the Czech Republic were financed from the International Non-Governmental Organization (INGO) Programme, and national infrastructures were funded through the Centre for Basic Research and Research Aims (MEYS 2011). For the 2011 roadmap update, a consultant from the ESIF was involved in the process and a call for proposals was organised. The thematic working groups were maintained to work on the landscape analysis and a peer-review group was composed of national experts. Some RIs from the 2010 roadmap were re-classified as promising projects, based on the assessment of the peer-review group.



The 2011 update emphasised the ‘integrative role of infrastructures’ in the context of the ERA and *“the creation of synergy between the Cohesion Policy and the future strategic framework for financing research and innovation at the European level; strengthening the mobility of research infrastructure workers, even those holding technical positions; and the possibility of using large infrastructures to meet the needs of today’s society”* (MEYS 2011, p. 8). The strategic elements of the Czech roadmap therefore continued to consider European developments.

### The new methodology for evaluating RI

In 2014, the MEYS designed a comprehensive methodology for evaluating RIs. The criteria contained in this document serve to evaluate all RIs striving to receive public support at national level or to be included in the Czech RI roadmap. The different dimensions to be reviewed in the evaluation are detailed in Chapter 4, section 2.3. The evaluation scale is presented in the following table.

Table 7: Evaluation scale of the MEYS Evaluation Methodology for RI (MEYS 2014, p. 12)

5	The RI is of excellent quality compared to leading actors worldwide with respect to originality, importance, quality and impact on the user community. The RI is highly relevant for the Czech research environment and inevitable for the accomplishment of priorities of the national strategies of support to R&D&I and for the competitiveness of Czech research.
4	The RI shows high quality and research potential but does not reach the top standards of international excellence. The RI is highly relevant for the Czech research environment, substantially contributing to the competitiveness of Czech research. It is crucial for accomplishment of priorities of the national strategies of support to R&D&I.
3	The RI’s quality and research potential enable good quality services to be provided in the given sphere. The RI shows significant usage possibilities and is relevant for the Czech research environment, however, it is not crucial for the competitiveness of Czech research.
2	The RI’s quality and research potential enable it to contribute to the provision of sufficient quality services in the given sphere. The use of the RI is significant, particularly on the national level. The RI is relevant for the Czech research environment; however, it lacks crucial strategic importance.
1	The RI’s quality and research potential enables it to contribute to the provision of services in the given sphere. The RI is of minor use or has only a limited relevance for the Czech research environment and it lacks any strategic importance.
0	The RI does not attain the level required for provision of relevant services at the national level or it lacks sufficient potential for use in national strategies of support to R&D&I.

The evaluation by the peer-review experts constitutes an input for the funding of RIs, but the actual financing is decided by the MEYS and must be approved by the Czech government (see next section). The methodology developed by the MEYS was an important step in formalising the criteria for evaluation and providing a coherent evaluation framework.



### 3.3.2.2. Current RI roadmapping process in Czech Republic

In 2014, for the first time, the MEYS organised a comprehensive evaluation of all RIs, irrespective of their funding source (national budget or structural funds) and their lifecycle stage. It was carried out by an International Evaluation Committee, comprised of experts from the six scientific areas represented in the roadmap: Physical Sciences, Energy, Environmental Sciences, Biomedicine, Social Sciences and Humanities, and ICT/e-infrastructures (two international and one Czech expert per area). The evaluation was carried out in two stages, based on the newly elaborated methodology: first, an assessment of all proposals according to the definition of research infrastructure, and second, an assessment of the quality of the research infrastructures.

The definition of research infrastructure is composed of three main elements (see details in Chapter 4, section 2.3):

- The operation of unique technological R&D facilities;
- Having at least a nation-wide importance and impact in the Czech Republic, and potential international overlap;
- Managing the research infrastructure on the basis of an open access policy consistent with international good practice.

The proposals that entered the second stage of assessment, were evaluated according to criteria pertaining to:

- Socio-economic impact;
- Uniqueness of technological facilities;
- Management and sustainable development strategy;
- Open access policy;
- R&D strategy;
- Cooperation with other research organisations and research infrastructures operated in the respective scientific field or multidisciplinary R&D area and industrial sector;
- Quality of R&D results achieved by using the research infrastructure;
- Potential for the development of new technologies.

The second phase of the evaluation was based on a self-assessment report developed by RI managers, and an assessment report from the scientific advisory board of the RI. The international expert reviewed both documents and produced their own report (based on the criteria detailed above). The second stage of the evaluation also included interviews between the experts and management representatives of the RI.

This evaluation resulted in 58 positively evaluated RIs, including 42 high priority RIs. They were recommended for public funding by the International Evaluation Committee, according to a rating from A1 (highest priority) to A4 (lowest priority). This outcome formed the basis of the 2015 Czech RI roadmap, which presents the positively evaluated projects and their level of prioritisation (as well as their current source of funding). The process is illustrated by Figure 6 and a short description of the actors involved is available in Table 8: Composition and tasks of actors involved in the national RI roadmapping process in the Czech Republic..

#### **Landscape analysis**

As for the previous 2010 roadmap and the 2011 update, a landscape analysis was carried out by the expert working groups. The goal of the landscape analysis is defined as "*putting individual R&D facilities into the RI landscape of the Czech Republic and identifying persistent*



*gaps, drafting the outlook for future development and presenting the possible scenarios for eventual clustering of research infrastructures (if applicable)*" (MEYS 2015, p. 17). All RIs evaluated positively by the International Expert Committee were included in this exercise. On top of the landscape analysis, each RI is individually described in the roadmap document, according to its background, outlook for future development and socio-economic impacts. The RI unit of the MEYS is responsible for the writing and editing of the roadmap document, in close collaboration with the expert working groups.

### **Reviewing and amendment procedures**

Once the 2015 roadmap was completed, it was first reviewed by the advisory body of the MEYS, the Council for Large Infrastructures, and by the International Peer-Review Committee – composed of seven members from the International Evaluation Committee (one per scientific area) and a Chair. The same process as that applied for 2010 and 2011 was used: the Deputy Minister for Research and Higher Education adopts the roadmap, which then has to be approved by the Minister for Youth, Education and Sports. Afterwards, it goes through an amendment procedure, whereby it is sent to all ministries, to the Czech Academy of sciences, to the conference of rectors and to other stakeholders. They have a limited time (around 15 days) to send their consent or amendments. Considerable amendments require a resolution meeting. Once the amendment procedure is completed, the RI roadmap is presented at the government meeting and it is adopted with or without a discussion. Once it is adopted, there is a government resolution. The government also has the responsibility of approving individual RIs for funding, as their inclusion on the roadmap is only a precondition for funding, not a direct commitment.

### **Developments**

The structure and content of the 2015 roadmap are similar to those of the 2010 roadmap and the 2011 update. It includes the same scientific areas, a landscape analysis and a list of prioritised projects, which are also individually described. However, the 2015 update did not include promising projects and listed only the RI projects that were already funded or were proposed for funding. The next roadmap update, envisaged in 2019, will be based on the evaluation carried out in 2017 on the same basis as the 2014 evaluation. However, such extensive evaluations are very resource-intensive for the experts, the RIs, as well as the MEYS. Therefore, the MEYS is planning to reduce their frequency in the future.

The current RI roadmapping process is illustrated in the following figure.



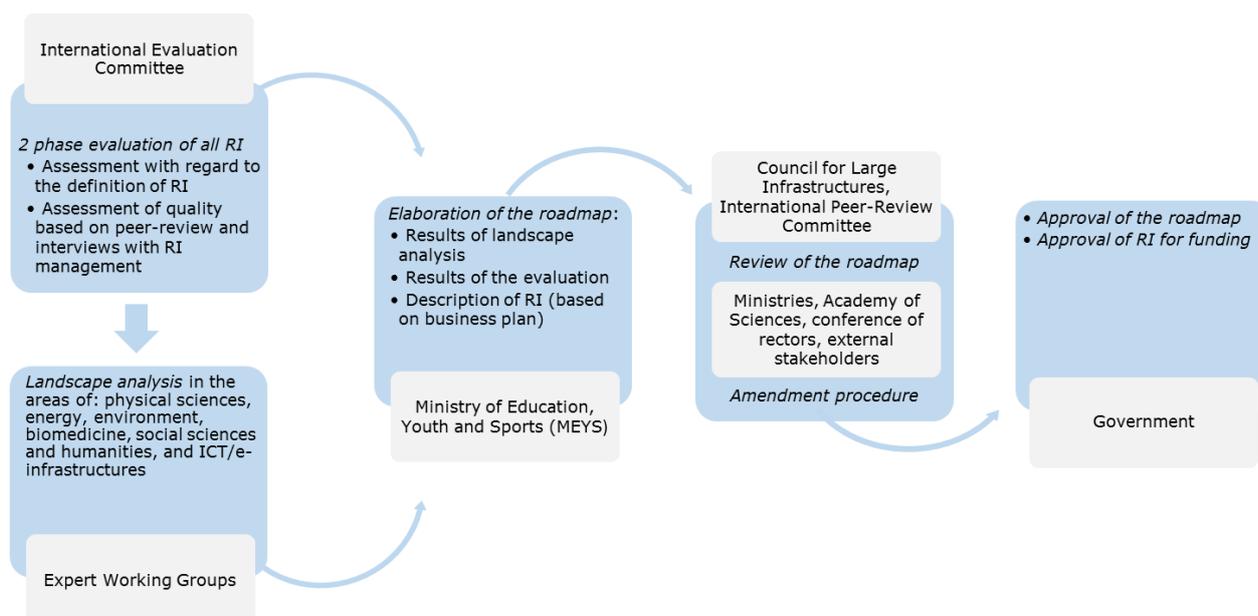


Figure 7: Czech RI roadmapping process, 2014-2015 (by Alexandra Griffiths, 2018)

### 3.3.3. Actors in the Czech RI roadmapping process

The table below sums up the role of the various actors involved in the Czech RI roadmapping system. This is a summary and not a comprehensive overview as, for example, the full list of stakeholders involved in the amendment procedure is not public. Overall, the main actors driving the RI roadmapping process are the MEYS, the advisory Council for Large Infrastructures, the expert working groups and the international evaluators. The Czech government is mainly responsible for the political oversight of the roadmap and for approving funding.

Table 8: Composition and tasks of actors involved in the national RI roadmapping process in the Czech Republic.

Actor	Composition	Tasks
Council for Large Infrastructures for Research, Experimental Development and Innovation	Representatives of the MEYS, the RDI Council, higher education institutions, Academy of Sciences of the Czech Republic, and the large research infrastructures operated in individual scientific fields (approx. 25 members)	Advising the MEYS on evaluation methodologies, on the evaluation process, and on the expert panels Reviewing the RI roadmapping process and the roadmap document
Czech government	Prime Minister, Ministers and deputy Ministers	Final approval of the RI roadmap and government resolution; Approval of individual RI for funding
Deputy Minister for		Adopting the RI roadmap



Research and Higher Education		
Expert working groups	Five to nine national experts from the six scientific disciplines represented in the roadmap	Landscape analysis
International Evaluation Committee	13 international experts (two per scientific area and a Chair), six Czech experts (one per scientific area)	Two-phase evaluation of all RIs (from 2014)
International Peer-Review Committee	Seven members of the International Evaluation Committee (one per scientific area and a Chair)	Reviewing the RI roadmap document (from 2014)
Research Infrastructure unit of the MEYS		Organising the RI roadmap process; Writing the RI roadmap document
Minister for Youth, Education and Sports		Approving the RI roadmap and launching the amendment procedure
Other ministries, Czech Academy of Sciences, Conference of Rectors, and other stake-holders		Amendment of the RI roadmap (if requested)

### 3.3.4. Analysis of the Czech case

The Czech roadmapping process is currently well established in terms of methodologies and procedures. The processes for evaluating and funding scientific projects are well perceived by many actors in the Czech scientific and RI community. The MEYS and the Council for Large Infrastructures have continuously improved the process for identifying, evaluating, funding and monitoring RIs, with input from national and international experts. Furthermore, the MEYS has made great efforts to align this process with calls for the ESFRI roadmap. Thus, the Czech Republic has developed its national RI landscape and increased its participation in pan-European RIs. RI stakeholders in the country are planning to continue in this direction.

However, there are still some bottlenecks in the process. Indeed, while the evaluation and selection of projects for the roadmap is well established and transparent, the evaluations are frequent and extensive. This could become a burden for all actors involved in the process. Furthermore, the link between the evaluation results and funding decisions is not well understood. After the latest RI roadmap update, the highest rated RIs received budget cuts so that all positively evaluated RIs could be funded. It is unclear whether this decision truly reflected the evaluation results and expert opinions. Prioritisation is a challenging exercise, but in view of limited budgets, it is important to provide funding efficiently and according to transparent criteria.

Related to the point above, the high number of RIs in the Czech roadmap (58) could become another bottleneck. Indeed, a small country like the Czech Republic has limited resources to support such an extensive portfolio and each facility must provide a truly unique service.



Therefore, international experts recommended developing more synergies and clusters. This process is already underway for e-infrastructures, which are being assembled under an umbrella organisation who are developing a common infrastructure for the whole country. Similar integration could be achieved in other scientific areas, for example nanotechnologies.

Finally, better communication could also be fostered between the MEYS and the RDI Council of the government, as well as with other Ministries and the Academy of Sciences. These actors could play a more important role in supporting the MEYS' RI strategy and roadmap in a context where political support for RIs is relatively unpredictable, due to changes in government. The importance of RIs for the whole research system and for solving societal challenges (e.g. environmental or biomedical research) could be better emphasised. For example, regular meetings (e.g. once a year) between the Council for Large Infrastructures and the RDI Council could be organised to exchange information and perspectives.

### 3.3.5. Good practices from the Czech case

- The MEYS developed an update one year after the first roadmapping process. The process for the update included an open call for submissions for the RI roadmap. This made the process more transparent and rendered it more accountable to national stakeholders.
- In the Czech Republic, independent panels of international experts review all proposals for the roadmap (new as well as existing RIs). The evaluation is based on self-assessment reports, assessments by the RI scientific advisory boards, and interviews with RI management. This approach significantly increases the objectivity of the evaluation process. To ensure that national stakeholders and the needs of national RI are taken into account, an advisory body to the MEYS composed of Czech experts, the Council for Large Infrastructures, reviews the RI roadmapping process.
- The Czech RI roadmapping process includes a landscape analysis, carried out by Czech experts from each scientific field represented in the roadmap (expert working groups). This analysis identifies strengths and gaps in the national RI landscape, and supports the strategic vision of the MEYS for RI.
- The MEYS developed a comprehensive methodology for the evaluation of RIs based on the one elaborated by ESFRI. This approach increases the transparency of the application process and is well coordinated with the process at pan-European level. The process is also timed so that projects can receive political support from the Czech government prior to the calls for the ESFRI roadmap.
- The Czech RI roadmapping process includes an amendment procedure, whereby the roadmap is submitted to other ministries and important R&D stakeholders for approval or amendment. While it is time-consuming, this amendment procedure increases the accountability and legitimacy of the RI roadmapping process.
- Following the advice of international experts, the MEYS initiated the process of integrating the Czech Republic's e-infrastructures – CESNET, CERIT and IT4Innovations – under an umbrella organisation (CESNET)<sup>3</sup>. This is a welcome step towards a more coherent and efficient e-infrastructure landscape in the country, with comprehensive services provided by one organisation.

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<sup>3</sup> CESNET website: <https://www.cesnet.cz/cesnet/?lang=en>



### 3.4. Swedish Case Study

#### Chronology

2018	Swedish Research Council's Guide to Infrastructure 2018
2018	Appendix to the Swedish Research Council's Guide to Infrastructure 2018
2016	Appendix to Swedish Research Council's Guide to Infrastructure 2016
2014	Swedish Research Council's Guide to Infrastructure 2014
2012	Swedish Research Council's Guide to Infrastructure 2012
2008	<i>Swedish Research Council's Guide to Infrastructure 2008</i> . Recommendations on long-term research infrastructures by the research councils and VINNOVA
2006	Swedish Research Council's Guide to Infrastructure 2006

#### 3.4.1. The Swedish R&I System

The national R&I system is governed through the Research Bill, which is produced every four years, and the 2012 National Innovation Strategy, which provides guidelines for innovation policy up to 2020 (Dahlstrand et al. 2017). The Research Bill proposes the budget and agenda for research for the following four years. This document is created in a process of consultation with the main stakeholders in the sector (public agencies and private actors). The latest Research Bill was submitted in November 2016 and was ratified by the Parliament in 2017. Although the Bill has a ten-year perspective, it focused particularly on the period from 2017 to 2020. (Dahlstrand et al. 2017).

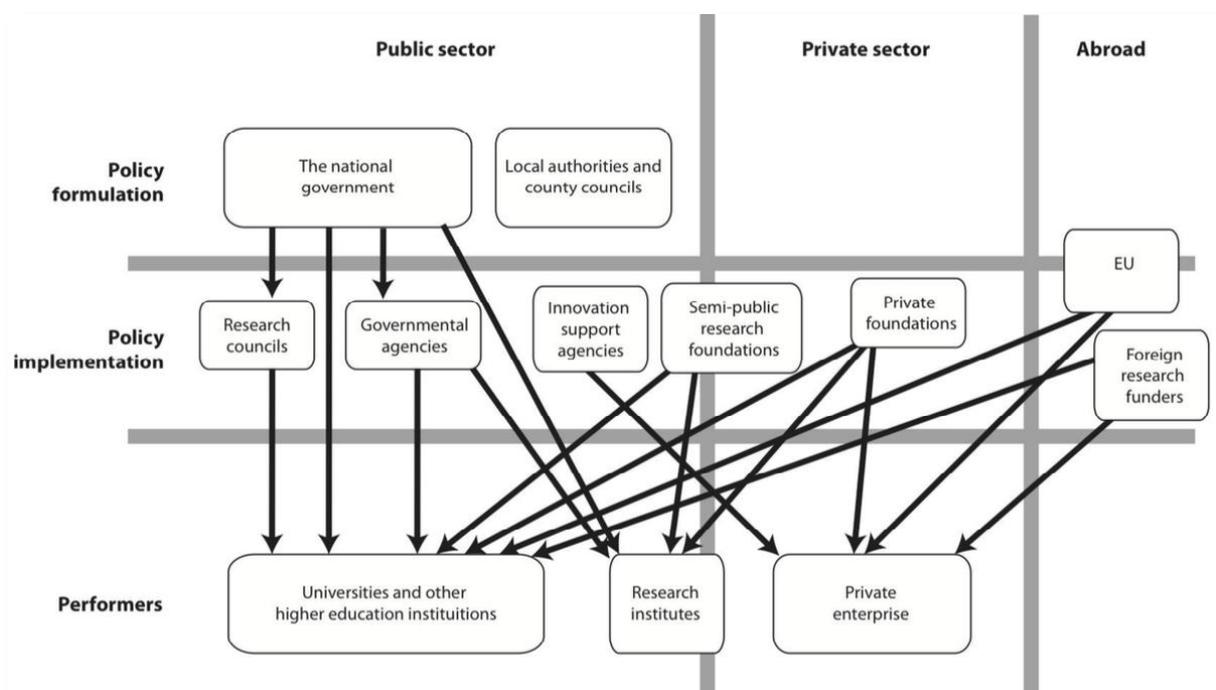


Figure 8: Overview of the Swedish research and innovation system governance structure (Hallonsten 2014)



### **Policy-makers involved with RI in Sweden**

Key actors in the Swedish R&I policy system are public agencies such as VINNOVA, the Swedish Energy Agency and the Swedish Research Council (VR). The VR is the principal actor for funding basic research, providing advice on the research system to the government and reporting to the Ministry of Education and Research. Moreover, the VR is in charge of the national RI roadmapping process and provides grants to RI via calls, amounting to as much as 50% of the total budget (VR 2018). The other public agencies involved in the national RI roadmapping process are VINNOVA, Formas and FORTE. VINNOVA, the central coordinating actor for innovation policy, is mandated with the implementation of the National Innovation Strategy and reports to the Ministry of Enterprise and Innovation. Formas is the Swedish Research Council for Sustainable Development, and its remit encompasses research funding, strategy, assessment and analysis as well as research communication and is directed by the Ministry of the Environment and Energy and the Ministry of Enterprise and Innovation. Forte is the Swedish Research Council for Health, Working Life and Welfare and is a research funding agency under the Ministry for Health and Social Affairs.

