European Commission

Support to Greece in the implementation of PSF Country recommendations

Final report

PSF OPEN

HORIZON EUROPE
POLICY SUPPORT FACILITY

Independent
Expert
Report

Research and Innovation

Support to Greece in the implementation of PSF Country recommendations

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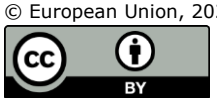

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EUROPEAN COMMISSION

Support to Greece in the implementation of PSF Country recommendations

Final Report

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Directorate-General for Research and Innovation
2023 Horizon Europe Policy Support Facility

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LIST OF ACRONYMS

ATHENA	Athena Research Centre in Information Technologies, Communications and Knowledge
DeiC	Danish e-Infrastructure Cooperation
DG RTD	Directorate-General for Research and Innovation
DMP	Data Management Plan
EC	European Commission
EIS	European Innovation Scoreboard
ELGO-DIMITRA	Hellenic Agricultural Organisation-DIMITRA
EOSC	European Open Science Cloud
EPANEK	Operational Programme Competitiveness, Entrepreneurship and Innovation
ERDF	European Regional Development Fund
ESEE	National Smart Specialisation Strategy
ESEK	National Energy and Climate Plan
ESETAK	National Strategy for Research Technological Development and Innovation

ESFRI	European Strategy Forum on Research Infrastructures
ESIF	European Structural and Investment Funds
EU	European Union
FAIR	Findable, Accessible, Interoperable, and Reusable
FNSO	French National Fund for Open Science
FP	Framework Programme
FWO	Research Foundation Flanders
GERD	Gross expenditure on research and development
GRNET	National Infrastructures for Research and Technology
GSRI	Greek General Secretariat for Research and Innovation
HAHE	Hellenic Authority for Higher Education
HFRI	Hellenic Foundation for Research and Innovation
HEAL-LINK	Hellenic Academic Libraries Link
HEI	Higher Education Institution
HOSI	Hellenic Open Science Initiative
HPC-ARIS	High Performance Computing System
HRIF	Hellenic Research and Innovation Foundation
IT	Information technology
KPI	Key Performance Indicators
LTS	Long-term sustainability
MA	Management authority
MADF	Ministry of Agricultural Development & Food
M&E	Monitoring and evaluation
MERAS	Ministry of Education, and Religious Affairs and Sports
MEYS	Czech Ministry of Education, Youth and Sports
MON-ESEE	Planning, coordination and monitoring unit of the national Smart Specialisation Strategy

NCRTI	National Council for Research, Technology and Innovation
NDC	National Documentation Centre
NREN	National Research and Education Network
NRI	National Research Infrastructure
NSRF	National Strategic Reference Framework
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programme
OPESP	Integrated National Quality Information System (HQA-OPESP), University of Crete
OS	Open Science
PBF	Performance-Based Funding
PCTI	Science, Technology, and Innovation Plan
PID	Persistent IDentifier
PSF	Horizon Europe Policy Support Facility
R&D	Research and Development
RRICs	Regional Research & Innovation Councils
RRF	Recovery and Resilience Facility
R&I	Research and Innovation
RI	Research Infrastructure
RPBF	Research Performance-Based Funding
RTDI	Research, Technological Development and Innovation
RTO	Research and Technology Organisations
RVCTI	Basque Network of Science, Technology, and Innovation
S3	Smart specialisation strategy
SSH	Social sciences and humanities
TSV	Federation of Finnish Learned Societies

POLICY SUPPORT FACILITY TEAM

The Policy Support Facility (PSF) Open team brought together a diverse set of competences, knowledge, and experience to address the assignment requirements.

- The **rapporteur Alasdair Reid**, in cooperation with the project manager, coordinated the organisation of the work of the expert panel, in particular in relation to the drafting of the implementation plans, consolidating written inputs. He also provided his own analytical input to the preparation of the report in relation to his competence area, notably on the key performance indicator (KPI) topic.
- The **thematic experts, Damien Lecarpentier and Thomas Zacharewicz**, provided input for the analysis of the areas subject to the specific support (open science & digitalisation and performance-based funding, respectively) and shared analytical and drafting tasks (division by topics/chapters). They contributed written input to both the draft and the final reports.
- The **project manager Susana Elena-Pérez** supported the expert panel in the organisation of the work and provided liaison with the EC. She ensured the overall organisational and technical support to the project, including arranging and taking minutes of all meetings and the management of the deliverable production.
- The **local support expert George Strogylopoulos** provided the expert panel with requested data and information and contributed to the report assessment of the Greek research and innovation (R&I) system and research infrastructure policy.
- The **senior expert for quality review, Ilaria Nardello**, reviewed the first draft of the implementation plans and provided the expert panel with suggestions for improvement. She also participated in the mid-term working meeting. She reviewed the third draft report, prepared after the second visit to the country.
- Communication activities were managed by the communications team comprising: Communication Manager Lucrezia Titi, Communication Officer Victoria Henderson, as well as Communication Assistants Virginija Balciunaite and Victoria Rodriguez.

The project was overseen by the PSF Team in the European Commission's (EC) Directorate-General for Research and Innovation (Unit A1 – 'European Semester and Country Intelligence'). **DG R&I policy** officer**, Vladimir Manolov** coordinated the exercise and ensured liaison with the Greek authorities.