### **Public funding of RI in Sweden**

Large scale RIs in Sweden are incorporated into universities (Jacob 2015) and are financed through a shared financing system between the universities and the municipality in which the university is located. The Swedish Research Council provides grants to RIs of national interest via calls, amounting to as much as 50% of the total budget (VR 2018).

*Definition: RI of national interest in Swedish RI roadmapping process*

The Swedish Research Council's definition of a *research infrastructure of national interest* is: "A research infrastructure of national interest is intended to provide resources that enable research for several research teams and different projects within one or several research fields." (VR 2018)

The other 50% of the funding needs to be covered by the universities. Swedish membership in international RIs, which are of interest for the Swedish user, is funded by the Swedish Research Council. These costs are covered using either earmarked funds for the specific RI, or funds from the Swedish Research Council's budget for RI, depending on where the decision to join came from (*Ibid.*).

### **National RI Strategy**

A strategic roadmap in the form of a Guide to Infrastructure is published every four years with a five to ten years horizon for specific developments to safeguard Swedish researcher access to first-class RIs. The Guide is elaborated by the Swedish Research Council (VR) and also feeds into their input for the Government's Research Bill. The most recent guide (VR 2018) was published in November 2018 and includes the recommendations for initiatives and system changes with a forward-facing view to the upcoming Research Bill 2020. In the following, the implementation process of the first national RI roadmap in Sweden is briefly elaborated to give some context. Then, the current RI roadmapping process is described in more detail.

1. Increase Swedish investments in RI.
2. Intensify the coordination of research and RI.
3. Clarify the allocation of responsibility for RI.



4. Improve the information and strengthen the user support for open access and maximum use of existing infrastructures.
5. Offer personnel at RI competence development and clear career paths.
6. Reinforce the engagement of Swedish researchers and Swedish industry in instrument and technology development.
7. Fulfil the major investments made into MAX IV laboratory and the European Spallation Source (ESS).
8. Inject resources to fill the rapidly increasing need for calculation, analysis, storage, transfer and accessibility of data.
9. Intensify the work of creating prerequisites for open access to research data.
10. Develop and clarify the legal prerequisites for handling personal data within research.

### 3.4.2. The Swedish RI Roadmapping Process

Below, the implementation process of the first national RI roadmap in Sweden is briefly elaborated to give some context after which the current process is described in more detail.

#### 3.4.2.1. Implementation of the Swedish RI Roadmapping Process

After the VR was formed in 2001, its Scientific Council for Natural Sciences and Engineering Sciences Council had the main responsibility for national and international infrastructures. The RI roadmapping process in Sweden was initially developed when the discussions for ESFRI started. An independent committee was set up in January 2005 to manage new RI projects, as they could not be handled in the same way as smaller research projects that were handled by the VR. At this time, ESFRI was broadening the scope of infrastructures and stimulating discussions around distributed RIs in different areas. The VR established an Infrastructure Committee (KFI) to address these issues. Shortly after, in June 2006, the first Swedish RI roadmap, the Swedish Research Council's Guide to Infrastructure (VR 2006), was published. It represented the first national long-term plan for RIs in Sweden and was the first of its kind in Europe. It was intended that the guide would serve as a consistent basis for assessing what joint RIs were required for future top-quality research. It also laid out the scope for meeting requirements and underpinned discussions surrounding the funding of future national RIs, as well as discussions with other countries on joint RIs. An update was published in 2008 (VR 2008).

#### **Establishment of the Infrastructure Council within the Research Council**

The 2008 Research Bill, the most extensive so far, stipulated that the VR should assume responsibility of national coordination for the support of RIs. The Infrastructure Committee was permanently deployed as the Infrastructure Council (RFI) and new resources were introduced, enabling a larger call for support for national infrastructures in 2009. Work on the third edition of the Guide for Infrastructure was launched, and it was then published in 2012 (VR 2012). In 2009, the Swedish Research Council also launched a call for National Comprehensive RIs. As a result, eight RIs were funded for the 2010 to 2014 period.

In 2012, the Swedish Research Council initiated an investigation to review the financing, organisation and management of infrastructures of national interest and mandated Kåre Bremer, the president of Stockholm University at the time, with this task. The fourth Guide for Infrastructure was published in 2014 (VR 2014) and in 2016, an Appendix (VR 2016) was published to elaborate on some changes that were made to the Swedish RI roadmapping



process. The changes are further elaborated in the following description of the current national RI roadmapping process.

### 3.4.2.2. Current Swedish RI roadmapping process

In 2014, the Board of the VR adopted a new model for prioritising and funding RIs. The new model for the delegation of responsibility, prioritisation and reinvestment at local, national and international levels is in the process of being implemented with the aim of encompassing RIs at all levels. The model follows a two-year cycle starting with a needs inventory and ending with a targeted call. Since 2015, the needs inventory has been carried out every two years.

#### Part One – Inventory of Needs

The model for the first step of the joint prioritisation and funding of national RI has been formulated by the VR in consultation with Swedish universities. The model includes recurrent needs inventories based on input from the universities, other funding bodies and research groups.



Figure 9: Timeline of the first half of the Swedish RI roadmapping process cycle (by Isabel Bolliger, 2018)

Every two years, the VR makes an inventory of RIs in Sweden, which was initiated for the second time in 2017. In the inventory of needs in 2017-2018, it received just under 100 proposals from higher education institutions, public authorities with research responsibilities, funding bodies and research groups.

The purpose of the inventory is to capture proposals for new national needs for RIs. The proposals submitted to the Swedish Research Council cover the following needs:

- Proposals for entirely new infrastructure, or needs for bringing together and significantly developing existing resources into infrastructure of national interest;
- Proposals relating to major upgrading of existing RIs, meaning upgrading of existing RIs that are operational, shall also be submitted to the needs inventory. A major upgrade aims at creating a comprehensive change to the scientific production, or a significant change to the technical approach. However, routine maintenance or gradual improvements may not be included;
- Needs for new international RIs, which relate to both Swedish participation in the construction of new international infrastructure and Swedish participation in existing organisations;
- Infrastructure with ongoing grants from the VR, for which the grant period ends no earlier than 31 December 2019 are not covered by the needs inventory. These have the opportunity to apply directly for continued grants in the targeted call.

The inventory is aimed at higher education institutions, public authorities with research responsibility, research funding bodies and researcher teams. The VR requests each need to consist of a well-developed proposal backed by several universities or other research performing organisations.

### **Requirements for a proposal for the needs inventory**

A proposal to the call for the needs inventory for RI of national relevance needs to include the following parts:

- An abstract, including a brief description of the RI, the need and type of RI, upgrade or development, the research area, conditions for accessibility, and a list of participating countries in case of international RI.
- Ethical considerations regarding issues raised by the research, such as the handling of personal data.

Moreover, a more in-depth description of the RI, of max. six pages has to be delivered which specifies on the following topics:

- The science case indicates on which scientific questions the proposed RI could increase knowledge on and how it could promote excellent and ground-breaking research.
- A survey of the field, stating if there are any similar RI and the relationship to them.
- An elaboration on the state of implementation of the proposed RI.
- A description of the potential user base,
- as well as the added value for society, industry and innovation.
- And a brief summary on financial aspects, including estimated construction and annual operation cost.

Finally, the administrating organisation has to be stated and the CV's of all participants provided.

### **Assessment and prioritisation of proposals for the needs inventory**

Once the inventory is completed, the VR's Council for RIs, RFI starts the assessment and prioritisation of the proposals. RFI has three advisory groups and one e-infrastructure committee that review and prioritise the proposals from the needs inventory. The groups are appointed by RFI and consist of researchers who are well informed on RI issues within a specific field of activity, such as registers and databases, observatories and measuring platforms, high technology laboratories and e-infrastructure.



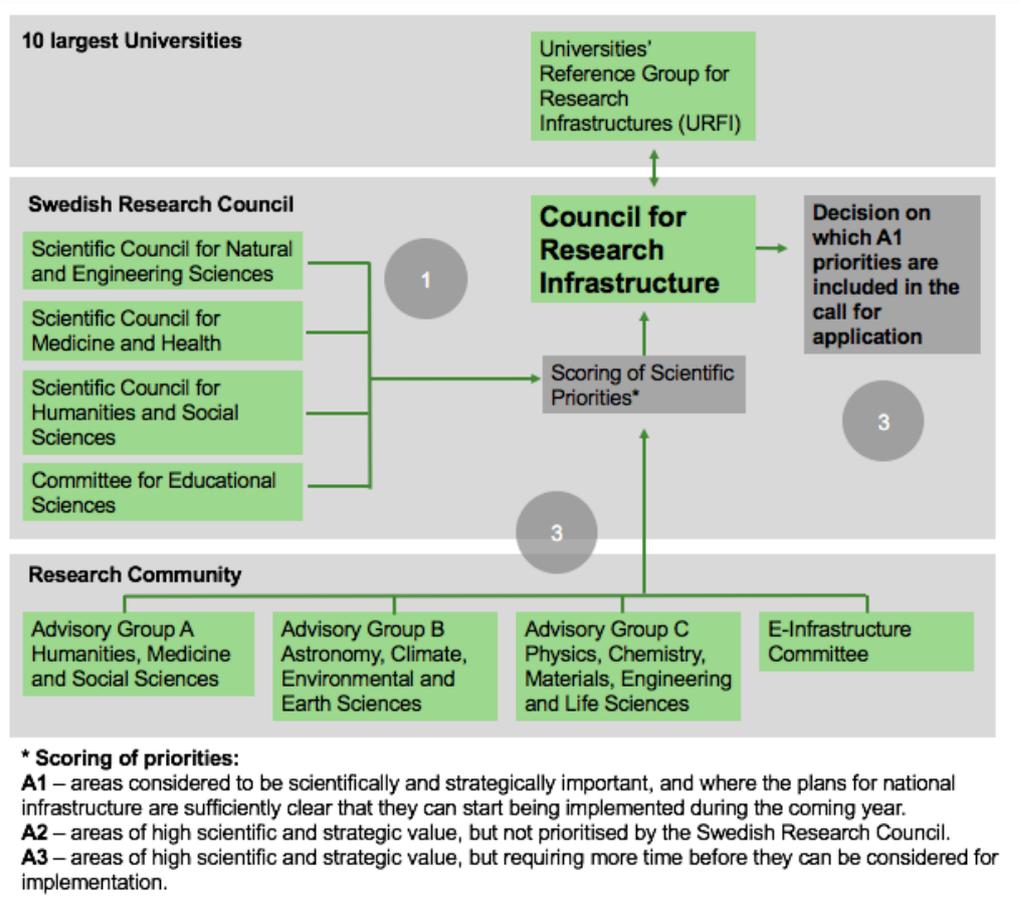


Figure 10: Assessment of Needs Inventory for Research Infrastructures in Swedish roadmapping process (by Isabel Bolliger, 2018)

In a first step, the VR's three scientific councils and the Committee for Educational Sciences enter a dialogue with the Universities' Reference Group for Research Infrastructures (URFI). The advisory groups assess the various proposals for RI along their:

- scientific,
- strategic,
- and national impact
- as well as how feasible they are.

The proposals are then divided up into seven categories, from A1 to X, where A1 is assessed as having the greatest priority.

- A1 areas considered to be scientifically and strategically important, and where the plans for national infrastructure are sufficiently clear that they can start being implemented during the coming year.
- A2 areas of high scientific and strategic value, but not prioritised by the Swedish Research Council.
- A3 areas of high scientific and strategic value, but requiring more time before they can be considered for implementation.

The results of the needs inventory then form the basis of a targeted call. The Appendix to the VR's Guide to Infrastructure includes a description of the high priority areas (A1, A2 and A3)

and a list of RI where the grant period will end in 2019 or 2020. It is only the areas in Category A1 in the Appendix that may be considered in the next call. The areas assessed as A3 may be considered only after the next needs inventory. However, not all areas identified in the Appendix to the Guide are covered by the call. RFI takes the final decision on which high priority areas will be included the call for grant applications for RIs. The fact that an area has been categorised as A1 is therefore a prerequisite, but not a guarantee, for being included in the next call. The final decision on which areas are included in the call is taken by RFI, based on a strategic consideration of the scientific benefit to Swedish research.



Figure 11: Timeline of 2<sup>nd</sup> half of the Swedish roadmapping process cycle (by Isabel Bolliger, 2018)

## Part 2 – Call for Proposals for Grants for RI of national interest

After RFI has decided on what RI are given the highest priority in the needs inventory, a call is issued which also includes application for grants for RI that already have an ongoing grant.

According to the VR's criteria, a RI of national interest must:

- be of broad national interest,
- provide conditions for outstanding research,
- be exploited by several research teams or users within the framework of high quality research projects,
- be of a size that makes it impossible to manage for individual research teams,
- be subject to a long-term plan in regard to the scientific objectives, funding and use of the infrastructure,
- be open and easily accessible to researchers, the industry and other users, and be subject to an accessibility plan (concerning both the use of the infrastructure, the access to collected data and the presentation of results).

and, where applicable,

- introduce new cutting-edge technology.

### Applicants eligible for the RI grant call

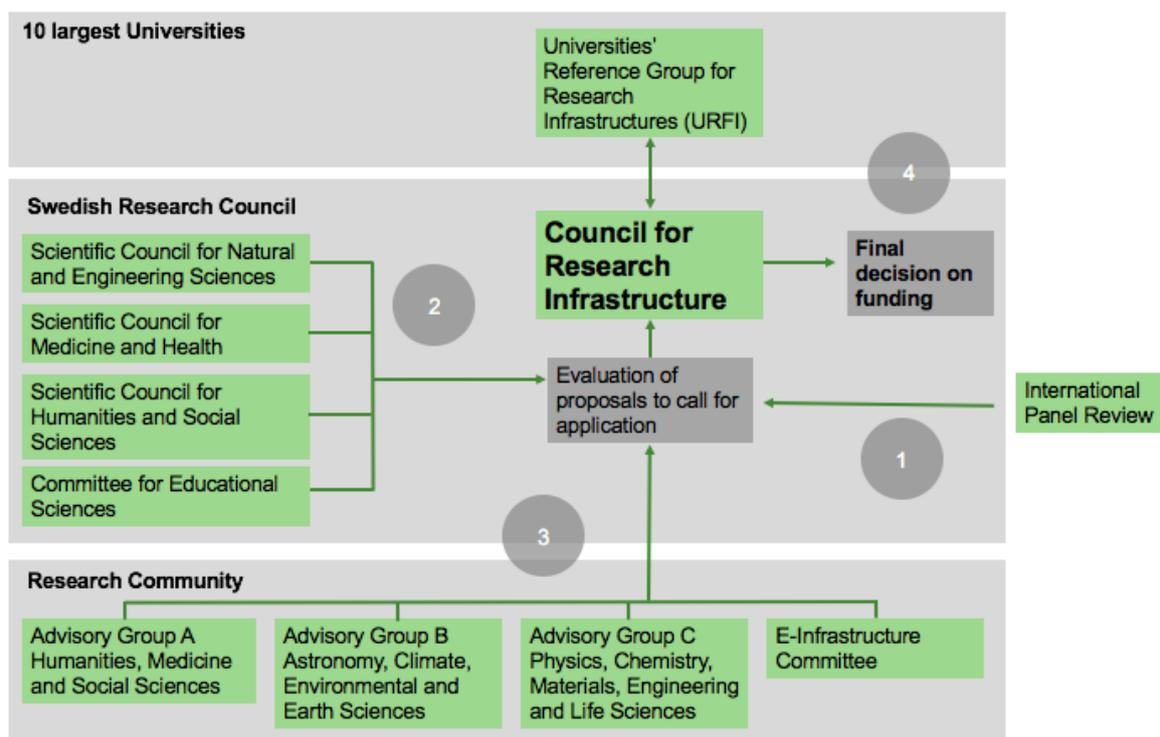
All Swedish universities or university colleges that fulfil the VR's requirements for administrating organisations are eligible applicants to the call. All applications have to be supported by a consortium of at least three universities and all consortium members must confirm their commitment in the form of letters of support.

### Requirements for an application to the RI grant call

The applications have to be done electronically through Prisma, which is the application system used by the VR, and need to cover the following points:

- Descriptive data
  - o Participating organisations
  - o Abstract, describing concerned infrastructure, its activities and organisation as well as the scientific goals, and the intended use of the grant.
  - o Popular scientific description, specifying the use of the RI, the opportunities it offers and in what way the new knowledge could be important.
- The RI's objectives
  - o Ethical considerations
  - o Scientific plan, including:
    - the scientific justification of the infrastructure/outline of the scientific field
    - and the significance for societal benefit and innovation.
- The RI's activities
  - o Infrastructure organisation and management (organisation plan)
  - o Infrastructure activities, including
    - a graphic overview,
    - a time plan,
    - specifications on the users,
    - existing cooperation with other national and international RI,
    - a description of the construction, development and operation of the RI,
    - and a risk analysis.
  - o Data management and need for supporting e-infrastructure
- Budget and research resources
  - o Total applied amount from the Swedish Research Council
  - o Budget
  - o Explanation of the proposed budget
- Key references
- Support letter
- Administrating organisation
- Participants





**Review of Applications:**

1. The international panel reviews each application based on scientific, organisational and technical criteria, but also on how the application relates to e-infrastructure and on the budget.
2. The scientific councils review the applications within their respective areas, and give a written statement on the scientific and strategic value of the applications to Swedish research
3. The advisory Groups give and summarising assessment based on the statements by the international panel, the scientific councils and its own scientific and organisational considerations. They also weigh in various national strategic aspects in their assessment.