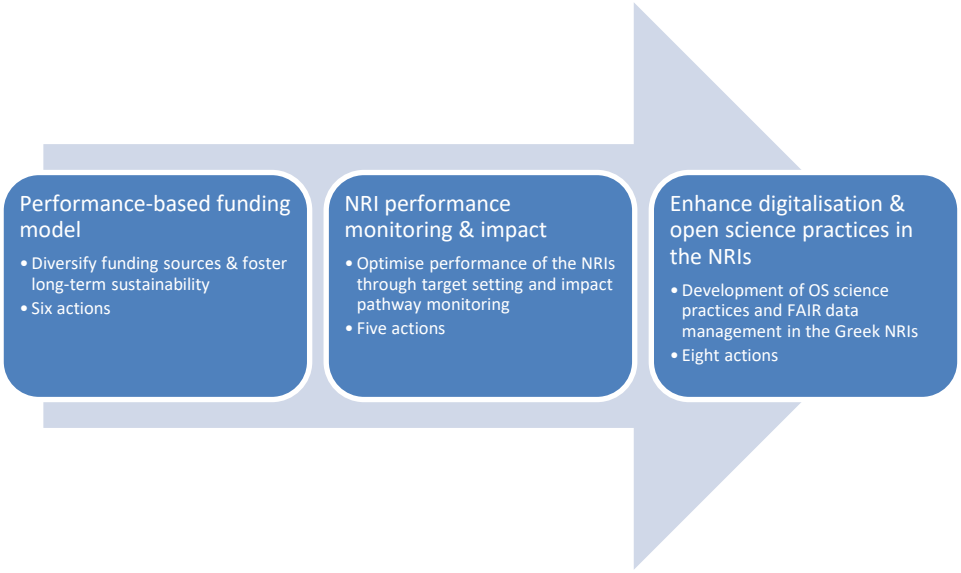
EXECUTIVE SUMMARY

Greek research and innovation (R&I) performance has significantly improved over the last decades, moving up from the group of catching-up countries of the European Innovation Scoreboard (EIS) to the group of moderate innovators. This is based on a series of factors amongst which has been a coordinated effort to invest in the upgrade of the R&I ecosystem, research infrastructure, scientific equipment, and human capacities. During the multi-annual financial period 2014-2020, the Greek authorities, with the support of the European Structural and Investment Funds (ESIF), invested over a 100 million EUR in launching and developing 28 national research infrastructures (NRIs). In 2022, the Policy Support Facility (PSF) country review provided a first assessment of this policy and of the level of maturity of. the 28 NRIs. In November 2022, the Greek Deputy Ministry for Development requested a second phase of PSF support to assist the General Secretariat for Research and Innovation (GSRI) to prepare for the next round of support for the NRIs.

This report addresses three of the recommendations made by the PSF Country Report

- Development of a framework for performance-based funding for NRIs.
- Development of a set of key performance indicators (KPIs) that reflect the role of the NRIs in the national R&I system
- Guidelines for open science (OS) and digitalisation to help NRIs further develop their data policies and connect with national and European research data platforms.

The report draws on a review of the literature and a series of interviews and consultations with Greek stakeholders and NRI coordinators that took place during two missions to Athens in spring 2023 by the expert panel.



Following an overview of the latest developments in Greek R&I performance, governance and policy, the report is structured in three 'implementation' plans which provide a review of the European and Greek 'state of the art' for each of the topics, followed by set of recommended actions. The report aims to contribute to a second wave of investment in NRIs

that should provide an overall leverage effect on the entire Greek R&I system further enhancing the positive trend in R&I performance over the last decade.

The three implementation plans are inter-linked 'building blocks'. Together they should provide, if correctly implemented, a strong foundation for ensuring an optimal investment of available ESIF funding to the selected NRIs. This will be done by incentivising the adoption of 'best practice' methods for the management and operation of NRIs, through the identification of and monitoring of progress along various 'pathways to impact' and, through the adoption and application by the NRIs of open science and FAIR data principles.

A funding system designed to enhance NRI performance

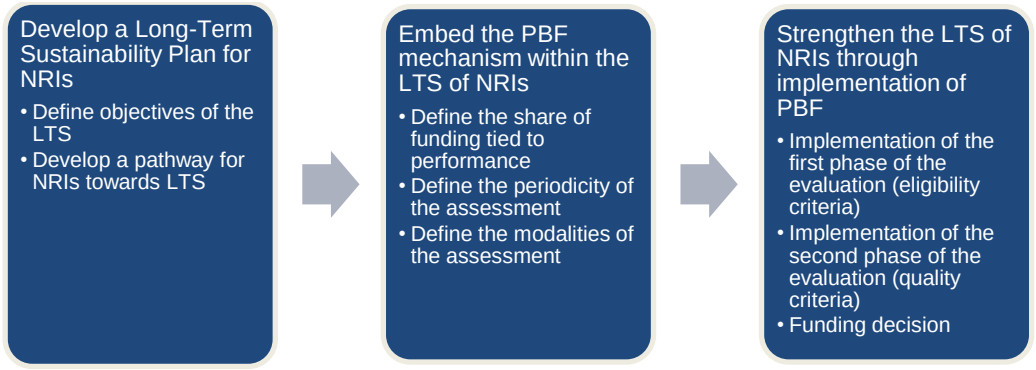
Research infrastructures are, if not exclusively to a very large extent, funded by public sector funds, notably during the investment phase, even if other sources of funding are then secured during the operational phase, including from the private sector. The long-term sustainability (LTS) of research infrastructures is not purely a question of securing funding, but the right mix of funding can help incentivise the sort of performance (effective support services for excellent research, attraction of business users, development and retention of skilled people, etc.). As a 2017 ESFRI report on Long Term Sustainability (LTS) underlined there is a need to "establish adequate framework conditions for effective governance and sustainable long-term funding for RIs at every stage in their lifecycle, together with effective management".

In this context, the expert panel examined models of performance-based funding (PBF) of research, and sough to adapt them to the specific case of the Greek NRIs. PBF provides a hybrid funding mechanism that combines characteristics of institutional and project-based funding mechanisms. It works based on five principles: research is evaluated, the evaluation is carried out ex-post, research output is evaluated, government funding is distributed based on the evaluation of results and the funding system applies nationwide. An alternative option is to sign performance contracts between research organisations and funding bodies (ministries or agencies) that set targets to be reached before the release of part of the funding allocated to the organisation. To date, PBF funding models are not generally applied to research infrastructures, but some elements of funding schemes have characteristics close to a PBF (e.g. Czech Republic, Basque Country). In Greece, the NRI funding has been project based (through the ERDF grants awarded during 2014-2020) with additional limited revenue raised from other grants and, in a few cases, service provision. The need to increase and diversify revenue and funding sources of the NRIs in the coming years is well recognised.

In the Greek context, a 2023 reform of funding mechanisms for higher education institutions (HEIs) introduced an annual allocation of 20% of institutional funding awarded on performance-based criteria. This new funding mechanism is in line with good practice in other EU Member States and should help to steer the activities of Greek HEIs towards national priorities, including research excellence as well as economic and societal impact. Within this funding scheme, the possibility for Greek HEIs to choose some of the categories on which their performance is evaluated takes account of the diversity of their activities and outputs and introduces some flexibility in the assessment.

Drawing inspiration from the LTS model development by the ERIC Forum, the PSF Open team proposed a performance-based funding system for Greek NRIs structured in three-steps. The first step is directly inspired from the ERIC LTS model and aims to develop a LTS plan for the NRIs though (a) the definition of LTS objectives and (b) the elaboration of a pathway to achieve them. The second step involves defining the funding scheme to enhance performance through the definition of (c) the share of funding tied to performance, (d) the periodicity of the assessment, and (e) the modalities of the assessment. Finally, the third step is the implementation of the PBF scheme through (a) the first phase of the evaluation

(eligibility criteria), (b) the second phase of the evaluation (quality criteria), and (c) the funding decision concerning a performance bonus. The performance bonus linked to criteria compliance should be high enough to be considered as an incentive and should steer the activity of NRIs. At the same time, the bonus should not exceed a threshold that would create too much uncertainty in a context in which Greek NRIs already exclusively rely on competitive project funding. We therefore recommend fixing this performance bonus between a minimum of 10% and a maximum of 20% of total funding.