Figure 12: Assessment of Grant Applications for Research Infrastructures in the Swedish roadmapping process (by Isabel Bolliger, 2018)

**Assessment of the grant applications for RI of national interest**

The assessment of the grant applications for RIs is done in three steps. First, an international panel reviews each application based on scientific, organisational and technical criteria, but also on how the application relates to e-infrastructure and on the budget. The panel has 10–12 international members, who together have a broad perspective on RIs and can put Swedish applications into a larger, global perspective. In the second step, the VR’s three scientific councils (Scientific Council for Natural and Engineering Sciences, Scientific Council for Medicine and Health and the Scientific Council for Humanities and Social Sciences) review the applications within their respective areas, and give a written statement, on the scientific and strategic value of the applications to Swedish research. In the third step the RFI’s advisory groups make a summarising assessment based on the statements by the international panel, the scientific councils and its own scientific and organisational considerations. They also weigh in various national strategic aspects in their assessment. Finally, RFI takes the decision which applications will be awarded with grants, which are normally depreciated over 3–5 years. The next needs inventory will start in autumn 2019 with the results will be presented in 2020.

All applications are evaluated by using the same reviewing process. This means that existing RI, applying for continued funding are prioritised in competition with new RI projects. This

joint evaluation is expected to create balance between long-term stability and necessary renewal.

### 3.4.3. Actors in the Swedish RI roadmapping process

The Ministry of Education and Research plays a very small role in the RI roadmapping process. Its main task is to develop the research bill, the overall strategic view of the government with regard to research policy. This research bill is based on a consultative process involving mainly stakeholders from research and industry. In that respect, the Swedish RI roadmap serves as a tool for the Swedish Research Council to advocate their position with regard to RI or other strategic areas. In spite of its small role in RI roadmapping, the MER has a political responsibility with regard to RI and also has a delegate in ESFRI.

The other actors, including their composition and their roles in the Swedish RI roadmapping process are elaborated in the following table.

Table 9: Composition and tasks of actors involved in the national RI roadmapping process in Sweden.

Actors	Composition	Tasks
RFI	<p>VR appoints the chair and members based on proposals from the VR's three scientific councils, and from the Forte, Formas and Vinnova research councils, who nominate one member each.</p> <p>In total thirteen members</p> <ul style="list-style-type: none"> <li>- nine are active researchers from different disciplines</li> <li>- one member of Forte, Formas and Vinnova</li> <li>- one representative of industry</li> </ul> <p>The term of office is three years and members can be re-elected for a further three years.</p>	<p><i>1. Needs inventory:</i> RFI decides on which high priority areas, that have been categorized as A+1, will be included in the call for grant applications for RI.</p> <p><i>2. RI grant applications:</i> RFI takes the final decision on which applications are awarded grants.</p>
Secretary General RI	<p>Secretaries General are active researchers and, as a rule, are employed by the Swedish Research Council on a part-time basis for a maximum period of six years.</p>	
VR's Scientific Councils for Natural and Engineering Sciences for Medicine and		<p><i>1. Needs inventory:</i> being consulted</p> <p><i>2. RI grant applications:</i> review the applications within</p>



Health for Humanities and Social Sciences		their respective areas, and give a written statement on the scientific and strategic value of the applications to Swedish research.
FRI Advisory Groups A B C e-infrastructure committee	The groups are appointed by RFI and consist of researchers who are well informed on RI issues within a specific field, such as registers and databases, observatories and measuring platforms, high technology laboratories and e-infrastructure.	<p><i>1. Needs inventory:</i> assess the scientific, strategic and national impact of the various proposals for research infrastructure, and how feasible they are.</p> <p><i>2. RI grant applications:</i> make a summarising assessment based on the statements by the international panel, the scientific councils and its own scientific and organisational considerations. They also weigh in various national strategic aspects in their assessment.</p>
URFI	The Vice-chancellors <sup>4</sup> of the ten largest universities President of the Association of Swedish Higher Education Institutions (SUHF)	
International Panel	10–12 international members, who together have a broad perspective on RI and can put the Swedish applications into a larger, global perspective.	<i>2. RI grant applications:</i> reviews each application based on scientific, organisational and technical criteria, but also on how the application relates to e-infrastructure and on the budget

#### 3.4.4. Analysis of the Swedish case

The Swedish RI roadmapping process started early in comparison to European countries and in parallel to the elaboration of the first ESFRI roadmap. Therefore, the Swedish RI roadmap represented the first national long-term plan for RI in Sweden and was the first of its kind in Europe. The Guide was intended to serve as a consistent basis for assessing what joint RIs were required for future top-quality research. It also laid out the scope for meeting the requirements and underpinned discussions on funding of future national RIs, as well as discussions with other countries on joint RI.

Since then, the Swedish RI roadmapping process as well as the funding system for RI has undergone major changes. National and European RIs lie now all within the realm of

<sup>4</sup> Or similar function with responsibility for RI.



responsibility of the Swedish Research Council (VR), which is also a major funder next to universities. Swedish universities are today required to fund at least half of the cost of these RIs and there is no differentiation made between construction and operational cost. Moreover, each application for funding of a RI has to be supported by at least three universities. These changes lead to stronger involvement of universities in the decision-making process, although there are still voices claiming they should still be more involved, particularly in the strategic planning for the RI landscape. Another feature of the Swedish RI roadmapping process is the thorough prioritisation of RIs happening during several stages of the decision-making process. This resulted mainly from external pressure with the strong limitations of the available budget for RIs, due to currency fluctuations with regards to the CERN membership fees but also the commitment for a large number of new RIs in the 2008 roadmapping process. Additionally, the Wallenberg Foundation, which is the largest private research funder in Sweden, decided to stop funding infrastructures. Therefore, the universities were forced to coordinate their needs better in view of maintaining an excellent RI landscape for their users.

Overall, the RI roadmapping process in Sweden is well established, with transparent methodologies and processes. The process is fully described in English and all documentation is easily accessible online. The main criteria during the prioritisation is the scientific excellence of RIs. The VR has also shown its ability to learn, and reached out to the universities to learn more about their views on the roadmapping process before adapting. However, some bottlenecks remain. The important sums tied into major RI projects may cause difficulties long-term for the sustainability and renewal of the Swedish RI landscape, especially for distributed infrastructures. Therefore, in the future, a portfolio approach, also considering to close down certain RIs, will be very important.



### 3.4.5. Good practices from the Swedish case

- The Research Infrastructure Council represents various scientific fields, other scientific councils of the VR as well as different sectors, e.g. a representative from Vinnova and industry.
- Within the RI roadmapping process, the Research Infrastructures Council consults with advisory groups, which also represent different scientific fields and universities as well as a specific group dealing with e-infrastructures.
- The Swedish Research Council encouraged universities and RPOs to prioritize their own needs and develop institutional roadmaps, which some have started to do (e.g. Chalmers University, KTH). This provides a solid foundation for institutions to justify and negotiate their RI needs.
- The major research performing universities in Sweden formed a specific group to discuss the matter of RIs where the vice-rectors are represented (URFI). This group is actively contributing to defining strategic areas and reviewing proposals.
- The Swedish Research Council calls for proposals include new and existing, as well as national and European RI, which are evaluated through the same process. This ensures that only top-class and most relevant RI are eligible. It also means that the process is streamlined, with clear common criteria for evaluation and there is a balance between long-term stability of existing RI and necessary renewal of the landscape.
- The evaluation of the scientific quality of RI grant proposals is evaluated by an international panel. This increases the objectivity of the process.
- The university staff of the URFI universities, dealing internally with RIs are continuously exchanging in view of mutual learning.
- The growing importance of e-infrastructures and matters of data management are being recognised in the Swedish RI roadmapping process.



## 4. Synthesis of desk study on evaluation and monitoring of RIs

The following chapter summarises the findings from the desk study on evaluation and monitoring practices in Europe, as described in the introduction. First, general concepts related to evaluation and monitoring are described. Then, individual case studies are presented in order to illustrate good practices.

### 4.1. General considerations and definitions on monitoring and evaluation in national research infrastructure roadmaps in Europe

As identified in the [InRoad Compendium](#), strategic priority setting for RIs developed through RI national roadmaps is already normal practice in most of European countries. To facilitate a better understanding of this practice we include below a general figure developed adapted from OECD (2008) which schematically depicts the interlinking between the different stakeholders that contribute to the national RI roadmapping processes and the monitoring and evaluation activities specifically linked with national RI roadmapping processes in Europe, based on analysis performed during the first part of the InRoad Project (InRoad Deliverable 3.2).

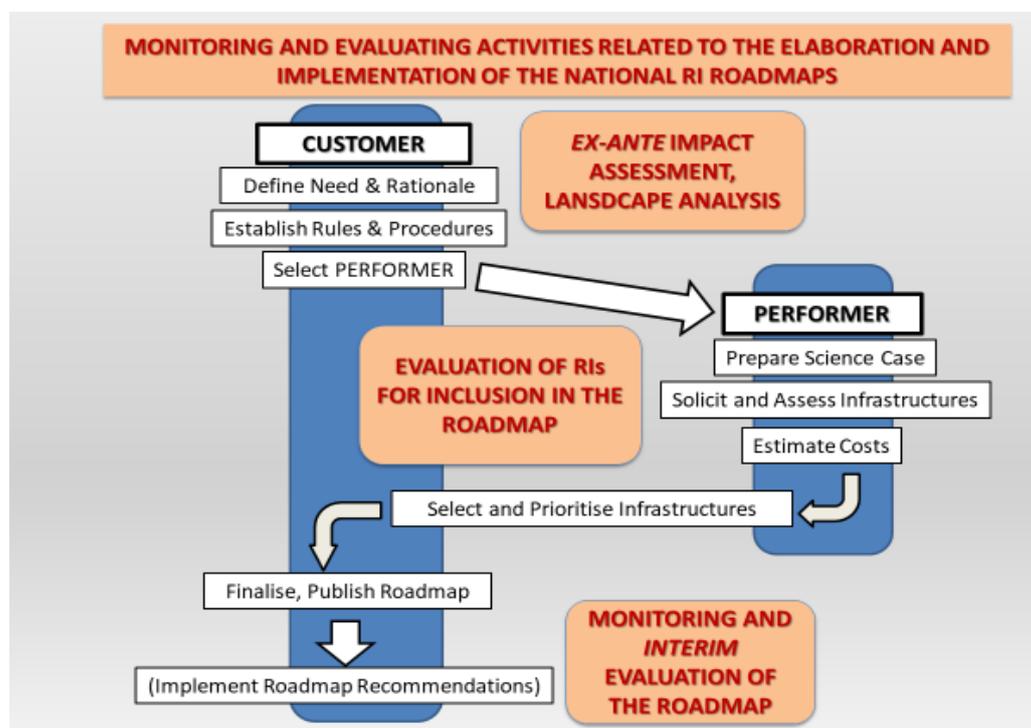


Figure 13: Monitoring and evaluation process linked to NRIRMP (adapted from OECD 2008, p. 9).

We use the term ‘ex-ante impact assessment’ to denote the evaluation of the rationale for an intervention, including the landscape analysis, carried out before the launch of a RI roadmap. This can include the planned monitoring and evaluation procedures which follow the realisation of the expected objectives in the roadmap, with the intention of correcting any deviation from operational objectives.

Proposals for roadmap inclusion are frequently submitted by RI managers. This may happen in different phases of the RI lifecycle: definition, planning, implementation, operation, etc., sometimes predefined, as for example in Germany. Governments frequently determine a set

of rules and procedures for being included in the national RI roadmap, providing concrete details on the process for the selection of RIs, including eligibility criteria, the timing and resources needed and the evaluation/selection of the RI methodology (composition of reviewers/expert panels, criteria to be used, etc.), which are denoted here as 'evaluation of RIs for inclusion in the roadmap'.

Finally, 'monitoring and interim evaluation of the roadmap' refers to activities related to the monitoring and evaluation of the performance of RIs included in the roadmap, together with other monitoring and evaluation activities specifically related to the roadmap itself, for example, the specific collection of data for roadmap monitoring, assessment of the realisation of general roadmap objectives, and so on. Based on this information, governments obtain the necessary evidence to make informed decisions on the roadmap as a whole, for example, proposing new areas of interest, increasing/decreasing the number of RIs to be included in the next roadmap, etc. Evidence obtained from periodic reporting and other monitoring activities normally supports the interim roadmap evaluations, which also could be carried out with some periodicity.

At policy level, evaluation activities are generally used for ensuring accountability, promoting organisational learning and for improving informed decision-making. Monitoring involves collecting evidence on progress towards expected results, analysing such evidence and, in when needed, taking the appropriate decisions.

Although most EU countries share general monitoring and evaluation requirements, the defined function of monitoring and evaluation depends on the political and administrative system in which the monitoring and evaluation practices are carried out (Molas-Gallart 2012). As Europe has rather diverse national R&I systems, it is difficult to make general observations when analysing these issues or trying to identify good practices suited for all EU countries. However, the information gathered and analysed on various practices across Europe allowed us to identify good practices described in the following section. These need to be related to their context, but they can provide a framework to better understand evaluation and monitoring principles, as well as a basis to develop future processes in other countries with similar characteristics.

## 4.2. Good practices in evaluation and monitoring

This information on good practices is based on the analysis of official publicly available policy documents dealing with monitoring and evaluation (M&E) approaches and methods for RIs in Europe, information directly provided by national government bodies, together with a literature review focused on M&E approaches and methodologies considered in national RI roadmapping processes. Based on the national reviews carried out previously, we have identified valuable practices in the RI selection process for roadmap inclusion, ex-ante evaluation and monitoring from Bulgaria, Czech Republic and Ireland which are described in this section.

### 4.2.1. Information on the National RI roadmap planned monitoring (Bulgaria)

The first national roadmap for RI (NRRI) in Bulgaria was adopted in 2010 and the latest update was finished in 2017, which covers the period from 2017 to 2023. The following figure illustrates the various policies and instruments that are linked to the NRRI.



### Policies and instruments of influence on the National Roadmap for Research Infrastructure (NRRI) of Bulgaria

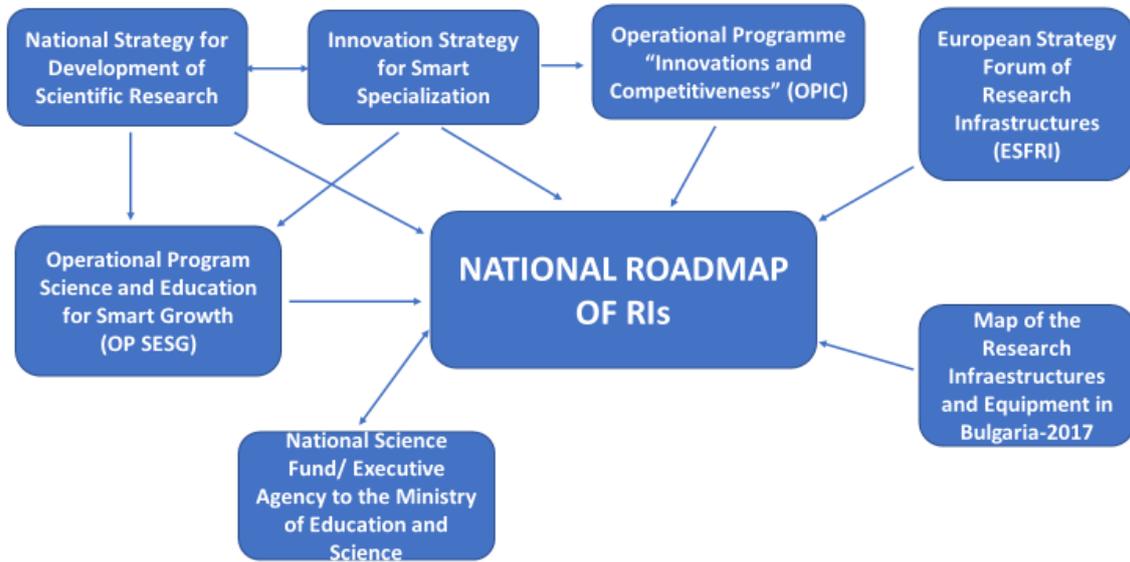


Figure 14: Monitoring the implementation of the roadmap

The general implementation of the Bulgarian RI Roadmap (NRRI) and the development of the individual RI are subject to regular national and international Monitoring & Evaluation (M&E). It includes a general review of the implementation of the NRRI policies at a national level, as well as corrective measures and possibilities for introduction of new instruments and schemes. For the overall monitoring of the implementation of the NRRI a new Standing Committee (SC) will be constituted as a consultative body to the Minister of Education and Science (MES).

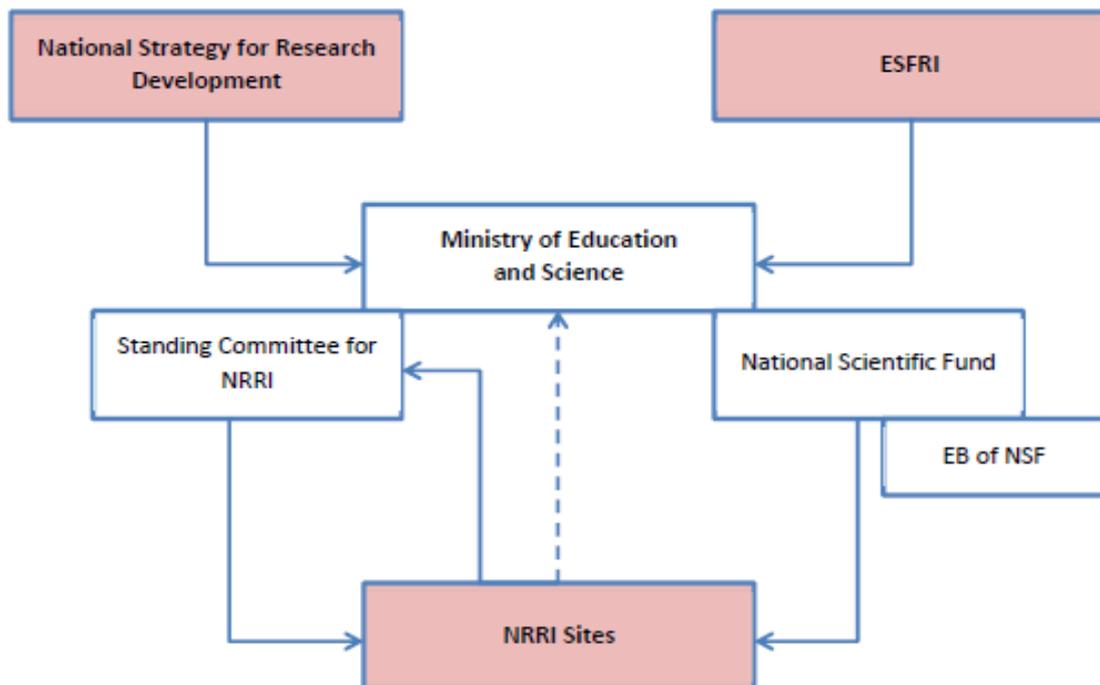


Figure 15: Standing committee for NRRI



The SC meetings are expected to take place at least twice a year, as the committee reviews the report of the Executive Council of the National Scientific Fund (NSF) on the scientific achievements and the financial reports of the individual research complexes. The mechanism for decision making is the following:

- Establishment of the NRRI SC by Order of the MES and the adoption of its rules of procedure;
- The sites included in NRRI perform a self-evaluation, the results of which are presented to the Science Directorate, MES, and the NSF;
- The Science Directorate performs independent socio-economic evaluation of NRRI site support;
- The NSF reviews self-assessment results;
- The NSF submits a proposal for annual financing of the NRRI sites;
- The NRRI SC proposes a decision for site prioritisation to the MES based on the annual report by NSF and the evaluation, assigned by the Science Directorate;
- The NSF pays the financial resources of the prioritised sites for the respective year and performs financial monitoring of the implementation of the NRRI;
- The NRRI SC reports annually to the Minister regarding the implementation of the NRRI.