A monitoring and evaluation framework for NRIs

In order to apply the PBF scheme, there is a need to establish a monitoring and evaluation (M&E) framework for the NRIs. Drawing inspiration from both European (ESFRI landmark monitoring, RI-PATHs guidance) and national approaches (Czech Republic, Flanders, Netherlands, Portugal) to monitoring and evaluating research infrastructures, the PSF Open panel has developed a tailored approach that should be implemented during the 2021-2027 funding period. The M&E framework takes account of the need for the NRIs to track progress towards common output and result indicators of the ERDF. However, the ERDF indicators do not provide a sufficient basis for monitoring and assessing the performance of a NRI which is primarily expected to provide services to users (academic researchers, private companies, public sector organisations), rather than producing publications, patents or product/process innovations itself.

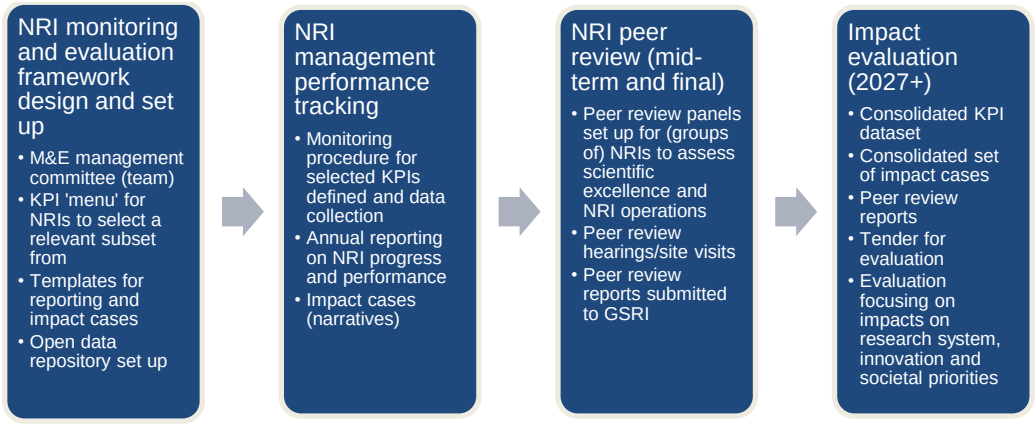
The proposed framework enables the Greek authorities to:

- (a) Assess NRIs performance via interim and ex-post evaluations;
- (b) Allocate a performance bonus (see implementation plan 1);

At an operational level, the KPIs and reporting framework support the NRIs to:

- Self-assess their own progress on their contribution to national priorities; and
- Develop and implementing LTS plans that ensure diversified sources of public funding as well as generating revenue from service provision to users.

The framework is split into four main steps, with specific actions foreseen for each step. A NRI Management team should be established (within the GSRI, but in close liaison with other ministries and agencies) with responsibility for supervising the monitoring and evaluation of the NRI and suitably resourced (two to three staff, budget for peer reviewers, evaluations, etc.) over the period 2023-2030. Moreover, a cross-departmental NRI supervisory committee be formed (meeting no less than once a semester) to review progress in implementing the plan and the development of the selected NRIs.



All NRIs should be required to report on a minimum obligatory set of KPIs, namely: usage of the NRI, education and training; income; publications and open science. NRIs are encouraged to define additional KPIs on their performance can be assessed. We recommend that each NRI adopts not more than 10 KPIs in total. Each NRI should provide a baseline situation as well as mid-term and final targets for each KPI. To support the NRI M&E framework, the PSF Open panel developed a template for NRI reporting (mid-term and final reviews) structured according to the six broad criteria developed by the previous PSF Country panel. To complement the KPIs and ensure a qualitative and narrative approach to recording and presenting pathways to impact, the NRIs should provide at least two impact cases by mid-term and four by the end of the period. A template for impact case reporting is provided. A final recommendation is that the NRI management team should set up, or use a procurement procedure, to develop a NRI monitoring database. This database would enable all NRIs to report online their KPI performance, as well as to submit impact cases. This database should include an open access repository of FAIR research data and digitally identified objects produced by the NRIs.

Enhancing research digitalisation and open science practices

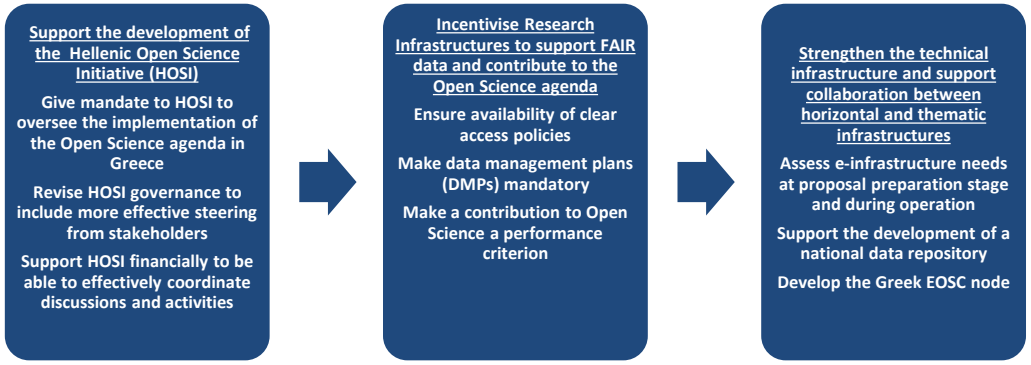
Over the last decade, open science (OS) has become a policy priority in Europe and is now the standard method of working under the European Commission's R&I funding programmes. OS has also been embraced by EU Member States, which have adopted national plans and strategies aimed at making OS the default practice in the research system. The publication in June 2020 by a group of Greek academic, research, and infrastructure stakeholders of a National Open Science Plan and the establishment in February 2022 of the Hellenic Open Science Initiative (HOSI), which aims to advance and implement this plan nationally, are positive developments. They will allow Greece to align with other well-advanced European countries. The Greek draft plan for OS, provides a sound basis for setting up a National OS Strategy. The draft plan is far-reaching, encompassing many aspects of the Greek research and open science ecosystem. It covers four key areas of the OS ecosystem (open access to publications, open access & reuse of research data, development and management of research software, and open access to NRIs and e-Infrastructures).