The NSF is expected to organise an independent external evaluation of the research activity of the national research infrastructure every two years, which includes conducting surveys and cost-benefit analyses for the regional and national economy

#### 4.2.2. Evaluation methodology for RI entering the national roadmap (Bulgaria)

The inclusion of RIs in the Bulgarian National Roadmap occurs through a diagnostic review, the development of research priorities under the National Research Strategy and the participation of Bulgarian research projects in the ESFRI Roadmap.

A first assessment is conducted by a national working group, formed by representatives of national ministries (Education and Science Transport, Information Technology and Communications), the Bulgarian Chamber of Commerce and Industry (BCCI), Universities, Academy of Science, non-governmental organisations and other relevant national institutions. The national working group reviews, assesses and selects the projects based on thematic areas. Projects that receive a high score are recommended for validation from an international expert panel and other projects and are recommended for re-processing and/or consolidation. The evaluation methodology covers quantitative and qualitative criteria based on three predefined criteria, which follow the ESFRI evaluation criteria. These criteria are detailed in the table below. All RIs entering the National Roadmap need to comply with priorities defined in the National Research Strategy, the Innovation strategy for Smart Specialisation and the ESFRI agenda.

RI entering the National Roadmap need to comply with priorities defined in the National Research Strategy, the Innovation strategy for Smart Specialization and the ESFRI agenda.



Table 10: Evaluation criteria for the Bulgarian RI roadmap.

EVALUATION CRITERIA	SUB-CRITERIA
<p><b>SCIENTIFIC AND TECHNOLOGICAL EXCELLENCE OF THE RI</b></p> <p><b>50% WEIGHT OF THE ASSESSMENT</b></p>	<ul style="list-style-type: none"> <li>I. The significance of the RI for the specific research fields: Relevance of the scientific objectives of the RI to facilitate and promote top-level science in Bulgaria; Capacity of providing potential for world class research and scientific breakthrough; Expected benefits for the national scientific and technological system for conducting cutting edge research at an international level, namely to increase the participation in international collaborative research projects, such as those of the Horizon 2020.</li> <li>II. Adequate identification of the RI's strengths, weaknesses, opportunities and threats (SWOT analysis)</li> <li>III. Degree of internationalization, including the integration in international RI initiatives, namely those of the European Strategy Forum for Research Infrastructures (ESFRI) Roadmap</li> <li>IV. Degree of inter-disciplinarity, including the effect of the RI on strengthening interdisciplinary research in Bulgaria</li> <li>V. Quality of the proposed training of researchers</li> </ul>
<p><b>GOVERNANCE CAPACITY AND IMPLEMENTATION FEASIBILITY</b></p> <p><b>25% weight</b></p>	<ul style="list-style-type: none"> <li>I. Degree of adequacy of the management structure and governance of the RI to the proposed scientific aims</li> <li>II. Adequate management and action plan implementation (<i>leadership; distribution of responsibilities; experience and capacity; identification of RI's strengths, weaknesses, opportunities and threats, SWOT analysis</i>)</li> <li>III. Competence and complementarities of the nodes and added value of the national RI at the regional, national and international levels, including contribution increase access to knowledge resources and scientific capacity in the field of operation of the RI</li> <li>IV. Adequate equipment and relevance of improvements to the existing and/or acquisition of new equipment, considering the scientific aims of the RI</li> <li>V. Quality of the access policy and data management plan (transparent policy for access to the infrastructure, including international access activities, conditions for provision of access, addressing remote access needs in relation to availability of e-infrastructures and data management issues; access policy for industry (addressing IP rights, if applicable, fees and confidentiality issues)</li> <li>VI. Operational readiness: maturity of the RI and appropriate relations between partners of the infrastructure and, if relevant, of the integration in an international research infrastructure</li> </ul>
<p><b>BUDGET AND SUSTAINABILITY</b></p> <p><b>25 % weight</b></p>	<p>Includes technical feasibility, human resource costs and cost-effectiveness of the proposed infrastructure (based on adequacy of requested funding and envisaged sources of funds, multi-annual budget plan with funding sources information and long-term sustainability plan of the investment.</p>

This evaluation criteria are used for both assessing RI entering the roadmap as well as for midterm evaluation/update of the roadmap.



### 4.2.3. Methodology to evaluate the RIs to be included in the national roadmap (Czech Republic)

The Czech Republic has a well-defined methodology to evaluate RIs that are included in their national roadmap, with clear connections to both national funding of RI and international commitments in EU RI policy (ESFRI and EU Cohesion funds).

The Czech Republic evaluation methodology is inspired by ESFRI evaluation procedures and has been elaborated within the framework of the Individual National Project and is denoted as 'Effective System of Evaluation and Funding of Research, Development and Innovation' financed by the ERDF, and is known as the IPN Metodika project. In the context of this project, RIs are categorized as Scientific Research Organisations.

This project, commissioned by the MEYS was carried out between 2012 and 2015, with a view to introducing periodic, systematic and objective evaluations of the RDI support system in the Czech Republic at all levels. The need to have a new evaluation methodology which includes a system that combines the use of indicators, peer review and an element of prospective thinking was one of the conclusions of an International Audit of the Czech RDI System, carried out during 2010–2011.

The fact that the project was funded by the ERDF, and included a public tender to carry out a study called 'R&D Evaluation Methodology and Funding Principles', a small-scale pilot test of the methodology, and a final international conference makes it possible to have several documents that describe in detail the methodology used to evaluate R&D infrastructures in the Czech Republic.

Based on the methodology developed by the Metodika project, the MEYS commissioned a comprehensive evaluation of RI of the Czech Republic in 2014 by an International Evaluation Committee, of 19 members, composed of a Chairman and six Scientific Boards composed of three experts on the R&D areas of: (1) Physical Sciences; (2) Energy; (3) Environmental Sciences; (4) Biomedicine; (5) Social Sciences and Humanities; and (6) ICT/e infrastructures. These experts came from a pool of experts with long-term experience with RI in their roles as users or RIs policymakers, and at least one of the members of each board came from the Czech Rep, so as to provide knowledge on the R&D context of the country.

#### **Evaluation Methodology**

The evaluation of the RIs is carried out using a two-stage evaluation process, combining the methods of panel and international peer-review, and interviews with the managers of the RIs. This evaluation is quite in-depth and prolonged, which is justified because the results are taken into account, among other things, in the the allocation of funding to RIs.

During the first stage, the proposal is assessed against the national definition of a RI to pass on to the second stage. This definition is composed of three elements:

- Operation of unique technological R&D facilities;
- Having at least nation-wide importance and impact in the Czech Republic and potential international overlap;

A well-defined methodology for the evaluation of RI has been implemented in the Czech Republic. This responds to the fact that the results of the evaluation are used to inform decision making in connection to both national funding of RI and international commitments in EU RI policy (ESFRI and EU Cohesion funds).



- Managing the RI on the basis of an open access policy consistent with international good practice.

This first stage evaluation is carried out exclusively by the six Scientific Boards, that act as evaluation panels, holding several meetings

In the second stage, the proposals are evaluated against a set of criteria pertaining to the following dimensions.

- **Socio-economic impact**, how does the RI contribute to solve socio-economic challenges in the context of the R&I system of the Czech Republic.
- **Uniqueness of technological facilities**, the technological level, knowledge intensity and uniqueness of the RI within the R&I ecosystem of the Czech Republic.
- **Existence of a management and sustainable development strategy**, that includes
  - a. a well-defined governance structure;
  - b. an intellectual property rights strategy;
  - c. a human resources development strategy;
  - d. a long-term sustainable development strategy and;
  - e. a public relations and marketing strategy.
- **Open access policy**, in that the RI is operated on the basis of an open access policy to its facilities for a broad range of potential users from the R&D community.
- **R&D strategy**, a substantial part of its R&D activities focuses on R&D to improve its services and expertise for the users, and the further development of technologies and expertise within the RI, and to a limited extent on the collaborative and contractual R&D.
- **Cooperation with other research organisations and RIs** operating in the respective scientific field or multidisciplinary R&D area and industrial sector (the RI has established a relevant formal framework determining rules of cooperation developed with partner research organisations and research infrastructures in the Czech Republic and abroad as well as with the industrial sector.
- **Quality of R&D results achieved by using the RI**, R&D results that are achieved by using the facilities and expertise of a RI must be of high-quality and adequate from the point of view of 'value for money'.
- **Potential for the development of new technologies**, based on how far the RIs are operated in high-tech and knowledge-intensive areas and used for the development of new advanced technologies.

The Czech Republic has developed a complete methodology for the evaluation of large-scale RIs, which is part of a broader system for the evaluation of the R&D support system in the country. The evaluation of RIs follows a two-stage approach, combining the use of six scientific boards with international experts (covering six R&D broad areas), followed by an international peer review (two or three reports per research infrastructure proposal). Interviews with the representatives of the research infrastructure management team are also used to gain more insight on specific aspects of the RI.

The second stage evaluation is carried out by international peer-review (two or three reports per RI proposal) to obtain additional independent expert opinions beyond the assessment conducted by the respective six Scientific Boards of the International Evaluation Committee.



In this second stage, the scientific panels who participated in the first stage carry out interviews with the representatives from the RI management teams in order to address questions about the operation of the RI and the delivery of services to external users.

Harmonisation of the panel results is done in a cross-panel session chaired by the head of the International Evaluation Committee. The decision on economic issues contains also a verification/negotiation phase, where the proponents have to explain and justify the budget proposal. The decision on funding is taken by the government and implemented by the ministry.

Positively evaluated RIs recommended by the International Evaluation Committee for public funding are divided into four performance-related groups indicating the priority for public funding in direct proportion to the quality-differentiated output of the evaluation: A1 (highest priority), A2 (high priority), A3 (middle priority), A4 (low priority).

The results of the evaluations are used to inform decision making in connection to:

- **Funding the large-scale RIs of the Czech Republic**, combining state R&I budget and EU Cohesion funds. In this regard, the roadmap acts as a stable, predictable and long-term funding framework for operation, further technological development and capacities and the capabilities of building research infrastructures.
- **Declaring the political and financial commitment of the Czech Republic** to the pan-European RIs with Czech involvement and participation that will be submitted for future ESFRI Roadmap updates;
- **Joining the emerging ERICs** to be established within the ERA in the years to come.

The evaluation of RIs carried out by the Czech Republic in 2014 involved not only long-time operating facilities but also those newly built by using the ERDF within the Operational Programme Research, Development and Innovation (OP RDI) in the course over the 2007-2015 period. The results of the evaluation are considered as an ex ante evaluation as they were used to prepare the next multiannual financial framework covering 2016-2022. This evaluation will be used to carry out continuous interim assessments of large-scale RIs, which will be financially supported by the MEYS. This evaluation will be carried out after the end of the first and third years in the seven-year large-scale RIs funding framework, followed by another comprehensive evaluation by the end of the period, to inform the preparation of the next multiannual programme.

The evaluation methodology, both, as a means to select RIs for the roadmap and for the evaluation of RIs included in the roadmap when periodic interim assessments are carried out, is very well documented (see for example the *Czech Republic RI Roadmap for the years 2016-2022* and the MEYS document 'Ex-ante evaluation methodology for large research infrastructures'). These documents present the framework for the assessment of new concepts/projects of large-scale RIS, which have not been included in the 'Roadmap of the Czech Republic of Large Infrastructures for Research, Experimental Development and Innovation for the years 2016-2022', but might have emerged since the last roadmap update in 2015 (based on the outcomes of the 2014 comprehensive evaluation of large-scale RIs). The documents have been prepared to inform the evaluators in the context of the evaluation exercise launched to obtain an independent expert basis and science-based recommendations for the 2018 update of the roadmap.



#### 4.2.4. Gap analysis and ex ante impact evaluation to define priorities in the national RI roadmap (Ireland)

As part of the Irish RI roadmap, in depth ex-ante assessment and prioritisation work, including gap analysis and ex-ante impact evaluation to define priorities, was performed.

As a means to support the preparation of the national Science, Technology and Innovation (STI) for the period 2006–2013, the Irish government carried out a comprehensive review of existing RIs, results of which were presented in the document 'Research Infrastructure in Ireland - Building for Tomorrow', published in 2007 by the former National Policy Advisory Board for Enterprise, Trade, Science, Technology and Innovation (FORFAS) and the Higher Education Authority (HEA). This document has been used as the Irish RI roadmap. The report was carried out to provide an overview of the quality of facilities currently available to third-level researchers and to identify gaps in the existing RIs that are most in need of attention in forthcoming rounds of national RI funding under the SSTI (Strategy for Science, Technology and Innovation).

To prepare the Irish RI roadmap, a review of existing RIs was carried out, as a means to identify gaps and design future funding of RIs, all in the context of the national STI strategy for the period 2006-2013.

For this National Review of RIs within the higher education system, all RIs were considered; there were no eligibility conditions as it involved the benchmarking of RIs in Ireland and the identification of gaps in the national platform of RIs. The results of this review were used to inform future RI funding. The review of the existing RIs was carried out across 9 broad disciplinary areas: Arts and Humanities; Biological and Agricultural Sciences; Computer Sciences; Creative Arts and Media; Earth, Atmospheric and Ocean Sciences; Engineering Sciences; Medical Sciences; Physical Sciences and Mathematics; and Social Sciences and Psychology.

This evaluation process followed a mixed approach that included consultation with stakeholders to gather their needs, site visits by 34 international experts, a workshop to obtain inputs from industry and business and finally a forum to discuss the outcomes of the visits, the workshops and the consultation. All the work was coordinated by an independent international Steering Committee composed of five experts.

Existing RI were evaluated following a mixed approach, that included consultation with stakeholders, on-site visits by international experts and a workshop with industry and business. The evaluation by coordinated by an international steering committee of 5 members.

The results of this evaluation were not used to inform the selection of RIs to enter the roadmap, but to inform future investments in RI in the higher education sector, as part of the national Strategy for Science, Technology and Innovation covering the period 2006–2013. The report set out the strengths, weaknesses and gaps in existing RIs as well as recommendations for future investments and suggestions for greater utilisation of existing national and international research facilities on a multi-user basis.

As part of the process of updating Ireland's STI priorities for the next period (2014–2020), a study to update Ireland's strategy with respect to RIs was commissioned to the Technopolis group by the Department of Jobs, Enterprise and Innovation to in 2015. This study had the following objectives:



1. Take stock of the RI investments made to date, in light of the national STI priorities (retrospective study).
2. Identify any future investment needs in the period to 2020 (and beyond) that may be strategically required for the achievement of national STI priorities (prospective study).

The study approach combined desk research, interviews, a survey about future RI needs and six workshops.

The study report pointed out that in total, the Irish National government invested between €60M and €80M per year in RIs during the studied period, and that due to these investments, Ireland's research community was able to use a broad range of RIs for a variety of scientific domains and application areas.

The study also highlights the fact that in Ireland, the RI strategy, mainly the financial resources available for RIs, is clearly dependent on and influenced by the national STI, which sets the priorities in terms of scientific challenges, business opportunities and societal challenges that require investments in, among other things, RIs.

One of the recommendations of this study was that: *"Ireland needs a RI roadmap to establish the prioritisation of national and pan-European Research Infrastructures; align RI priorities with STI priorities; facilitate political support at all policy levels; help to define national and regional budgets; and allow for long-term financial commitment by public and private stakeholders. The process of developing the roadmap should engage relevant ministries, agencies, industry, etc."* (FORFAS 2017).

The Irish government commissioned another study on national RIs, as part of the process for updating Ireland's STI priorities for the period (2014-2020). This study, which included both a retrospective and prospective study, concluded that the RI strategy, mainly the financial resources available for RIs, is clearly dependent on and influenced by the national STI and recommended the Irish Government the need to prepare the roadmap, as a tool to design the national RI strategy.



## 5. Cross-country analysis: trends and good practices

Over the past decade, the number of national RI roadmaps and their updates have increased. This development is accompanied by a multiplicity of factors driving national roadmap processes: the establishment and development of the ESFRI Roadmap, the establishment of Smart Specialisation Strategies (RIS3), and budgetary fluctuations that make it essential to have clear mechanisms for prioritising RI projects.

InRoad's preliminary findings highlighted the need for a common understanding of methodological aspects related to RI roadmapping, the purpose of the roadmap exercise, as well as the interplay between national, European and institutional RI roadmapping processes. At a minimum, a better mutual understanding of the definitions and terms used by national authorities is essential to help with the classification of facilities and the application of specific terms. The following cross-analysis develops InRoad's findings on the diversity of national RI roadmapping processes and identified trends. Furthermore, it identifies some key areas for intervention. In general, InRoad findings show that successful attempts to increase coordination between different levels take into account the specificities of national R&I systems, as well as opportunities for a higher degree of coordination through transparent processes and public accountability. Explicit purposes and well-defined processes for RI roadmapping, clear definitions, a clear vision of what the missions and needs of RIs are, are all elements that can better support mutual exchange, policy learning and coordination.

### 5.1. ESFRI as a driver of national RI roadmapping in Europe

Since the founding of the European Strategic Forum for Research Infrastructures (ESFRI) in 2002, national RI roadmapping processes have strongly evolved. Focusing solely on the ESFRI roadmap processes, their work can be roughly grouped in the following phases:

- The main intention of the **1<sup>st</sup> phase** can be understood as incubation of projects, incl. the first three ESFRI Roadmaps (2006, 2008 and 2010), which are mainly lists of opportunities;
- The **2<sup>nd</sup> phase**, from 2010 to 2016, was triggered by the request of the Council of the EU for more prioritisation. Since then, the ESFRI Roadmap includes an assessment of the implementation of the projects and a prioritisation of RI projects. ESFRI Roadmaps are based on integrated landscape analyses that identify not only needs and gaps in different thematic fields, but also cross-disciplinary issues. In this phase, a High-Level Expert Group was formed by the European Commission (EC) to evaluate implementation status of projects on the ESFRI Roadmap. The [AEG report](#) (Calvia-Goetz et al. 2013) resulted in the introduction of new rules, such as a maximum period of 10 years for projects to be included the ESFRI Roadmap before upgrading to a landmark status or, if requirements are not fulfilled, being removed from the roadmap;
- The **3rd phase** of the ESFRI Roadmap for RI introduced an ecosystem approach. The ESFRI Roadmap 2016 includes a landscape analysis, the assessment RI project implementation and the scientific case. The 2018 ESFRI Roadmap 2018 encompasses the entire RI portfolio and additionally includes a periodic peer-review of the scientific status of four landmarks as a case study. The new guidelines provide precise definitions of RI, lifecycle and phases of the lifecycle;
- The **4th phase**, as currently envisaged, will be characterised by the challenges lying ahead, e.g. the need to refine the methodology for monitoring RI projects and for the periodic review of landmarks. Further consolidation of the European RI landscape is



needed in order to guarantee long-term sustainability of European RIs and ESFRI needs to find its role in the global context.

The establishment of the ESFRI roadmapping process has been a key driver of national RI roadmapping processes. By encouraging countries to develop their own national roadmaps, driving discussions on pan-European RI, and developing state-of-the-art methodology, ESFRI has had an essential role in increasing coordination of research infrastructure policies. Hence, trends towards more sound and complete RI evaluation and monitoring procedures, stronger prioritisation and consideration of the existing European RI ecosystem can also be found at the national level, where the following steps are increasingly being taken into account:

- **Bottom-up approach** in order to elaborate the scientific needs of the national user community;
- **Landscape analyses** in order to assess gaps, strengths and priorities for RI within the national ecosystem and increasingly also in Europe;
- **Strategic planning** (top-down) in order to elaborate priorities and long-term strategies;
- **Evaluation methodologies** for the selection of RI proposal for the national roadmap and assessment of quality of existing RI.

It is also important to note that the national RI roadmapping processes and the ESFRI roadmapping processes are interlinked and feed into each other. National RI roadmapping processes contribute to identifying and supporting pan-European RI. Thus, a higher degree of coordination between regional, national and European RI roadmapping processes and also between relevant stakeholders is still needed to identify needs and decide on priorities. At the same time, aspirations to enhance the adaptability of national RI roadmaps to supranational roadmaps need to acknowledge and respect the sovereignty of each country in setting specific priorities for their national research policy. For example, the InRoad case studies showed that institutional processes such as budget cycles, national legislations on public funding of research, research bills or simply elections could shape or constrain RI roadmapping processes. This must be taken into account when designing national processes, but also when elaborating coordination mechanisms.

In general, InRoad findings show that successful attempts to increase coordination between different levels take into account the specificities of national R&I systems, as well as opportunities for a higher degree of coordination through transparent processes and public accountability. Explicit purposes and processes for RI roadmapping, clear definitions, a clear vision of what the missions and needs of RI are, are all elements that can better support mutual exchange, policy learning, and coordination. ESFRI, as well as other fora and networks, have already greatly contributed to this. Therefore, InRoad encourages continued work to produce comprehensive information on RI and draw lessons from exchanges between (and within) countries. Areas of particular interest for further work (based on existing initiatives and identified needs) are: how to calculate full costs of RI, how to accurately monitor their performance, how to assess their socio-economic impact and return on investment, how to develop interdisciplinarity and synergies between RI, how to manage increasing volumes of data and how to address ethical issues. Solving those challenges will require the development of common strategies.



## 5.2. RI definitions in national RI roadmaps

ESFRI structures its RI definition in its public roadmap 2018 guide according to three main issues; 1) purpose and users of RI, 2) kind of RI or organisational model, e.g. central and remote resources and laboratories, and 3) type of RI: single sited, distributed, virtual, global RI (ESFRI, 2016).

However, variations in RI definitions of EU MS/AC make it difficult to refer to the same subject matter in the coordination of RI roadmapping processes with other countries and with ESFRI. There is a clear need to foster a better understanding of how a country defines its RI beyond national relevance and what are the deviations between the national roadmap definitions and those in ESFRI and the reasons for such disparities.

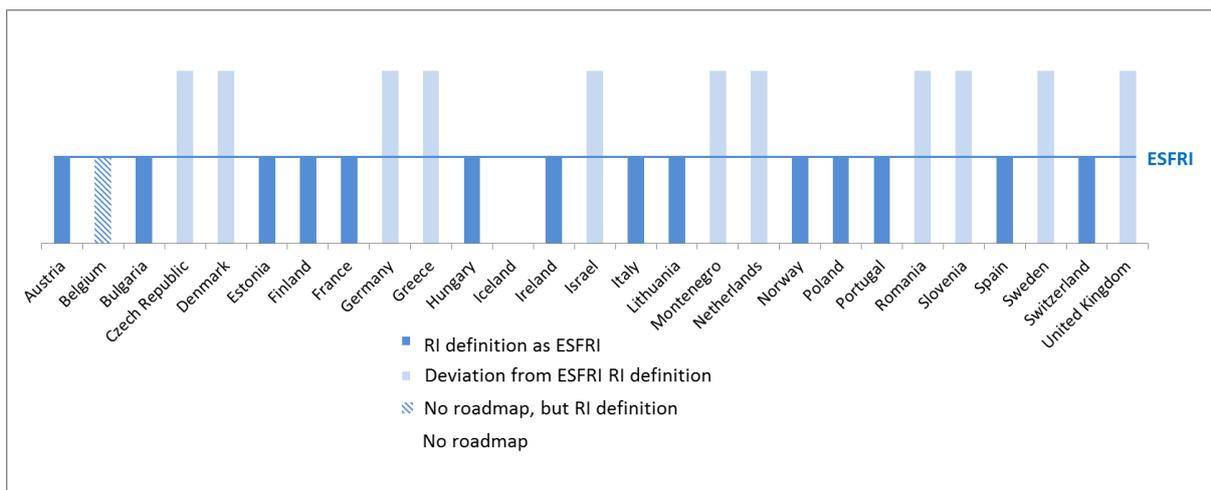


Figure 16: National roadmap RI definitions of EU MS/AC in relation to ESFRI RI definition (Ruecker, et al. 2018).

More than half of the investigated EU MS/AC share the same RI definition as ESFRI (19 out of 27; 70%) including Austria, Belgium (RI definition, but no roadmap exists yet), Bulgaria, Estonia, Finland, France, Hungary, Ireland, Italy, Lithuania, Norway, Poland, Portugal, Spain and Switzerland which has a RI definition very close to the ESFRI RI definition. However, there are seven countries (30%) that have an RI definition that deviates from that of ESFRI. These countries are Denmark, Germany, Greece, Israel, the Netherlands, Slovenia, and Sweden. The remaining country, Iceland, does not yet have a roadmap (Ruecker, et al, 2018).

The deviation of the RI definition from the ESFRI form in these countries mainly concerns:

1. Specific minimum threshold values, e.g. Denmark specifies approximately €3–14M investment needs for construction and/or implementation; Germany considers construction costs of at least €50M. For RIs in the fields of humanities and social sciences or educational research, a threshold of €20M applies; the Netherlands specify a lower threshold value in terms of total capital investment and operating costs for five years of M€ 10 for their large-scale RIs. These costs do not include accommodation costs for the facility. The operating costs pertain exclusively to the costs needed to make the facility accessible. These therefore do not include costs for the research programme.
2. Specifications of which RIs are included in the roadmap and which are not, e.g. Denmark excludes memberships of convention-based international RIs (e.g. CERN,



ESO) and some other national RI collaborations from the roadmap process; Greece includes RIs that are relevant to the ESFRI roadmap, but in addition also RIs which are important according to national priorities; Israel's RI definition also includes a number of pieces of equipment which, used as a whole, contributes to a specific research area.

3. Service life of the RI, e.g. Germany considers a service life generally of at least ten years, the Netherlands of at least five years with at least another extension of five years; Czech Republic a four-year period with a possible prolongation of three years.
4. User access regulations to RI, e.g. access to German RI on the roadmap is generally open, and their utilisation is regulated on the basis of scientific quality standards; in Sweden, RIs must be generally accessible to Swedish researchers and need to be open and easily accessible to researchers, industry and other stakeholders; in Israel, RIs need to be available to all scientific researchers in Israel, while access to international users is not described.
5. Systems supporting RI, e.g. in Slovenia, RIs often require a structured information system for data management and for enabling information and communications as specified in the RI definition.
6. Distinguishing National Strategy for RI from the ESFRI strategy, e.g. in Greece priorities regarding ESFRI RI are aligned to the National RI Strategy, however the national strategy for RI is independent from the ESFRI strategy.
7. Technological developments of RI and innovation capacity; e.g. Sweden defines RI in addition to introducing new cutting-edge technology and Finland considers RI to develop both research and innovation capacity.

This list of deviations of national RI definitions from the ESFRI definition, as well as the recognition that national RI definitions vary considerably in the level of detail, point out that general guidelines on key elements of a RI definition would be beneficial for better understanding of the RI basis of discussion in the national roadmap of Europe, thus improving transparency and facilitating RI coordination at EU-level. In addition to the ESFRI RI definition, the RI definition should also include the following criteria:

- Threshold criteria for RI costs;
- Minimum service life of the RI;
- Specification of which RIs are included in the national roadmap and to what extent and which are excluded;
- Access regulations and specification of users;
- Technological and innovation capacity building and development.



### 5.3. Purpose of national RI roadmaps

Understanding the exact purpose of national roadmaps is essential for political decision makers, funding agencies, and the user community for better grasping the strategic interest, scope, and orientation of other countries with respect to RI as well as concerning the specific functions of the national roadmap. This understanding is a key requirement for identifying joint strategic interests and negotiating joint RI with other countries at European level.

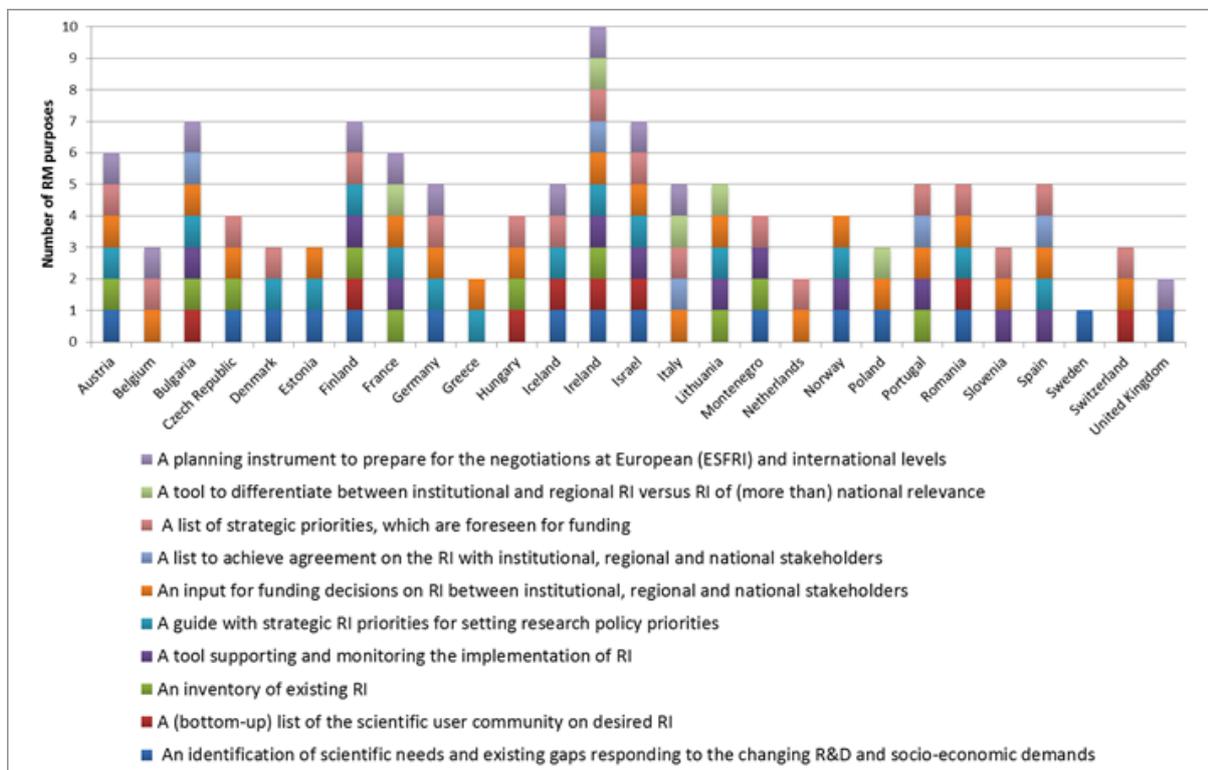


Figure 17: Purposes of national roadmaps as indicated in the validated InRoad compendium (Ruecker et al., 2018).

It is striking that the number of roadmap purposes that were selected from a predefined list at the InRoad consultation and then validated in the country fact sheets of the subsequent InRoad compendium varies considerably from country to country. The majority of countries have three to five purposes in their roadmap (10 out of 27 countries; 37%). The maximum numbers of purposes were found in Ireland that captured all 10 purposes in their national roadmap, while the minimum numbers of purposes were in Sweden (1), Greece, and the Netherlands (both 2). Larger numbers of purposes (5–10) were found in countries like Ireland (10), Finland, Bulgaria and Israel (all 7), Austria and France (both 6), Germany, Iceland, Italy, Lithuania, Portugal, Romania, and Spain (all 5).

Additionally, country representatives specified further purposes during the validation of results, illustrated in the table below.



Table 11: Additional purposes in national RI roadmaps in four countries

Czech Republic	An inventory and an evaluation of existing RI
	A list of strategic priorities which are foreseen for funding subject to governmental approval
	An input for the ESFRI roadmap update
Greece	To support the decision-making process in compliance with strategic priorities in research, aiming to enhance the effectiveness of investment planning for RI at national and regional levels
	To support the development of an evidence-based national strategy in the framework of international negotiations linked to EU priorities and, where appropriate, the European Strategy Forum on Research Infrastructures
	To contribute to the Greek strategy for the ERA-National roadmap 2015–2020 objectives
The Netherlands	Better priority setting within a research field
Switzerland	Coordination instrument to respond to the needs related to RIs at national level

These findings indicate that predefined roadmap purpose options may not sufficiently capture the complexities of national roadmap purposes.

A further limitation of these predefined roadmap purpose options in the consultation was that the order of priority of the roadmap purposes was not specified. The importance of this point became evident when countries changed the selection of their roadmap purposes when they were asked to validate their responses. In the validation, additional roadmap purposes were selected, e.g. 'A planning instrument to prepare for the negotiations at European (ESFRI) and international levels' and 'A tool to differentiate between institutional and regional RIs versus RIs of (more than) national relevance', while certain purposes were deleted, e.g. 'An inventory of existing RIs', 'A (bottom-up) list of the scientific user community for the desired RI'.

Furthermore, when comparing the roadmap purpose in the actual roadmap texts, the main purpose is clearly specified, e.g. the national roadmap in Finland is a plan for key RIs in Finland that are under development, will be newly required during the next 10–15 years, or will be upgraded. It also includes participation in international projects and memberships of international RIs. The plan includes both RI opportunities and challenges for Finland and recommendations with measures to further improve the Finnish RI ecosystem. The indicated measures serve to monitor the development regularly.

In order to increase understanding of the primary purpose of national RI roadmaps and, with this, enhance strategic coordination of RIs at EU-level, InRoad recommends that countries reflect on the relative importance of the roadmap purpose in the context of their respective national R&I system. Practically, having one dedicated section to describe the purpose of the national roadmap would facilitate mutual understanding on this issue.

RI coordination at EU-level also benefits strongly from prior clarification of national strategic priorities foreseen for funding and the actual national funding decisions. Among the purposes



most frequently mentioned by respondents as being relevant for national RI roadmapping the following factors were reported: (1) 'having an input for funding decision on RI between stakeholders' with 78% (21), followed by (2) 'listing strategic priorities for foreseen funding' with 67% (18), and (3) 'identifying scientific needs and existing gaps' with 56% (15). It turns out, that most countries that have the purpose (1) 'having an input for funding decisions on RI between institutional, regional and national stakeholders' also include the purpose (2) 'listing strategic priorities for foreseen funding' in their roadmap.

In summation, RI coordination at EU-level would benefit from better understanding of the specific national RI roadmap purposes. This requires further strategic and policy information that may be collected for the roadmap (e.g. inventories and landscape analysis). To facilitate such an understanding, it would be desirable that such documents would be made easily accessible, e.g. at a central online place reserved for each country such as the ESFRI Research Infrastructures Monitoring System ([ESFRI-MOS](#)) and written in English. For example, Finland includes in one document both its roadmap and its RI strategy and combines it with the description of the RI ecosystem as well as recommendations and measures to improve the RI ecosystem. With this integrated approach, all relevant information can be easily identified by the different stakeholders and more easily reviewed.

#### 5.4. Periodicity and elements of national research infrastructure roadmapping processes

While it is a feature of the European landscape and specific national R&I systems, the diversity of roadmapping processes, including their periodicity, makes coordination among EU MS and AC more challenging. The figure below shows that there is little alignment in terms of roadmap periodicity between individual countries or with the European level (ESFRI lev-el). While it is not necessary or feasible to precisely align the timing – since it is due to national policy cycles and other internal factors –, the development of clear guidelines with defined steps for roadmapping and for the evaluation of RIs would allow for better coordination and promote the long-term sustainability of the RI landscape.