The role of RI is increasingly recognised in national OS strategies and national roadmaps. The PSF Open panel reviewed experience of other EU Member States (the Czech Republic, Denmark, Finland, France, etc.) in defining the role and contribution of NRIs to OS. RIs are often invited to include in their access conditions the principles of open access publication, and of opening by default of data and source code and to formalise their OS policies through a public strategy document.

A second key issue examined is the e-needs of RIs and the role of e-infrastructures. ESFRI's approach to support FAIR data management provides a good model for application at national levels. Indeed, several countries have begun to require their RIs to anticipate their e-infrastructure requirements at an early stage in their funding cycle. While e-infrastructures may offer RIs from all disciplines open access to the advanced digital capabilities, resources, and expertise they need to collaborate and to carry out data- and computing-intensive science, persistent identifiers (PIDs) and repositories are among the critical services that RIs will need to improve FAIR data management practices. The use of PIDs by RIs – for research data and software – is often seen as one of the critical actions which underpins effective data sharing, together with the use of metadata and open formats.

Finally, OS practices require systemic change, which can take several years. In addition to making strategic investments in infrastructure and tools to support FAIR data in a coordinated, interoperable, and cross-disciplinary way, it is critical to invest in skills and training, targeting both researchers and data managers operating at NRIs. NRIs should be encouraged to recruit professionals responsible for processing, quality checking, describing and preserving data. In Greece, research infrastructures can rely on a solid network of experts on open access, in particular, through the OpenAIRE network, and infrastructure, via GRNET, to support them in their digital and FAIR strategies.

The panel's recommendations for OS and digitalisation are designed to facilitate the development of OS practices and FAIR data management within the Greek research infrastructure ecosystem. The recommendations target the elements that are most relevant to NRIs and will help them to improve their OS practices and contribute to the OS agenda.



The recommendations are structured in three main lines of action.

- Support and develop HOSI as the Greek forum for OS, where policy and technical developments are discussed and overseen.
- Incentivise NRIs to support FAIR data and contribute to the OS agenda
- Strengthen the technical infrastructure and support collaboration between thematic and horizontal infrastructures and services.

1. Introduction: scope of the PSF Open and activities undertaken

1.1. Scope and objectives of the PSF Open

During the dissemination event of the PSF Country review of the Greek national research infrastructures (NRIs), the General Secretariat for Research and Innovation of Greece (GSRI) expressed its commitment to the policy needs defined in the PSF final report and its engagement with the PSF in the implementation of recommendations. On 4 November 2022, the Deputy Minister of Development and Investments, Mr Christos Dimas, formally requested the support of the Policy Support Facility (PSF) in the form of PSF Open.

The PSF Open exercise addressed three PSF recommendations from the PSF Greece Country report (EC, 2022):[1]

- **Development of a general framework for performance-based funding of research infrastructures (RIs),** as referenced in recommendation 4.1.2 of the PSF Report 'Develop a medium-term, performance-based funding framework for NRIs' (p.128).
- **Development of a set of key performance indicators (KPIs) that reflect the role of the NRIs in the national R&D system**, as referenced in recommendation 4.1.5 of the PSF Report 'Adopt a set of key performance indicators that reflect the specific role of RIs in the national R&I system' (p.134).
- **Guidelines for open science and digitalisation** around which NRIs should further develop their data policies and connect with national and European research data platforms, as referenced in recommendation 4.2.5 of the PSF Report 'Enhance open science and FAIR research data management capacities of the NRIs' (p.140).

The project provided expert support to define the three *implementation plans* to address the mentioned recommendations. The recommendations are formulated to ensure that the past investment in NRIs is optimised during the 2021-2027 period. The **aim is to place the NRIs on a footing of long-term sustainability** that fosters scientific excellence while contributing to meeting national socio-economic and societal challenges, in line with the National Smart Specialisation Strategy (ESEE) for 2021-2027.

1.2. Activities undertaken during the PSF Open

The PSF expert panel has defined three implementation plans with a concrete set of actions and with associated timing for their implementation:

- Implementation **plan 1: 'A funding system designed to enhance performance'** (Section 4).
- Implementation **plan 2: 'A monitoring and evaluation framework for the NRIs'** (Section 5).
- Implementation **plan 3: 'Enhancing research digitalisation and open science practices in the NRI ecosystem'** (Section 6).

[1] Report available at: https://op.europa.eu/en/publication-detail/-/publication/fc6b0103-45ed-11ed-92ed-01aa75ed71a1/language-en/format-PDF

Each plan includes: a review of the state of the art in Greece compared to European and international practice; an overview of the proposed actions to strengthen the Greek NRI ecosystem including a roadmap diagram; and a full description of each of the envisaged actions, indicating the action owner, timeframe, resources needed and key milestones.

The PSF panel's work has built on:

- The previous PSF Country report (including the survey sent to the NRIs between December 2021-January 2022);
- The Multi-Annual Financial Plan 2014-20 of the Greek NRIs;
- A literature review on the key topics and on the existing practices in Greece and in other European countries;
- A series of interviews and meetings with Greek national stakeholders, the NRI coordinators, representatives of selected projects and policy-makers during the first panel mission to Greece at the end of March 2023;
- Working sessions with Greek stakeholders during the second mission from 30 May to 1 June 2023, during which the first drafts of the implementation plans were discussed.

The implementation plans will be presented at a dissemination event in Athens in autumn 2023. The process of defining the implementation plans is summarised in the figure below.

Figure 1. Key steps in the PSF Open Greece

The PSF panel thanks all Greek stakeholders and NRI projects' representatives (see list of interviewees in Annex 1 – Interviewees/participants in meetings) for their constructive contribution to the review.

2. The Greek R&I system and the national research infrastructures

2.1. Research and innovation performance and trends

The Greek research and innovation (R&I) system has developed significantly over the last two decades. In 2011, gross expenditure on research and development (GERD) amounted to 0.68% of GDP (€1,391 million); in 2021, it reached 1.45% of GDP and had almost doubled in terms of absolute expenditure (€2,635 million). According to the national reform programme 2020, the goal is for R&D expenditure to reach 1.81% of GDP by 2030. Since 2008, Greece has advanced from the group of Catching-up countries of the European Innovation Scoreboard (EIS) to the group of Moderate Innovators.

Greece	Performance relative to EU in 2023	Performance change 2016-2023	Performance change 2022-2023
SUMMARY INNOVATION INDEX	**79.5**	**22.2**	**0.5**
Human resources	**71.5**	**6.8**	**-3.0**
Doctorate graduates	70.3	11.4	-11.4
Population with tertiary education	118.5	6.0	6.0
Lifelong learning	17.6	0.0	0.0
Attractive research systems	**71.0**	**14.1**	**0.3**
International scientific co-publications	92.1	48.5	6.6
Most cited publications	93.3	7.1	3.9
Foreign doctorate students	1.4	-2.1	-13.9
Digitalisation	**48.5**	**-6.1**	**-6.1**
Broadband penetration	26.4	-12.1	-12.1
People with above basic overall digital skills	78.8	0.0	0.0
Finance and support	**63.6**	**35.5**	**5.0**
R&D expenditures in the public sector	100.0	35.5	-6.5
Venture capital expenditures	45.0	32.4	2.0
Government support for business R&D	44.5	38.7	24.0
Firm investments	**70.5**	**23.1**	**-2.1**
R&D expenditure in the business sector	44.4	31.5	-0.8
Non-R&D Innovation expenditures	106.2	9.0	-6.0
Innovation expenditures per employee	66.6	27.6	0.1
Use of information technologies	**39.3**	**-2.6**	**6.1**
Enterprises providing ICT training	48.3	-8.9	8.9
Employed ICT specialists	30.0	3.4	3.4
Innovators	**167.3**	**106.9**	**15.1**
Product innovators (SMEs)	179.0	123.7	16.6
Business process innovators (SMEs)	157.0	89.0	13.5
Linkages	**117.7**	**58.1**	**-9.4**
Innovative SMEs collaborating with others	174.8	56.6	-16.0
Public-private co-publications	146.9	84.6	14.8
Job-to-job mobility of HRST	58.3	47.1	-14.7
Intellectual assets	**51.8**	**8.8**	**-1.5**
PCT patent applications	37.2	1.2	-2.9
Trademark applications	95.1	31.8	2.5
Design applications	25.8	0.3	-2.7
Employment impacts	**124.2**	**37.5**	**22.2**
Employment in knowledge-intensive activities	81.9	0.0	0.0
Employment in innovative enterprises	158.9	73.0	43.3
Sales impacts	**85.5**	**27.5**	**-9.7**
Medium and high-tech goods exports	20.6	3.8	-2.2
Knowledge-intensive services exports	103.4	25.5	-17.0
Sales of innovative products	158.0	66.6	-12.2
Environmental sustainability	**71.8**	**-2.5**	**1.8**
Resource productivity	88.5	55.4	16.2
Air emissions by fine particulate matter	71.8	11.6	5.0
Environment-related technologies	55.2	-57.9	-11.7

GREECE is a Moderate Innovator with performance at 79.5% of the EU average. Performance is below the average of the Moderate Innovators. Performance is increasing at a rate higher than that of the EU (8.5%-points). The country's performance gap to the EU is becoming smaller.

Relative strengths

- Product innovators
- Innovative SMEs collaborating with others
- Employment in innovative enterprises
- Sales of innovative products
- Business process innovators

Relative weaknesses

- Foreign doctorate students
- Lifelong learning
- Medium and high-tech product exports
- Design applications
- Broadband penetration

Strong increases since 2016

- Product innovators
- Business process innovators
- Public-private co-publications

Strong decreases since 2016

- Environment-related technologies
- Broadband penetration
- Enterprises providing ICT training

Figure 2. Greece R&I performance – 2016-2023

Source: EC & Hollanders (2023)

The overall Greek innovation performance remains below the EU average, however the country's performance gap to the EU is reducing over time (summary innovation index trend), at a rate higher than that of the EU (8.5%-points).

2.2. Research and innovation policy governance system

In Greece, there is a long-standing fragmentation of research policy management and funding sources, which are provided by several ministries: the GSRI, the Hellenic Foundation for Research and Innovation (HFRI)[2] and regional authorities. The National Council for Research, Technology and Innovation (NCRTI) and 13 Regional Research & Innovation Councils (RRICs) provide advice to ministers and national agencies, and regional authorities respectively on R&I topics.

There has been an inadequate coordination amongst these policy advisory and management bodies, as well as an administrative separation of research funding management between universities and research centres. Moreover, there is still a high level of bureaucracy in the various bodies involved in the financing of research activities, which is due to specific laws, regulations and provisions that hinder the research projects (e.g. slow evaluation procedures).

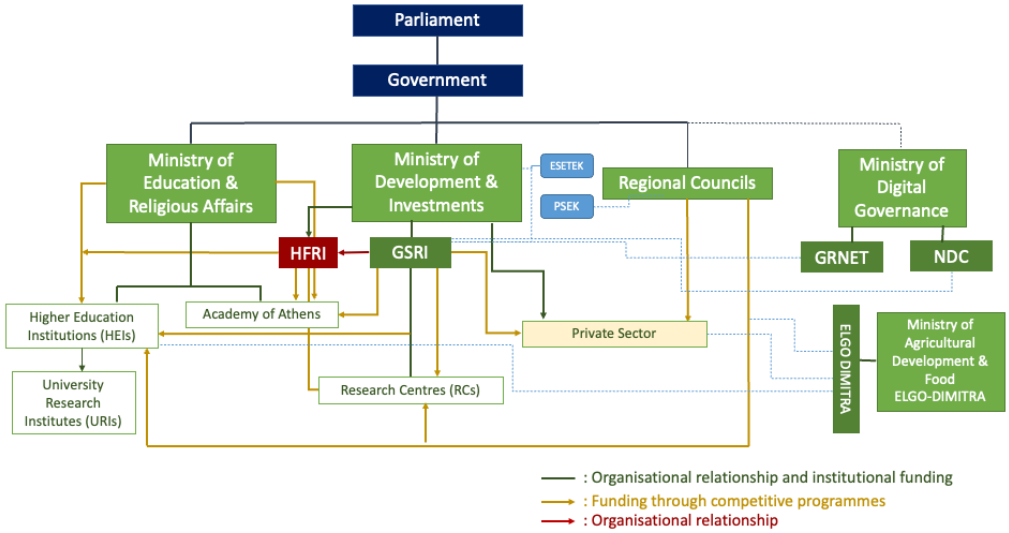


Figure 3. Greece: Research and innovation governance & funding system

Source: authors

The GSRI is a public body, under the Ministry of Development and Investments, tasked with planning and coordinating the implementation of R&I policy. It supports the activities of the research community as well as trade and industry bodies, through competitive R&I programmes, and it supervises the majority of public research centres. Furthermore, it follows

[2] See: https://www.elidek.gr/en/homepage/

EU and international developments related to R&I and represents Greece in EU committees and international organisations in its areas of competence.