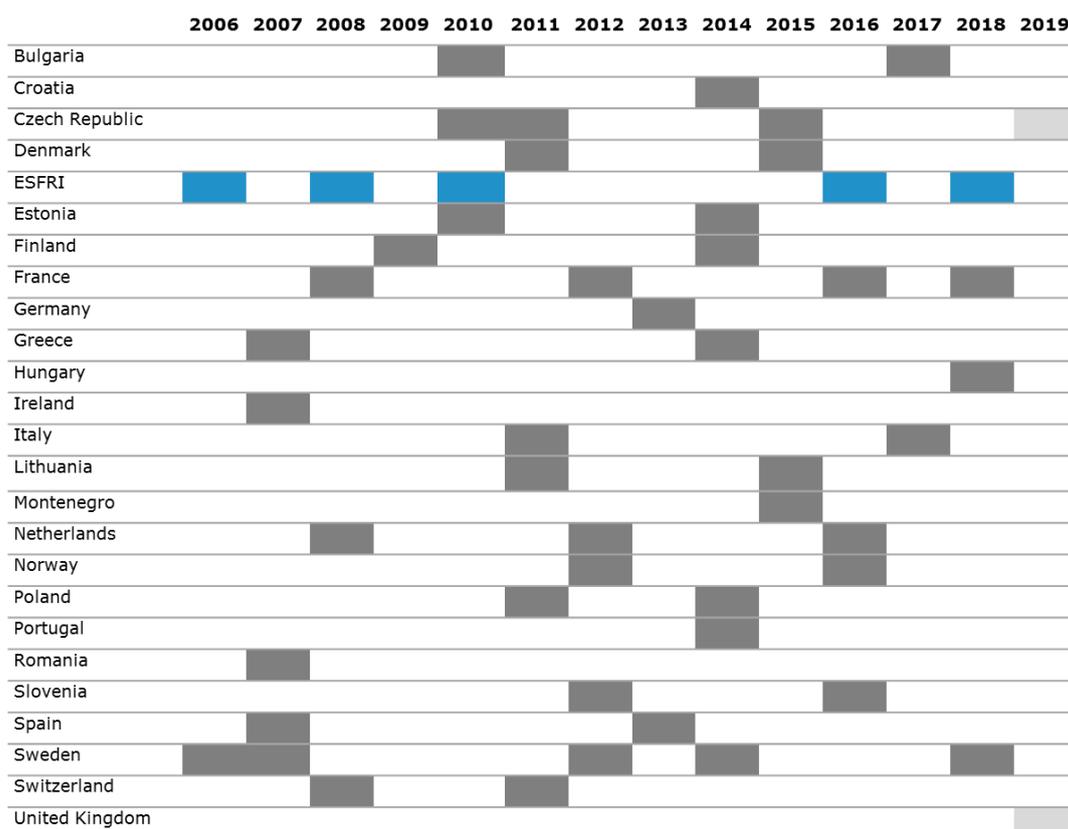


Figure 18: Year of publication of roadmaps and updates in 27 MS and AC compared to the ESFRI roadmap (by Alexandra Griffiths and Isabel Bolliger, 2018)

A first welcome step would be for each country to have a clearly defined timeline for reviewing and/or updating the roadmap, which is still not the case in some countries. Indeed, the periodicity of the updates is not always explicitly mentioned in the roadmap document. Updates are resource-intensive for the RI, the evaluators, and the authority in charge of the roadmap. Moreover, RIs also need time to develop and mature between evaluations. Thus, they do not need to be too frequent. It is also understood that the periodicity of the national roadmap process may change after some time or experience delays if there are significant changes in the national context or new elements to be considered.

**Only 24% of the countries studied include funding commitments in the RI roadmap, while 59% use the roadmap as an input for funding** (the remaining percentage are countries with no active roadmap, or where the roadmap has no clear link to funding). The link between funding and roadmapping also has an effect on timing. But even when funding commitments are not included, RI roadmaps and their respective updates enable countries to review and set their national priorities, to develop their strategy in view of investments for national and pan-European RIs and finally to link with regional Smart Specialisation Strategies, which are a prerequisite to use European Structural and Investment Funds (ESIF). In many countries, such strategies could be better linked to long-term funding plans in order to increase predictability in the national RI landscape. As a counterpoint, many RI stakeholders interviewed by InRoad have pointed out that there is a lack of clarity within European programmes and calls for RIs; for example, links between the ESFRI roadmap and Framework Programme funding calls are not well understood. Strengthening those links would also facilitate roadmapping at the national level.



Considering these elements, some countries have designed their RI roadmapping process so that RIs are selected for the national roadmap prior to the ESFRI call (e.g. the latest Czech roadmap update), thus providing the required political support. Sweden has designed a dual process, wherein the roadmap as a strategy document is published every four years, but an Appendix (not represented in the figure) based on an inventory of needs is published every two years to define strategic areas and organise calls for funding. This process was designed in response to changing responsibilities and funding models for RIs. Overall, InRoad encourages countries to strive for a stable and predictable process based on commonly accepted principles and careful consideration of the ESFRI timeline.

Regarding the different elements of the roadmapping process, the analysis of the InRoad consultation results completed by a desk review<sup>5</sup> showed that mainly the following are taken into account in roadmapping processes at the national level:

- **79% include calls for applications (bottom-up)**, wherein RI projects and existing RIs can submit applications to the roadmap;
- **79% include a prioritisation** of RIs or RI projects (based on applications or a pre-selection process);
- **79% include scientific evaluation** of RIs (from the call or pre-selection);
- **79% include monitoring of projects and existing RIs**, which is used as input for roadmap updates or is carried out in parallel to the roadmapping process;
- **79% include support from independent national experts** to 1) identify existing or new projects of interest, 2) conduct or contribute to landscape analyses, 3) evaluate proposals, or 4) take part in monitoring (usually more than one of those tasks);

There is considerable variation between countries in the way these elements are implemented and how they are used within the roadmapping process. Furthermore, there is still a lack of publicly available information on methodologies, especially for monitoring (see Chapter 4). And while most countries organise open calls, others base the national roadmap on a pre-selection of relevant RIs and projects (e.g. France and Denmark). Open calls are more resource-intensive, but when properly implemented, they ensure that all RIs and emerging projects are considered.

To the extent possible, the development and periodical update of a list of already existing national facilities, including those involved in ESFRI projects or preparatory phases could facilitate a comprehensive overview of the RI landscape in each country. **58% of the countries analysed report having such inventories**. In that respect, links between the MERIL project or other existing RI databases, national roadmapping processes and ESFRI could bring more coherence to the RI landscape. In complement to inventories, landscape analyses provide valuable evidence and information on strengths, needs and gaps, and how to better define the strategic objectives sought when launching a national RI roadmap. **74% of countries who responded to the consultation claimed that landscape analyses should be part of the RI roadmapping process**, but among the countries that carry out landscape analyses, the review of official publicly available documents showed that

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<sup>5</sup> The following analysis considers Austria, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Montenegro, Netherlands, Norway, Portugal, Romania, Spain, Sweden, and Switzerland. Other countries were not included due to lack of available data.



information on the methodology for those landscape analyses is quite scarce. In general, the majority of countries do not provide clear and enough information on this strategic phase of the roadmap elaboration.

The evaluation of the scientific excellence of RIs and new proposals is a prerequisite for inclusion in the roadmap in most cases. To evaluate excellence, **63% of the countries analysed use international expert panels**. National experts (e.g. top scientists and/or RI managers) are almost always involved in different parts of the national RI roadmapping process, which is a welcome contribution. However, for the scientific evaluation, the use of international, independent experts is strongly recommended to limit risks of conflicts of interest and to ensure the required level of expertise.

Prioritisation is reported in most cases. It is often a challenging task but it is increasingly necessary, as resources are limited and not all excellent proposals can be funded. Therefore, other criteria such as uniqueness, national relevance or socio-economic impact need to be taken into account. In most countries studied, it was found that there is scope for clearer priority-setting and increased transparency. Notably, the linkages between evaluation, roadmapping and decision-making, e.g. funding decisions, are not always clear. To support this, consultations with all relevant stakeholders about their priorities, and involvement of stakeholders in the roadmapping process (through specific advisory groups or committees), have shown positive results.

In general, transparent processes with well-defined steps, methodologies and goals are essential to create trust and legitimacy. Based on the elements described above and good practices from the various case studies, the following schematic was elaborated to show what a good RI roadmapping process may entail. It shows in a dynamic way the different steps and indicates when inputs from different actors are needed to support prioritisation and quality in the process.



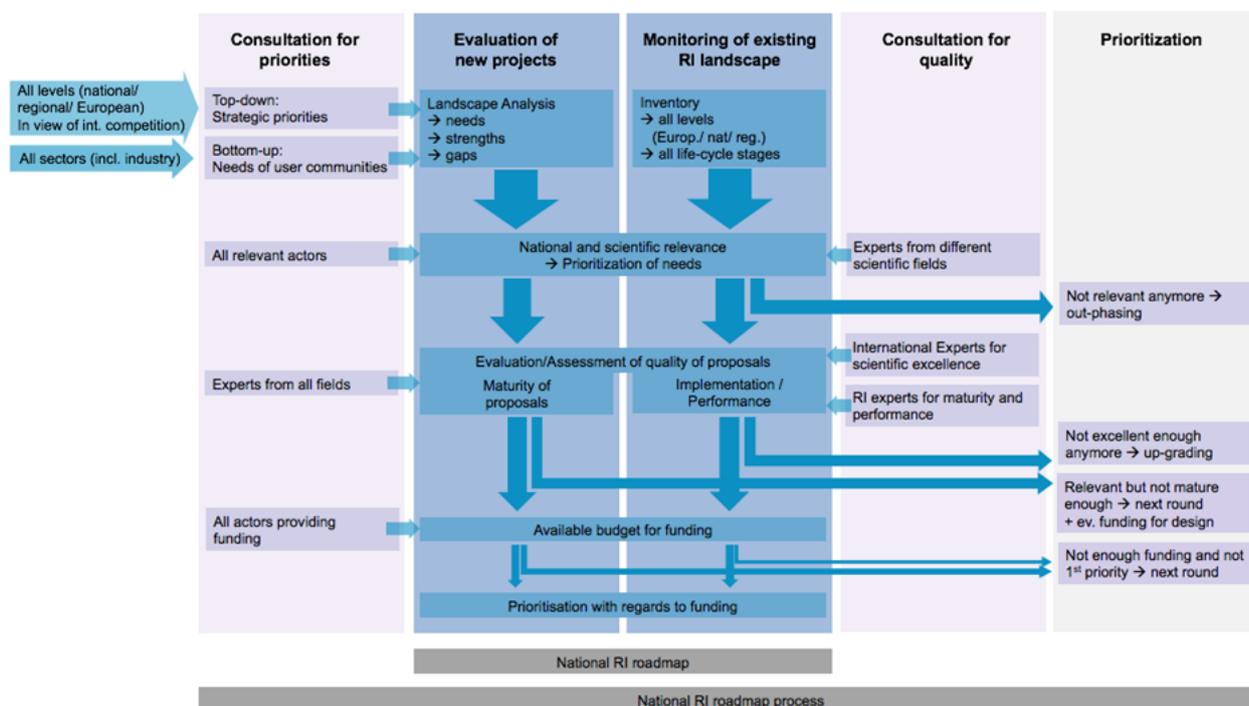


Figure 19: Elements of good practice for national RI roadmapping processes (by Isabel Bolliger, 2018).<sup>6</sup>

<sup>6</sup> These elements of good practice of a national RI roadmapping process will be further elaborated within a PhD thesis of Isabel Bolliger, which is elaborating on national decision-making processes for prioritizing and funding of large-scale Research Infrastructures.





there is no one-size-fits-all process for RI roadmapping and careful consideration of the specificities of the national system is essential.

This makes for a complex system, but a higher degree of coordination is achievable if countries can agree on common principles and coordination mechanisms that respect national specificities (e.g. benchmarking). Examples of such coordination can be found in recent history, with the establishment of ESFRI, the elaboration of the ERIC framework and many successful international agreements for RIs. Those examples show that challenges for the long-term sustainability of RIs can be addressed through common efforts. Finally, well-functioning NRIRMP are a prerequisite for a sustainable European RI landscape, and countries are encouraged to reflect on how different levels – regional, national, European – can be better linked.

## 5.6. Monitoring and evaluation processes in national research infrastructure roadmaps in Europe

### **Ex-ante impact assessment of the RI roadmap (before launching it)**

In general, the European national RI roadmaps are long-term, policy-relevant exercises based on strategic goals (see the [InRoad Consultation Report](#) for further information), but very few of them include precise information on the results expected at different time periods (short, medium and long term) and/or on the M&E activities to be carried out for assessing the accomplishments of RIs included in the roadmap. Information on ex-ante impact assessment (sometimes referred to as diagnostic review, prioritisation or landscape analysis) is quite scarce and in generally most countries do not provide enough or clear information on this strategic phase of roadmap elaboration. In this sense, a clear ex-ante impact assessment (in the sense of the EC concept, see for example: European Parliament 2015) is therefore missing in most of the European national RI roadmaps.

### **Selection of RIs for the inclusion/maintenance in the roadmap**

Presently, the evaluation methodologies for selecting RIs to be included in the national roadmaps are quite similar across the EU countries and are mostly based on expert peer review procedures, varying in specific methodological aspects such as eligibility conditions, phases of the evaluation, criteria for selecting the experts, RI selection criteria, etc.

There are many gaps and much missing information in the publicly available information on methodological procedures followed in the evaluation process, which makes it difficult to follow the whole process in many countries.

Most of the countries reviewed use expert peer-review to evaluate the RIs that submit proposals to enter the RI roadmap, in many cases combined with strategic panel evaluation. However, differences have been found in issues such as the eligibility conditions, the different phases of the evaluation, the processes and requirements for selecting experts and reviewers, the configuration of panels, etc.

### **Interim evaluation/ monitoring (follow-up) of the RI roadmap**

There is increasing awareness among policymakers and stakeholders that a periodic assessment of the real achievements of the RI roadmap portfolio, in comparison to expected results, should be performed and corrective measures should be taken when needed. However, there is very limited information on the monitoring (follow-up) practices conducted by EU countries in relation to RI roadmapping procedures. This deficit of information could be linked to the lack of precise information on the expected results related to the implementation



of the national RI roadmap, already discussed. This is something that was also pointed out by the Horizon 2020 Advisory Groups for RI and the ESFRI 2011 Evaluation report and it could be linked to more general issues such as the cultural, administrative and political differences in the way each country approaches internal planning, funding and organisation of their science and technology policy, including M&E practices.

### 5.7. Portfolio of indicators and metrics for RI roadmapping monitoring and evaluation

In research and innovation policy, indicators constitute a very diverse policy tool, utilized with different roles in the policy life cycle. **Descriptive indicators** are used to monitor and describe the initial situation followed by **analytical indicators** utilized for its analysis. In the policy formulation stage following the diagnosis, **impact indicators** are used for the expected developments, but also for overall programming and planning and for medium and long-term objectives. For the comparison of expected impacts of different policy options, **ex-ante impact indicators** can be used for the assessments. Finally, **control indicators** can be used for the description of the final situation after the implementation of the decided policy intervention complemented by **impact indicators** for the reflection of its outcome within formal assessment methods and eventually **effectiveness indicators** for assessing its effectiveness (Lehtonen, 2015). However, the relationship between indicators and policy making has been difficult and somehow questioned (Leporiet al; 2011). From the policy making side, criticisms have been given on the lack of more simple and usable indicators at times when political decisions need to be taken. In fact, most of R&I indicators are not considered to have sufficient quality and comprehensiveness to answer complex policy questions. In that sense, R&I indicators are not conceived as sources of objective measures which provide full answers to specific questions, but rather as providing additional evidence for the assessment of complex phenomena which are not directly measurable (Strehlenert et al 2015).

In this regard, some concrete recommendations on the required R&I indicator properties have been given by the European Commission in their document: 'Desirable Properties of Indicators' (2010) to support of the Europe 2020 innovation strategy and are included below:

#### **DESIRABLE PROPERTIES OF R&I INDICATORS (European Commission, 2010)**

1. **Simple and understandable:** The indicator, which should be linked to a specific policy objective, has to be easily understandable for the audience, e.g. policy makers, but also to RI managers and RI users and industry representatives. It should have a precise technical meaning but should not be too technical that threatens its comprehensibility. The link to the targets should be so sharp, that it has the power to mobilize to call for action.
2. **Sizable and direct:** The indicator must cover a significant share of the issue. It should be sizable and relevant to its substance, but also linked to the framework conditions of the relevant innovation system.
3. **Objective:** Indicators based on answers to survey questionnaires are important component for the in-depth analysis, but they should be complemented by numerical data, as much as possible.
4. **Presently computable:** In general, indicators should be available quickly, be easily measurable and based on existing data.
5. **Stable:** Indicators should be sufficiently recognized and tested that they can last for several years without modifications being needed. Furthermore, the indicators should keep the same meaning over the years, i.e. an increase in the value of the indicator should reflect the progress.



6. **Internationally comparable:** Indicators should allow the calibration of the position of a specific country/region relative to other areas of the world, because this is an essential aim of a research and innovation policy benchmarking exercise.
8. **Decomposable:** Innovation indicators and possible targets should be translatable into specific targets for different countries/regions. This adaptability of the indicators will be a key success factor, because research and innovation policy take place at the country or even regional level. A related requirement is unbiasedness, i.e. the indicators should not *a priori* be strongly correlated with characteristics of the R&I systems of specific countries and regions. These biases can be corrected for by using indicators weighted by GDP or expressing rates of change rather than levels.
9. **Low susceptibility to manipulation:** Indicators should not be so focused or narrow in scope that behavioural changes of the units of measurement, can change their meaning or significance.
10. **Easy to handle technically:** Indicators should allow a consistent measurement at different levels of aggregation.
11. **Sensitive to stakeholders' views:** Innovation indicators need the support of most of the stakeholders. Therefore, indicators constructed for a supranational level must be adapted to national or regional level to receive the endorsement of the stakeholders active at these levels.