The HFRI was founded by Law 4429/2016[3] and is supervised by the Deputy Minister of Development and Investments responsible for Research & Technology. HFRI was founded with the objective to "*promote R&I in Greece and more specifically to support and assist unrestricted research without any thematic or geographical limitations, having quality and excellence as a unique criterion.*" It provides support for the development of Greek researchers, at all stages in their career and in all fields of research. A 2021 evaluation found that the HFRI contributed to constraining the brain drain phenomenon, facilitated the return of early career researchers, enabled the renewal or acquisition of high-value research equipment, and supported participation of Greek researchers in Europe-wide RIsin the field of Social Sciences and Humanities (SSH).

The Ministry of Education, Religious Affairs and Sports (MERAS) is responsible for higher education institutes, university research institutes and overseeing the Hellenic Authority for Higher Education (HAHE).[4] HAHE organises the monitoring of and external evaluation (carried out by a panel of independent experts) of academic units, including on their research activity.

The Ministry of Digital Governance is a recently established (2019) public administration unit. For the first time, it brings together all critical information technology (IT) and telecommunications structures related to the provision of electronic services to citizens and the wider digital transformation of the country. It is not directly related to R&D activities. However, under its auspices are two very significant organisations: GRNET and the National Documentation Centre (NDC).[5]

GRNET[6] acts as an advisory body to the Ministry of Digital Governance in matters of design and upgrading of advanced information systems. It contributes to the promotion and implementation of the ministry's strategic objectives. It has a central role as coordinator of all digital infrastructures for education and research. It advises and supports the State, with the design of advanced information systems and infrastructures, as well as the design, development and maintenance of advanced computing and network infrastructures and services. GRNET supports the Pan-Hellenic fibre optic network; data centres; high performance computing (HPC) system (HPC-ARIS); the operation of the National Competence Center EuroCC-Greece HPC Hub[7]; the operation, development and promotion of the National Digital Academy; coordination of the project 'Innovation Hub for Digital Governance' (DigiGov InnoHub). The Hub supports innovation at national and European level, coordinating and participating in OS projects and participating in the formulation of a national strategy for Artificial Intelligence.

GRNET provides international interconnectivity through the pan-European GÉANT network and is the national research and education network (NREN). It also manages the Greek

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3 Paragraph 5 of Law 4429/2016 was replaced with article 111 paragraph 3 of Law 4623/2019 and where in the law, the mentioned ministry is the Ministry of Education and Religious Affairs, this has now been replaced by the Ministry of Development and Investments.

4 See: https://www.ethaae.gr/en/about-hahe/about-hahe

5 See: https://www.ekt.gr/en/index

6 See: https://grnet.gr/en/

7 See: https://eurocc-greece.gr/about/

Internet Exchange (GR-IX), a national infrastructure that interconnects the most important internet companies operating in Greece (e.g. internet service providers, cloud, hosting, VoIP, etc.). In parallel, a new research institute for artificial intelligence, data processing and algorithm development, has recently been established in the 'Athena' research centre, under the auspices of GSRI.

The Ministry of Agricultural Development & Food (MADF) has a network of laboratories across the country, working in support of the primary sector and food industry. However, there is no direct collaboration with the other ministries on R&D issues, except in the case of the NRIs. The network of institutes and laboratories of MADF are named ELGO-DIMITRA[8] (Greek Agricultural Organisation DIMITRA). The main object of ELGO-DIMITRA is the development and support of actions aimed at the modernisation and development of the country's agricultural sector, the improvement of production processes, the strengthening of competitiveness, the certification of quality agricultural products and food, plus the establishment and certification of correct agricultural practices and controls in the production-distribution chain.

2.3. Greek research and innovation policy

Greece lacks a stable, predictable and sufficient flow of funding for basic research with specific strategic priorities and systematic evaluation of the bodies that conduct this type of research (Pissaridis et al., 2020). However, the establishment of the HFRI in 2016, along with the financing of six flagship actions addressing specific challenges, are positive steps in this direction. Additional flagship actions will be supported by the national Recovery and Resilience Facility (RRF) Plan 'Greece 2.0'[9]. However, there is not a specific strategy beyond these financial commitments.

R&I policy in Greece is based mainly on two strategies. The National Strategy for Research Technological Development and Innovation (ESETAK) (not yet adopted), provides the general framework for the development of the country's RTDI system during 2021-2027. ESETAK is based on two central pillars: the ESEE 2021-2027[10], and the basic research policy. The ESEE is a comprehensive agenda of economic transformation, with the aim of improving the competitiveness of the national production system. ESSE aspires to improve critical dimensions of the national innovation ecosystem, firstly in a horizontal way (e.g. human resources, skills, and infrastructure). However, there is strong vertical targeting in selected thematic areas or sectoral ecosystems, where the country should invest, as Greece has productive entities that can support the development of relative competitive advantage.

ESETAK embraces both ESEE and the pillar of basic research, meaning 'blue sky research' that may not always have a directly applied nature, e.g. social sciences and humanities (SSH), but which can create a broad background of knowledge and form the basis for solving current or anticipated future problems. ESETAK adopts the basic assumptions and goals of the ESEE, in order to ensure a common orientation. However, it highlights the interventions that are necessary to complete the entire Greek R&I system.

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8 See: https://www.elgo.gr/

9 See: https://greece20.gov.gr/en/

10 See the synposis in English available at https://gsri.gov.gr/wp-content/uploads/2022/11/Synopsis_National-Smart-Specialisation-Strategy-2021-2027.pdf

In addition, the design of ESETAK aims to harmonise with a) national strategic plans and policies, such as the National Recovery and Resilience Plan 'Greece 2.0', the National Energy and Climate Plan (ESEK), the National Plan for the Just Transition, the Digital Transformation Bible 2020-2025[11], business and investment strategies, and regional development strategies, etc.; b) the policy directions of the European R&I landscape and in particular the European Research Area (ERA) policy agenda[12]; c) the global challenges in the context of the 17 United Nations sustainable development goals (SDGs), and the European Green Deal for a green, digital and inclusive transition.

2.3.1. National research infrastructures: the 2014-2020 programming period

The GSRI, as the State's competent body for R&I, developed during the 2014-20 programming period a multi-annual funding plan, through which 28 NRIs were financed. The NRI plan was aligned with the strategic priorities of the smart specialisation strategy (S3) for 2014-20, an ex-ante conditionality for the use of the European Structural and Investment Funds (ESIF) for R&I. A total of 28 NRIs were financed (see Figure 4 and Annex 3) by the EPANEK Operational Programme for Competitiveness (2014-2020).

In preparation for developing the NRI strategy for the 2021-27 programming period, GSRI made use of the European Commission's PSF. A panel of international experts examined the performance of the 28 NRIs in terms of their contribution to the economy and society, their relevance to the S3, international recognition as well as their development prospects. The final assessment report[13] included a set of recommendations aimed at the further improvement of the operations and efficiency of the NRI during the period 2021-2027, through the adoption of a long-term sustainability model that will promote scientific excellence while also contributing to addressing socio-economic challenges.

Measure	Initial allocation of funds (€)	Awarded after calls (€)	Final commitments (€)	Funded projects	Participating organisations
Support of NRIs	93,000,000	95,538,798	91,546,050	28	212
Strategic development of research centres	31,860,000	31,860,000	30,324,368	30	30
Regional Excellence	45,000,000	87,161,763	87,160,763	44	
Total	169,860.000	214,560,561	209,031,181	103	242

Figure 4. Total financing of NRI and other relevant financing during the period 2014-2020

Source: GSRI

The main recommendations were:

[11] See: https://digitalstrategy.gov.gr/en/

[12] European Commission, Directorate-General for Research and Innovation (2021): *The new European Research Area*. Publications Office of the European Union, https://data.europa.eu/doi/10.2777/2736

[13] See: https://gsri.gov.gr/apotimisi-ton-erevnitikon-ypodomon-2014-20/

- Establish a NRI coordination technical assistance unit.
- Foster the organisational transition from a project consortium to a single legal entity model for NRIs.
- All NRIs should have a dedicated management team.
- Strengthen capacity to engage with and deliver services to industry and societal users. To develop an innovation-orientated approach, the NRIs should reinforce their organisational capacities and expertise.
- Enhance OS and FAIR research data management capacities of the NRIs, in line with the Greek OS Plan, established from the bottom up by the main academic and public research institutions.

2.3.2. Institutional and regulatory framework for the period 2021-2027

The main elements of the regulatory framework for the current period are:

- Law 4712/2020, which designates the General Secretariat of Public Investments and the National Strategic Reference Framework (NSRF), in cooperation with the competent Ministries and Regions, responsible for the coordination of the S3 (Article 36, Law 4712/2020 (A' 146)).
- The Council for the ESEE is re-established, with the main objective of recommending to the Minister of Development and Investments the approval of the ESEE (Decision of the Minister of Development & Investments no. 24448/26-02-2021 (B' 943)).
- The Planning, Coordination and Monitoring Unit (MON-ESEE) established with the mission of planning, managing and coordinating the implementation of the ESEE.
- The ESEE Coordination Network was also established (Government Gazette 2416/B/ 12-04-2023) to coordinate and address common issues and strengthen the complementarity between the national and regional branches of the ESEE.
- Law 4961/2022 ‘on emerging information and communication technologies, the reinforcing of digital governance and other provisions’ was published in the Government Gazette (GG 146/A/27-07-2022). This law regulates the utilisation and use of a basic set of contemporary advanced technologies with significant economic and social impact.

All R&I support actions for the period fall under the European Regional Development Fund (ERDF) enabling condition for Policy Objective 1: A smarter Europe by promoting innovative and smart economic transformation, namely good governance of national or regional smart specialisation. This calls for the continuous monitoring of the fulfilment criteria for the enabling condition, namely:

1. Up-to-date analysis of bottlenecks for innovation diffusion, including digitalisation.
2. Existence of a competent regional national institution or body, responsible for managing the S3.
3. Monitoring and evaluation tools to measure performance towards the objectives of the strategy.
4. Effective functioning of the entrepreneurial discovery process.
5. Actions necessary to improve national or regional R&I systems.
6. Actions to manage industrial transition.
7. Measures for international collaboration.

2.4. National research infrastructures: 2021-2027 programming period

In early 2023, the GSRI Directorate of R&I Planning and Programming announced a consultation on a Call for Expressions of Interest for the new National Research Infrastructure funding Action in the context of the 'Competitiveness' Programme 2021-27 into Open Consultation. The deadline was 28 March 2023. Through the open consultation, the research-academic community was given the opportunity to verify, propose amendments or enrich the plan: the main criterion was alignment with the national ESEE for 2021-2027 and its contribution to an innovative economic transformation of the country. The consultation findings have been incorporated in the new version of the call. The call text is in line with the recommendations of the PSF experts, both in terms of implementing the selection process of the NRI to be funded, the evaluation criteria and the funding based on their performance (performance-based funding and KPIs), as well as moving towards the strategic directions for supporting the NRI and international good practices. The main principles of the call for NRIs are:

- To support those NRIs from the Multi-annual Financial Plan 2014-20 that have completed the preparatory phase of development and are proceeding with their full operation.
- The further strengthening of those NRIs of the Multi-annual Financial Plan 2014-20 that need to complete the preparatory phase of their operation.
- The selection of a limited number of new NRIs to support their preparatory phase, in the event that additional needs emerge in the priority areas of the national ESEE 2021-27.

The duration of the projects cannot exceed four years. The maximum public expenditure for the financing of the full operation phase of an NRI is €8m, if it includes mergers of existing NRIs (created in the framework of the 2014-20 programming period). The public expenditure for the financing of existing mature NRIs (to be proven through specific KPIs) will not exceed €6m, while the public expenditure for the financing of NRIs which require further development to reach full operations is up to €4m. Overall, the maximum number of NRIs that will be included in the 2021-27 roadmap will not exceed 20.

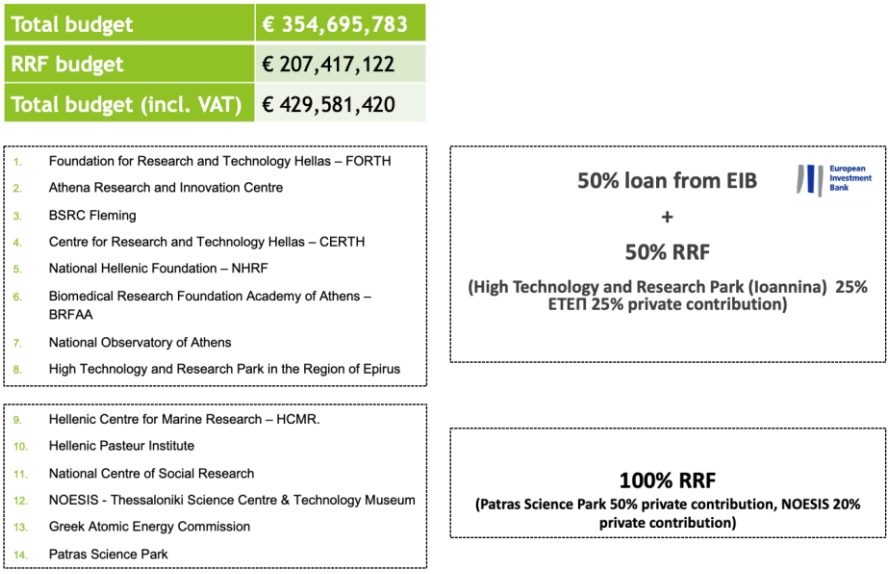

Figure 5. Funding for research infrastructures under the RRF

Source: GSRI

Finally, for the sources of financing for the programming period 2021-27 and in addition to the ESIF co-funded 'Competitiveness' programme[14] (€120m are specifically dedicated to the second phase of development of the NRIs), resources to support research infrastructures, but not specifically the NRIs, are also drawn from the RRF (€207m), the regional operational programmes (€30m) and HFRI (€120m). The RRF funding is focused notably on buildings, although some funding is directed at the upgrade of research infrastructure equipment.