The following figure gives an overview of frequently used science and technology indicators:

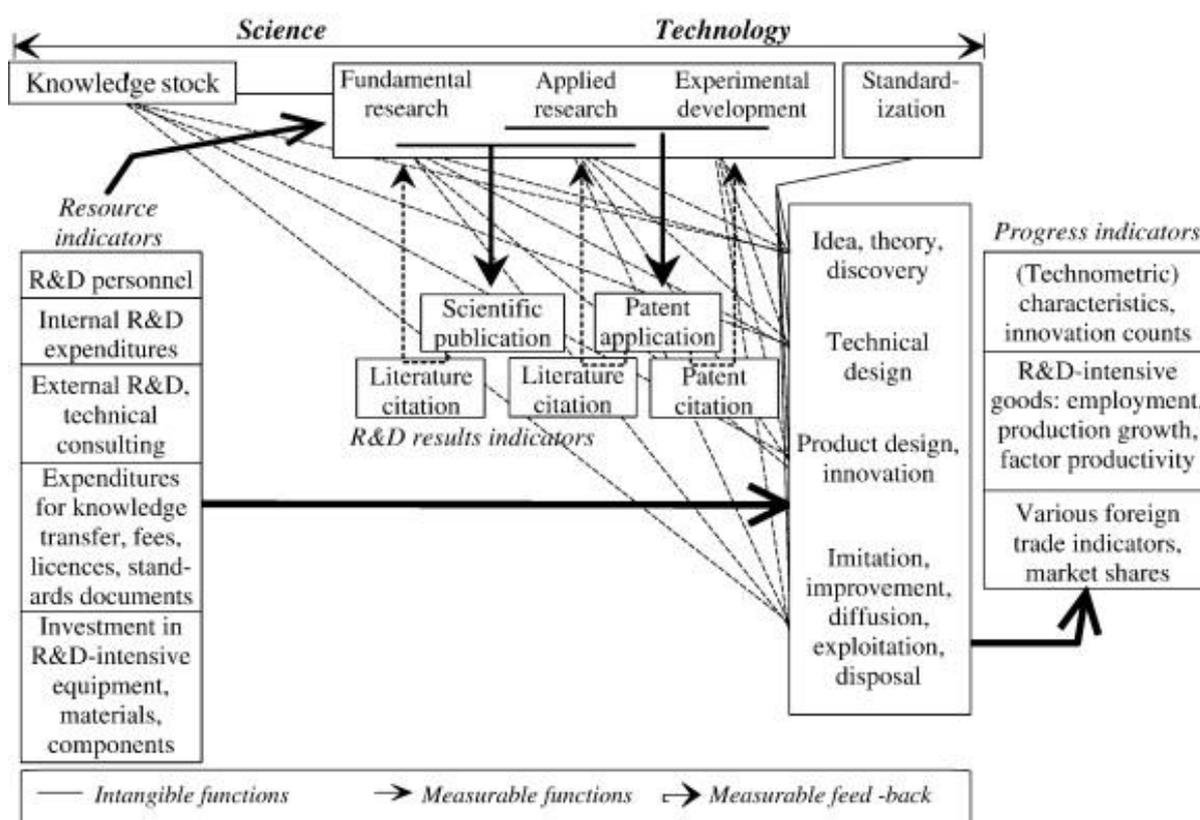


Figure 21: Frequently used science and technology indicators (based on Blind, 2008).

On this specific issue, the Global Science Forum Expert Group of Research Infrastructures of the OECD organised in March 2018 in Paris, an International Workshop on "**Establishing a reference framework for assessing the socio-economic impact of Research**

**“Infrastructures”** with the objective of collecting targeted feedback on impact assessment indicators and methodologies from RIs stakeholders, based on real case studies and to initiate the discussion on the draft assessment framework to identify potential gaps and limitations. During the Workshop, OECD representatives presented the results of their survey on **“Main indicators for establishing a reference framework for assessing the Socio-economic impact of RIs”** sent out to RI managers from a diverse sample of RIs and to External Stakeholders (policy makers, funders, local authorities and hosting organizations). The main indicators proposed by these two groups, with potential use for all the phases of the RI lifecycle and for the roadmapping process, are presented below:

**MAIN INDICATORS EMERGING FROM THE OECD SURVEY OF RI MANAGERS AND EXTERNAL STAKEHOLDERS FOR ESTABLISHING A REFERENCE FRAMEWORK FOR ASSESSING THE SOCIO-ECONOMIC IMPACT OF RIs (OECD GSF Workshop Paris, 19-20 March 2018)**

**SCIENTIFIC IMPACT**

**For RI Managers:**

- Bibliometric data (specific publications pattern of each field)
- Number of (*new*) users / Collaboration with leading teams worldwide
- Available experimental/observational instruments, products and services
- Access/use (*incl. user visits*) of experimental/observational facilities
- Access/use of research data, digital products, services (*incl. web statistics*)
- Available digital resources (*data, databases, collections, storage, etc.*)
- Percentage of international manpower
- Number of Nobel Prizes & other important awards linked to work carried out at the RI

**For External Stakeholders:**

- Number of users / Collaboration with leading teams worldwide
- Bibliometric data (*specific publications pattern of each field*)
- Access/use of research data, digital products, services (*incl. web statistics*)
- Access/use (*incl. user visits*) of experimental/observational facilities
- Available digital resources (*data, databases, collections, storage, etc.*)
- Available experimental/observational instruments, products and services
  - Specific data on citations (*citation lifetime, database citation, etc.*) / Specific profiles of publications (*for targeted types of users*)
  - Impact on researcher productivity / User perception

**TECHNOLOGICAL IMPACT**

**For RI Managers:**

- Patents/licenses/copyrights, background IP used, etc.
- Prototypes/innovations, technology transfer, co-development with various partners
- Proprietary use of the facility by industry
- Involvement of industry in collaborations
- Availability/access to technology platforms and specific products
- Involvement of industry in the financing of academic research at the facility
- Involvement in standardization bodies

**For External Stakeholders:**

- Prototypes/innovations, technology transfer, co-development with various partners



- Involvement of industry in collaborations
- Patents/licenses/copyrights, background IP used, etc.
- Proprietary use of the facility by industry
- Availability/access to technology platforms and specific products
- Involvement of industry in the financing of academic research at the facility
  - Enabling technologies developed
  - Income earned from patents

## **TRAINING AND EDUCATION**

### **For RI Managers:**

- Various categories of human resources who are/have been working with(*in*) the RI
- Training programmes
- Number of masters, PhDs or postdocs trained within the RI and employed by other RIs or by industry
- Number of graduates employed by the RI through relevant sponsorships

### **For External Stakeholders:**

- Training programmes
- Various categories of human resources who are/have been working with(*in*) the RI
- Number of masters, PhDs or postdocs trained within the RI and employed by other RIs or by industry
- Number of graduates employed by the RI through relevant sponsorships
  - Key skills developed by users and staff
  - Use of the RI / RI data for teaching

## **DIRECT ECONOMIC IMPACT**

### **For RI Managers:**

- Total budgets plus total number of full-time equivalents (FTE)
- Public procurements and contracts
- Industrial suppliers and users: number and revenues generated (incl. regional dimension)
- Collaborative projects with industry
- Dedicated economic impact studies
- Purchases and industrial/commercial contracts in partner countries
- R&D time spent using RI provided data

### **For External Stakeholders:**

- Total budgets plus total number of FTE
- Number of firms using the RI (*incl. regional dimension*)
- Collaborative projects with industry
  - R&D time spent using RI provided data (e-RI)
  - Identified impact pathways (*on industrial research productivity*)

## **INDIRECT ECONOMIC IMPACT**

### **For RI Managers:**

- Innovative projects based on RI outputs
- Number of start-ups around the RI and spin-offs generated by the RI
- Medium-/ long-term collaborative contracts with industrial partners
- Local/regional impact on environment, energy infrastructure, etc.



- Statistics on IP created by past collaborators and students from experiment collaborations
- Impact on the local/regional innovation ecosystem
- Indirect/induced job creation in the economy
- Economic impact on tourism
- Number of PhDs/engineers from the RI employed by industry

#### For External Stakeholders

- Medium-/ long-term collaborative contracts with industrial partners
- Innovative projects based on RI outputs
- Impact on the local/regional innovation ecosystem
  - Revenues generated by IP

#### ADDITIONAL KEY PERFORMANCE INDICATORS HIGHLIGHTED IN THE SURVEY

- Technical operating parameters of the facility, e.g.: Reliability / Running time and availability / Physical safety / Data management capabilities
- Science&Technology performance, e.g.: Experimental and observation efficiency / Quality, quantity and availability of data / Services / User satisfaction
- Business development / Programme & staff development / R&D planning / RI development / Standardized/harmonized internal procedures (*especially for a distributed RI*)
- Contribution to policy decision / Implementation of international agreements and commitments (*inter-institutional, inter-organizational*)
- Use of specific KPIs during the construction phase: Business plan / Schedule performance (*physical progress*) / Completion of high-level milestones / Safety / Quality management / etc.

The results of the survey showed a good consensus on series of indicators for which data are collected and which are used in the various dimensions of impact assessment.

Another very interesting initiative on RI indicators is the recently launched H2020 project '**Charting Impact Pathways of Investment in Research Infrastructures' (RI-PATHS<sup>7</sup>)**. The objectives of this project are: i) to take stock of the existing approaches for impact assessment of research infrastructures and identify future data needs, ii) to design a modular impact assessment model that covers all main impact pathways of research infrastructures, and iii) to define a set of core indicators, provide guidance and pilot the impact assessment model with research infrastructures. They have recently published deliverable that has compiled literature of the most common methodologies currently employed for the socioeconomic impact assessment of research infrastructures RIs. They have grouped relevant contributions from the literature in six main approaches:

- 1) Socioeconomic assessment based on impact multipliers
- 2) Methodologies applying the knowledge production function
- 3) Cost-benefit analysis
- 4) Approaches based on multi-methods, multiple partial indicators
- 5) Theory-based approaches
- 6) Case studies

Their review highlights that there is not a single methodological approach that can appropriately answer all the questions that a socio-economic Impact Assessment addresses

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<sup>7</sup> <https://ri-paths.eu/>



and they include interesting discussion on suitable indicators. This project expects to have a validated Impact Assessment model for RIs by September of 2019, and a final methodological handbook by May 2020.

The results of the ongoing initiatives from the OECD Global Science Forum and the RI-PATHS project already mentioned, together with the ongoing work on these issues by ESFRI, from the academic sector and from another H2020 projects are expected to provide new insights and pragmatic approaches that would be of interest for the European countries developing national RI roadmaps in the near future.



## 6. Key results from the case and desk studies

Different drivers of national RI roadmapping processes can be identified: the ESFRI strategy and roadmap, regional development strategies and the ESIF funding framework, but also national interests and R&I strategies. Institutional and cultural elements also play an important role: legal frameworks, funding frameworks, the structure of the R&I system, the type of administration (e.g. centralised/decentralised), and other national characteristics also shape individual roadmapping processes at country level. As a result, we can observe a diversity of practices, in spite of the common drivers identified. Among this diversity, we can identify some key elements for a good process that are summarised in the following section.

### **Key results from the Finnish case**

In Finland, the national RI strategy and roadmap with implementation measures is a plan to reach a national R&I vision with clear targets, which invites RI funders, hosts and users to align their strategies and capacities with this national plan. Thus, long-term sustainability and the strategic orientation of a national RI ecosystem requires coherence between a long-term national plan with related national strategy, implementation and funding measures as well as the roadmap on one side and the corresponding strategies, measures and roadmap elements in terms of the host and users on the other.

The Finnish RI strategy and roadmap process involves a continuous dialogue with national roadmap actors, RI hosts, funders and users as well as international experts to foster understanding of the national strategies and roadmapping processes, but also needs as well as international RI developments. For a national RI ecosystem to be internationally competitive, continuous reflection on its needs and performance is required combining the perspectives of roadmap actors, RI hosts, funders and users in a holistic system and adjusting strategies and roadmapping processes to meet changing needs.

### **Key results from the Dutch case**

The introduction of a Permanent Committee, which is almost solely responsible for developing the large-scale scientific infrastructure roadmapping process, has created the foundation for long-term strategic planning.

The imbalance between available funding resources and needed investments for RIs in the Netherlands is limiting the funding of new RIs. By forcing RIs with similar or compatible thematic backgrounds to submit a joint proposal to apply for the national roadmap, redundancies through using similar equipment can be avoided and synergies can be achieved. Additionally, the facilities applying for funding must commit to paying half of the operational costs for a period of ten years, thus guaranteeing sustainable budget planning.

Moreover, funding decisions on RIs in the Netherlands are linked to strategic priorities. As a result, RIs need to orient their research with more focus towards national priorities.

### **Key results from Czech case**

The establishment of clear, transparent procedures and the involvement of stakeholders and experts are a prerequisite for a sound RI roadmapping process. This is demonstrated in the Czech case, where the following elements are particularly well received by the national RI community.

First, the presence of an advisory body such as the Council for Large Infrastructures of the MEYS ensures that key stakeholders with knowledge about the national RI landscape are able



to give input to the roadmapping process. Moreover, the roadmap contains a strategic view based on current developments in the European RI landscape, the ERA objectives and work carried out in ESFRI. This allows Czech RIs to be positioned within the European context and shows that the strategy of the MEYS is based on a multi-level approach. As a complement to the overall strategy, the landscape analysis carried out by national experts in all the disciplines represented in the roadmap, provides information on the strengths, gaps and needs in the Czech RI landscape.

Regarding the evaluation, the advice of independent, international experts with extensive knowledge of RIs complements the knowledge of national experts. Moreover, the evaluation methodology includes clear criteria and procedures. All of these elements increase the objectivity and transparency of the roadmapping process.

We can therefore conclude that despite some remaining bottlenecks discussed in Chapter 3.3 of Annex 1, the Czech RI roadmapping process is well-established and the Czech RI roadmap is a key document in the national R&I strategy. Therefore, other countries with similar characteristics could learn from the Czech process and its good practices.

### **Key results from the Swedish case**

The funding system and roadmapping process for RI in Sweden have undergone some major transformations in the last years, which resulted from thorough investigations into the matter. The interviews for the Swedish case study revealed a predominant satisfaction with the current process and particularly the changes towards stronger involvement of universities is well perceived. Distinct for the Swedish process is the strong involvement of the Swedish research community, and the consultation with different scientific fields, as well as the importance of scientific excellence, within the prioritisation process. Sweden also took a lead in the ecosystem approach, encouraging its universities to elaborate institutional priorities, and the aim to consider these institutional priorities within the identification of national and European priorities.

Overall, the Swedish process is very transparent in terms of available documentation, which is very detailed and all easily available online and in English. The relevant actors are well aware about the process and are informed well by the Swedish Research Council.

### **Key results from desk studies on evaluation and monitoring**

**Czech Republic** is a good example of the use of well accepted evaluation / monitoring criteria to select the research infrastructures that are included in their national roadmap. The methodology was inspired by the ESFRI evaluation procedures. During its 1<sup>st</sup> stage, the proposal needs to comply with the definition of a RI to pass on to the second stage. In this 2<sup>nd</sup> stage proposals are evaluated against a set of criteria: socio-economic impact, uniqueness of technological facilities, the technological level, knowledge intensity and uniqueness of the RI within the R&I innovation ecosystem of the Czech Republic.

The second stage evaluation is carried out by an international peer-review. In this second stage, the scientific panels who participated in the first stage, are able to carry out interviews with the representatives of the research infrastructures management team in order to address questions on the operation of the research infrastructure and the delivery of services to external users. Harmonization of the panel results is done in a cross-panel session chaired by the head of the International Evaluation Committee. The decision on economic issues contains also a verification / negotiation phase where the proponents have to explain and justify the budget proposal. The decision on funding is taken by the government and implemented by the



ministry. The selection process is based on an external expert assessment (international peer review). It is led by international expert panels, which conduct several meetings in person. Harmonization of the panel results is done in a cross-panel session. The second stage evaluation is carried out by an international peer-review (2 or 3 reports per research infrastructure proposal) to obtain additional independent expert opinions beyond the assessment conducted by the respective 6 Scientific Boards of the International Evaluation Committee

**Bulgaria** demonstrates another example of evaluation methodology for the inclusion of RIs in the National Roadmap, covering quantitative and qualitative criteria inspired by the ESFRI approach.

The assessment criteria of the individual RI include the following components:

- Demands and benefits of their scientific research
- Development, maintenance and usage of research equipment
- Scientific quality of the research and key beneficiaries of the research results (*assessed through publications, patents, citations, number of consumers, etc.*)
- Institutional capacity (*composition of the scientists, who perform the scientific research; availability of habilitated staff; number of PhDs, age profile, etc.*)
- Management of programs for scientific research, financed on a competitive basis from national and international sources
- Activity in attracting funding from different sources
- Social-economic benefits and relevance of the research results (*availability of created product, technology, methodology, etc.*)
- Established partnerships: regional, national and European

An international peer review panel with reputed and skilled scientists has been used to evaluate RI to be integrated in the Bulgarian roadmap.

**Ireland's** roadmapping process is a good example of the utilization of gap analysis and ex ante impact evaluation to define priorities in the national RI roadmap

To prepare the Irish RI roadmap, a review of existing RIs was carried out, as a means to identify gaps and design future funding of RIs, all in the context of the national STI strategy. For this national review of RIs, all RIs were considered and there were no eligibility conditions as it involved the benchmarking of all RIs in Ireland and the identification of gaps in the national platform of RI. This study had the following objectives:

- Take stock of the RI investments made to date in light of national STI priorities (retrospective study);
- Identify any future investment needs in the period to 2020 (and beyond) that may be strategically required for the achievement of national STI priorities (prospective study).

The review set out the strengths, weaknesses and gaps in the existing infrastructures as well as recommendations for future investments and suggestions for the greater use of existing national and international research facilities on a multi-user basis. Noteworthy recommendations of this study were that Ireland needs a RI roadmap to establish the prioritisation of national and pan-European RIs; to align RI priorities with STI priorities; to facilitate political support at all policy levels; to help to define national and regional budgets; and allow for long-term financial commitment by public and private stakeholders. The process of developing the roadmap was considered essential to engage relevant stakeholders.



## 7. Conclusion

The objective of this report was to describe common trends and good practices in national RI roadmapping processes, as well as evaluation and monitoring mechanisms for RIs, in Europe. For this, four country case studies (Finland, Netherlands, Czech Republic and Sweden), three country desk studies on evaluation and monitoring mechanisms (Czech Republic, Bulgaria and Ireland), a cross-country analysis (including 27 countries in Europe) and feedback from the InRoad validation workshop in 2018 were taken into account. The findings of this Annex provide the evidence for the recommendations from the InRoad report on coordination between national and European RI roadmapping processes.

With regard to good practices, the results of the case studies indicated the importance of suitable and sustainable structures for coordinating, implementing and communicating national RI roadmapping processes as well as coherent strategies to successfully manage and implement them. Continuous dialogue between all national stakeholders is necessary to achieve a better understanding of the relevant RI terms and definitions. This dialogue serves as a basis for the orientation of national stakeholders towards common goals for the development of the national and European RI landscape.

The case studies also revealed that the identified good practices of RI roadmapping processes in the selected countries need to be related to the R&I system in which they are embedded and the the different actors involved. Therefore, characteristics of the national R&I systems and the relevant RI actors in the investigated countries were described alongside the national RI roadmapping processes and good practices. Since the case studies investigated relatively small countries with a central political system and distinct national R&I strategies, the identified good practices need to be carefully considered and possibly adapted to the conditions of larger countries, or countries with federal political systems and different R&I strategies.

The desk studies showed that monitoring and evaluation terminology is used and understood in different ways across European countries, making it difficult to compare the different approaches. Evaluation methodologies for selecting RIs to be included in the national roadmaps vary in specific methodological aspects such as eligibility conditions, phases of the evaluation, criteria for selecting experts, RI selection criteria, and so on. There is very limited information on the monitoring (follow-up) practices carried out in European countries in relation to RI roadmapping. The definition and use of a set of measurable, simple, relevant and reliable indicators, designed to facilitate the supervision of the overall RI roadmap goals, could facilitate in a very significant way this monitoring process. Finally, a clear ex-ante impact assessment (in the sense of the European Commission concept) is missing in most of the European national RI roadmaps. Concrete definition of national RI roadmap strategic objectives and expected results could facilitate future coordination with the RI policy at EU level.

In summary, the case studies, desk studies and cross-country analyses indicated that there is a large diversity of national RI roadmapping processes. However, among this diversity, good practices can be identified and opportunities for a higher degree of coordination of national RI roadmapping processes at EU-level become apparent. Therefore, InRoad hopes to contribute to the exchanges of experience going on between European stakeholders and within ESFRI in view of improving the long-term sustainability of the RI landscape.



## 8. References

- Academy of Finland (2014) 'Finland's strategy and roadmap for research infrastructures 2014-2020'. Retrieved from <https://www.aka.fi/globalassets/awanhat/documents/tiekartta/webroadmap2014eng.pdf> [Last access 10/2018].
- Academy of Finland (2017) 'Quality, impact and renewal in international cooperation: Academy of Finland international policy for 2017-2021'. Retrieved from <https://www.aka.fi/globalassets/40akatemia/academy-of-finland-international-policy-23-feb-2017-valmis.pdf> [Last access 10/2018].
- Academy of Finland (2018) 'Finland's strategy and roadmap for research infrastructures 2014-2020'. Interim review report 2018. Retrieved from [https://www.aka.fi/globalassets/tiedostot/aka\\_infra\\_tiekartta\\_raportti\\_en\\_030518.pdf](https://www.aka.fi/globalassets/tiedostot/aka_infra_tiekartta_raportti_en_030518.pdf) [Last access 10/2018].
- Blind, K. (2008) 'Regulatory foresight: Methodologies and selected applications'. *Technological forecasting and social change* 75 (2008), No.4, pp.496-516.
- Calvia-Goetz, A., Franciosi, A., Larsen, S., Marks, J., Tichmann, K., Wade, R., and Zic Fuchs, M. (2013) 'Assessing the projects on the ESFRI roadmap. A high level expert group report'. European Commission (ed.). Retrieved from [https://ec.europa.eu/research/evaluations/pdf/archive/other\\_reports\\_studies\\_and\\_documents/esfri.pdf](https://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/esfri.pdf) [Last access 12/2018].
- Dahlstrand, Å. L., Jacob, M., and Sprutacz, M. (2017) 'RIO Country Report 2016: Sweden', Luxembourg: Publications Office of the European Union. 28574 EN, DOI: 10.2760/115672. Retrieved from <https://rio.jrc.ec.europa.eu/en> [Last access 11/2018].
- EC (2016) 'ERA Progress Report 2016. Country Snapshot Sweden'. Retrieved from [http://ec.europa.eu/research/era/eraprogress\\_en.htm](http://ec.europa.eu/research/era/eraprogress_en.htm) [Last access 11/2018].
- EC (2010) 'Elements for the setting-up of headline indicators for innovation in support of the Europe 2020 strategy: Report of the High Level Panel on the Measurement of Innovation, Directorate-General for Research and Innovation', Brussels. Retrieved from <https://ec.europa.eu/research/innovation-union/pdf/elements-for-the-setting-up-of-headline-indicators2013.pdf> [Last access 11/2018].
- EC (2018) 'Programme: Research, Development and Education - CZ ESF/ERDF'. *European Structural and Investment Fund data*. Retrieved from <https://cohesiondata.ec.europa.eu/programmes/2014CZ05M2OP001> [Last access 11/2018].
- Eurostat (2017) Statistics Database, <http://ec.europa.eu/eurostat/data/database> [Last access 11/2018].
- Hallonsten, O. (2014) 'ERAWATCH Country Reports 2013: Sweden'. Luxembourg: Publications Office of the European Union. Retrieved from [https://rio.jrc.ec.europa.eu/sites/default/files/riowatch\\_country\\_report/ERAWATCH%20Country%20Report%20Sweden%202013.pdf](https://rio.jrc.ec.europa.eu/sites/default/files/riowatch_country_report/ERAWATCH%20Country%20Report%20Sweden%202013.pdf) [Last access 12/2018].



- Halme, K., V.-P.Saarnivaara, and J. Mitchell (2016) 'RIO COUNTRY REPORT 2015: Finland'. Retrieved from [http://publications.jrc.ec.europa.eu/repository/bitstream/JRC101190/fi\\_cr2015.pdf](http://publications.jrc.ec.europa.eu/repository/bitstream/JRC101190/fi_cr2015.pdf) [Last access 10/2018].
- Jacob, M. (2015) 'RIO Country Report Sweden 2014', Luxembourg: Publications Office of the European Union. DOI: 10.2791/569707. Retrieved from <https://rio.jrc.ec.europa.eu/en> [Last access 11/2018].
- Jacob, M., Dahlstrand, Å. L., and Sprutacz, M. (2016) 'RIO Country Report 2015: Sweden'. Institute for Prospective Technological Studies, Joint Research Centre. Retrieved from <https://rio.jrc.ec.europa.eu/en> [Last access 11/2018].
- Lehtonen, M. (2015) 'Indicators: tools for informing, monitoring or controlling?' in: The Tools of Policy Formulation: Actors, Capacities, Venues and Effects. New Horizons in Public Policy ed. by A. J. Jordan, J.R Turnpenny and E. Elgar: 76-99.
- Lepori, B.; Reale E., and Slipersaeter S. (2011) 'The construction of new indicators for science and innovation policies: the case of project funding indicators'. In: *Science and Innovation Policy for the New Knowledge Economy*. Cheltenham: Edwar Elgar Publishing, 37-59.
- MEYS (2010) 'Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic'. Prague, March 2010.
- MEYS (2011) 'Roadmap for Large Research, Development and Innovation Infrastructures in the Czech Republic. May 2011 Update'. Prague, May 2011.
- MEYS (2015) 'Roadmap of Large Infrastructure for Research, Experimental Development and Innovation of the Czech Republic for the years 2016–2022'. Prague, October 2015. Retrieved from [www.msmt.cz/file/37456\\_1\\_1](http://www.msmt.cz/file/37456_1_1) [Last access 07/2017].
- MEYS (2014) 'Evaluation Methodology for Research Infrastructures'. Retrieved from <https://www.slideshare.net/ipnmetodika/evaluation-methodology-for-research-infrastructures> [last access 11/2018].
- Ministry of Education (2009) 'National-level research infrastructures. Present State and Roadmap. Summary and Recommendations'. Retrieved from <http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/78877/opm02.pdf?sequence=1&isAllowed=y> [Last access: 09/2018].
- Ministry of Education, Culture and Science (2013) 'Uncharted Frontiers: the Netherlands' Roadmap for Large-Scale Research Facilities'. Retrieved from [https://www.infrafrontier.eu/sites/infrafrontier.eu/files/upload/public/pdf/Infrafrontier%20Research%20Infrastructure/2013-07-01\\_Roadmap\\_RI\\_NL\\_2012.pdf](https://www.infrafrontier.eu/sites/infrafrontier.eu/files/upload/public/pdf/Infrafrontier%20Research%20Infrastructure/2013-07-01_Roadmap_RI_NL_2012.pdf) [Last access: 09/2018].
- Molas-Gallart, J. (2012) 'Research governance and the role of evaluation: A comparative study'. *American Journal of Evaluation*, 33(4):583-598.
- Monaco, S., Wikgren, M., Barriere, S.G., Gurell, J., Karlsson, S., and Aldberg, H. (2016) 'The Swedish Research Barometer 2016: An Overview of the Swedish Research System in International Comparison'. Retrieved from <https://publikationer.vr.se/en/product/the-swedish-research-barometer-2016/> [Last access 11/2018].

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- Roadmaps in Europe, (InRoad Deliverable 3.2), (2018)
- Netherlands Organisation for Scientific Research (NWO) (2018) 'Connecting Science and Society'. NWO strategy 2019-2022. The Hague.
- Netherlands Organization for Scientific Research (NWO) (2016) 'National Roadmap Large-Scale Scientific Infrastructure'. Retrieved from <https://www.nwo.nl/binaries/content/documents/nwo-en/common/documentation/application/nwo/permanent-commission/roadmap-large-scale-scientific-infrastructure/Roadmap+grote+onderzoeksfaciliteiten-en.pdf> [Last access: 09/2018].
- OECD (2008) 'Report on Roadmapping of Large Research Infrastructures'. Based on the OECD Global Science Forum (GSF) *Workshop on Enhancing the Utility and Policy Relevance of Roadmaps of Large Research Infrastructures*, Bologna, Italy, June 2008. Retrieved from: <http://www.oecd.org/sti/inno/oecdglobalscienceforum.htm> [Last access 02/2018].
- OECD (2016) 'Reviews of Innovation Policy: Sweden 2016'. Retrieved from [http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/oecd-reviews-of-innovation-policy-sweden-2016\\_9789264250000-en#page1](http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/oecd-reviews-of-innovation-policy-sweden-2016_9789264250000-en#page1) [Last access 11/2018].
- OECD GSF Workshop Paris, 19-20 March 2018, [https://www.innovationpolicyplatform.org/system/files/Moulin\\_Report%20on%20Surveys\\_JAM.pdf](https://www.innovationpolicyplatform.org/system/files/Moulin_Report%20on%20Surveys_JAM.pdf) [Last access 12/2018].
- Research and Innovation Council Finland (2017) 'Vision and road map of the Research and Innovation Council Finland'. Retrieved from: [https://valtioneuvosto.fi/documents/10184/4102579/Vision\\_and\\_roadmap\\_RIC.pdf/195ec1c2-6ff8-4027-9d16-d561dba33450/Vision\\_and\\_roadmap\\_RIC.pdf.pdf](https://valtioneuvosto.fi/documents/10184/4102579/Vision_and_roadmap_RIC.pdf/195ec1c2-6ff8-4027-9d16-d561dba33450/Vision_and_roadmap_RIC.pdf.pdf) [Last access 10/2018].
- Ruecker, G.R., Geyer, D., Wekerle, A., Knebel Doeberitz, von S., Ritter, C., Guinea, J., Gómez, A.J., Jorge, T., Silveira, C., Coimbra, C., Quintais, A., Hrušák, J., Paci, A. M., Lalle, C., Thies, A., de Andrés, C., and Lubicka, B. (2018) 'InRoad Compendium: Country factsheets on research infrastructure roadmapping procedures, funding, evaluation and monitoring as well as national embedment of European Member States and Associated Countries'. Bern: Swiss National Science Foundation (SNSF), February 2018. Retrieved from: [http://inroad.eu/wp-content/uploads/2018/03/26022018\\_InRoad\\_Compendium\\_Final.pdf](http://inroad.eu/wp-content/uploads/2018/03/26022018_InRoad_Compendium_Final.pdf) [Last access 11/2018].
- Särkioja, M. (2018) 'Monitoring research infrastructures'. FIRI Seminar, 2018. Retrieved from: [https://www.aka.fi/globalassets/30tiedepoliittinen-toiminta/firi/sarkioja\\_firi-seminaari\\_2018-05-03\\_final.pdf](https://www.aka.fi/globalassets/30tiedepoliittinen-toiminta/firi/sarkioja_firi-seminaari_2018-05-03_final.pdf) [Last access 11/2018].
- Srholec, M., and Szkuta, K. (2016) 'RIO Country Report 2015: Czech Republic', Luxembourg: Publications Office of the European Union. DOI: 10.2791/161713. Retrieved from <https://rio.jrc.ec.europa.eu/en> [last access 11/2018].
- Strehlenert H., Richter-Sundberg L., Nyström M.E., and Hasson H. (2015) 'Evidence-informed policy formulation and implementation: a comparative case study of two national policies for improving health and social care in Sweden'. *Implementation Science*, 10:169: 1-10.



- Swedish Higher Education Authority (2015) 'Higher Education in Sweden: Status Report'. Full report available in Swedish only.
- Swedish Research Council website (2018) 'Council for Research Infrastructures', [https://vr.se/english/en\\_sidfot/about-the-swedish-research-council/scientific-councils-councils-and-committees/council-for-research-infrastructures.html](https://vr.se/english/en_sidfot/about-the-swedish-research-council/scientific-councils-councils-and-committees/council-for-research-infrastructures.html) [last access: 09/2018].
- Technological Commissie Nationale Roadmap Grootchalige Onderzoeksfaciliteiten (2008) 'Nederlandse roadmap grootchalige onderzoeksfaciliteiten'. Retrieved from <https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2009/02/11/nederlandse-roadmap-grootchalige-onderzoeksfaciliteiten/nederlandse-roadmap.pdf> [Last access: 09/2018].
- Van den Broek, J., Deuten, J., and Jonkers, K. (2018) 'RIO Country Report The Netherlands 2017', EUR 29183 EN, Publications Office of the European Union, Luxembourg.
- VR (2006) 'The Swedish Research Council's Guide to Research Infrastructures. Summary 2006'. Stockholm, Swedish Research Council.
- VR (2008) 'The Swedish Research Council's guide to Infrastructure. Recommendations on Long-term Research Infrastructures by the Research Councils and VINNOVA'. Retrieved from <https://www.vr.se/download/18.../Rapport+5.2008.pdf> [Last access 11/2018].
- VR (2012) 'The Swedish Research Council's Guide to Research Infrastructures 2012'. Retrieved from <https://publikationer.vr.se/en/product/the-swedish-research-councils-guide-to-infrastructures-2012/> [Last access 11/2018].
- VR (2014) 'The Swedish Research Council's Guide to Research Infrastructures 2014'. Retrieved from <http://www.vr.se/inenglish/researchinfrastructure/guidetoresearchinfrastructures.4.2b56827a13380c5abfd80001506.html> [Last access 11/2018].
- VR (2015) 'Appendix to the Swedish Research Council's Guide to Research Infrastructures'. Retrieved from <http://www.vr.se/inenglish/researchinfrastructure/guidetoresearchinfrastructures.4.2b56827a13380c5abfd80001506.html> [Last access 11/2018].
- VR (2018) 'The Swedish Research Council's Guide to Research Infrastructures 2018'. Retrieved from [https://www.vr.se/download/18.312b62c9166b295ec241390/1541065048121/Guide-to-research-infrastructures\\_VR\\_2018.pdf](https://www.vr.se/download/18.312b62c9166b295ec241390/1541065048121/Guide-to-research-infrastructures_VR_2018.pdf) [Last access 11/2018].



## 9. Annexes

### 9.1. Selection matrix

Country	Selection criteria							Selection priority and case responsibility		
	The national RI Roadmapping includes a scientific and economic evaluation of new and existing projects	Funding linked with strategic priorities, funding instruments	The national RI Roadmapping is linked to national research priorities in general	The national RI Roadmapping is coordinated with Roadmapping at EU level	The national RI Roadmapping is based on previous RI Roadmapping exercises (one roadmap update)	The national RI Roadmapping includes a business plan	The national RI Roadmapping includes an assessment of the European and national research landscape	Selection priority	Agreed to participate	Responsible WP3 - Partner
Sweden	X	X	Not answered in consultation	X	X	X	X	1	Yes	UNIL
Czech Republic	X	X	X	X	X	X	X	1	yes	UNIL
Netherlands	x	X	X	Not answered in consultation	X	X	X	1	yes	DLR
Finland	x	X	X	X	X	X	X	1	yes	DLR



## 9.2. Interview Guide

### Overall guiding questions for all interviews

Based on the following research questions (RQ):

- RQ1. What are the detailed steps taken in the realisation of the national RI roadmap?
- RQ2. What are the mechanisms in place for coordination with other countries and with the roadmap process at European level (e.g. ESFRI roadmap)?
- RQ3. How do the relevant actors identify benchmark mechanisms within a national RI roadmap processes in view of better coordination with other countries and with the roadmap process at European level (e.g. ESFRI roadmap)?

RQ 1:

What is/are your task(s) within the national RI roadmap process?

Why did you/your organization decide to do it that way?

What are your experiences with the process?

Are there any challenges in the process in its current form and what would you like to see changed?

RQ 2:

- Is there any mechanism in place for coordination with other countries and with the roadmap process at European level (ESFRI roadmap)?

RQ 3:

- How do you think better coordination with other countries and with the roadmap process at European level (ESFRI roadmap) can be realized?

### Specific questions for the interviews

1. Actor in charge for RM process

RQ1:

How was the roadmap process in your country designed and implemented?

Why is the process organised this way?

How are other relevant actors involved in the planning and execution of the roadmap process?

How does the coordination between the different actors look like/work?

How is the adequacy of the RM process assessed and is it subject to any changes planned?

Are there any challenges and bottlenecks you see within the roadmap process in your country?

RQ2:

- How is the process coordinated with other countries or the European level, if at all?
- What challenges and bottlenecks do you see in view of the coordination of the national roadmap with other countries and the European level?
- Did you have any learning experiences between the different RM updates that could be relevant for increasing coordination at EU level?
- Which update cycle would you recommend to EU MS/AC for better synchronisation?
- What would be necessary and/or which roles and mandates would need to be clarified or revised to achieve improvements?



RQ3:

- How do you think could the process be better coordinated with other countries and the European level?
- What mechanism of approach would you propose to increase coordination across countries in general?

2. Actors taking decisions regarding prioritisation and/or funding of RI

RQ1:

- What kind of evidence is used to support decisions and prioritisation?
- What criteria are applied to decide on funding national RI? And to participate in international RI?
- Do you see any challenges/bottlenecks regarding the decision-making process and prioritisation and funding of RI?
- Are you planning any changes in the way decisions are taken?

RQ2:

- Is the decision-making on national priorities separated from the one on international priorities? If yes, how are these two coordinated?
- What challenges and bottlenecks do you see in view of the deciding between investment into national and international RI of priority?

RQ3:

- How do you think could the national roadmap process be better coordinated with other countries and the European level in view of strategic prioritisation/funding?

3. Actor in charge of evaluation and monitoring

RQ1:

- What evaluation/monitoring mechanisms are part of the roadmap process or linked to it?
- What are the objectives of the evaluation procedure?
- What criteria do you apply? How were these criteria defined? Are the same criteria applied for all types of RI?
- Who is evaluating the proposal? How is independence, expertise, impartiality guaranteed?
- Are there any challenges/bottlenecks you see?
- Are you planning any changes to the RI evaluation methodology?

RQ2:

- Are you taking into account evaluations or monitoring of RI of other countries or the European level?
- What challenges and bottlenecks do you see in view of the coordination of the national RI evaluation with other countries and the European level?

RQ3:

- Do you think the national roadmap process could be better coordinated with other countries and the European level in view of evaluation methodologies? In your opinion, how could this be done