3. Overview of the proposed actions to enhance the performance of the Greek NRIs

In the context set out above, this report proposes **a strategic and operational framework for enhancing the performance of the Greek NRIs that will be funded during the period 2021-2027.** The report aims to provide a basis for looking beyond 2027 and supporting preparations for the next multi-annual financing period. The current dependence on EU funding, through ESIF, for financing the investment in and operations of the NRIs (and indeed the entire Greek public R&I system) is not sustainable. In the longer term, there will be a need to increase Greek national budgetary resources allocated to the Greek R&I system and more generally to diversify funding sources. This diversification can be achieved by making the NRIs attractive partners and suppliers of services to both Greek and international research, business and other 'clients'.

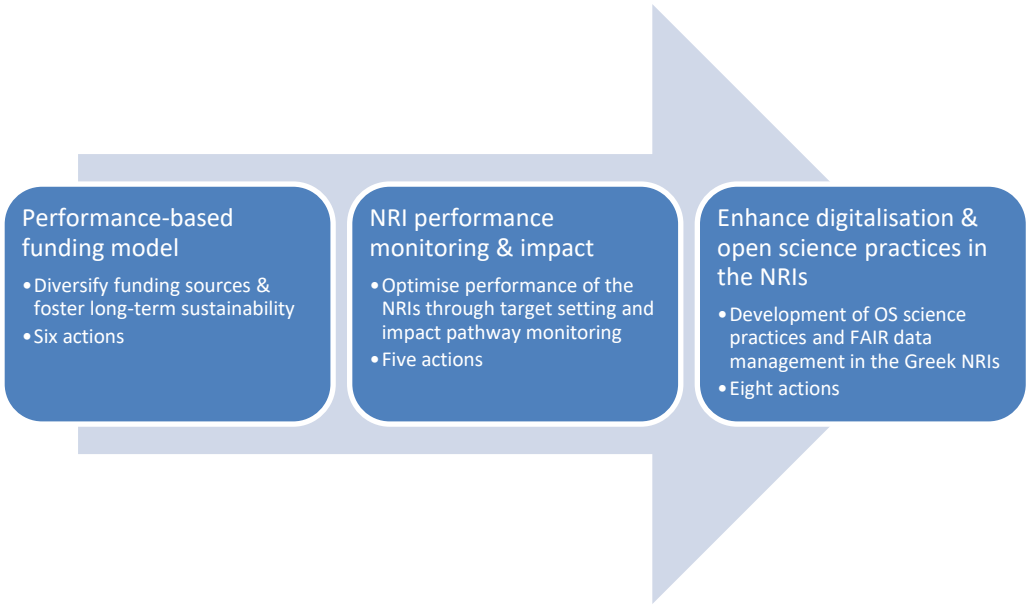

Figure 6. Overview of the three implementation plans

The three implementation plans are inter-linked 'building blocks'. Together they should provide, if correctly implemented, a strong foundation for ensuring an optimal investment of available ESIF funding to selected NRIs by fostering the adoption of 'best practice' methods for the management and operation of NRIs, identification of and tracking of progress along

[14] See: http://21-27.antagonistikotita.gr/ (in Greek)

various ‘pathways to impact’ and, through the adoption and application by the NRIs of OS and FAIR data principles, a leverage effect on the entire Greek R&I system.

Each plan, after a review of the European and Greek state of the art, sets out a number of recommendations and presents a detailed set of actions using the template below.

Action number	Action title
Action owner(s)	Organisation(s) in the Greek R&I system that should be the lead for implementing the action.
Timeframe	Indicative timeframe for the action.
Resources	Human, funding, regulatory/administrative measures, etc.
Description of the action	Details of what needs to be done to implement the action.
Milestones	Main milestones for the action.

Figure 7. Description of the proposed actions included in the implementation plans

4. Implementation plan 1: a funding system designed to enhance performance

4.1. Review of the state of the art in Greece compared to European and international practice

4.1.1. The development of research performance-based funding in the European Union

Over the last decades, performance-based funding (PBF) frameworks have become a central instrument through which many EU Member States have sought to increase the effectiveness and performance of their public sector research systems. In 2010, the OECD countries indicated their interest to engage in mutual learning on this topic.[15] Similarly, at EU level, the European Commission mentioned in 2012 its aims to foster "*more effective national research systems – including increased competition within national borders and sustained or greater investment in research.*"[16] This commitment to increase research performance through continent-wide competition was reaffirmed in 2021 as a cornerstone of the new ERA agenda. The development of PBF systems is one of the funding mechanisms designed to reach this objective by fostering competition between research institutions.

Traditionally, public research funding has been classified into two main categories.[17] The first is institutional funding, which can be defined as "*the funding of institutions with no direct selection of projects or programmes to be performed. Under this type of funding, it is the receiving institution that has discretion over the R&D projects that are to be performed, not the funding organisation.*"[18] The second main category of research funding is called project funding, defined as "*money attributed to a group or an individual to perform a R&D activity limited in scope, budget and time, normally on the basis of the submission of a project proposal describing the research activities to be done.*"[19] It has been generally assumed that institutional funding is mainly non-competitive, while project funding is characterised by a higher degree of competition.

Since the 1980s, the evolution of European research funding systems has been guided by the active role of governments in defining scientific policy. Specifically, there has been a shift from a model of delegation of academic activity to the scientific community (both universities and public research organisations) to a model in which governments aspire to direct and channel research towards socio-economic and political needs. To achieve this, project funding has emerged and grown in importance as a tool that allows public funders

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15 OECD (2010), *Performance-based Funding for Public Research in Tertiary Education Institutions: Workshop Proceedings*, Éditions OCDE - OECD, Paris, https://doi.org/10.1787/9789264094611-en.

16 European Commission (2012). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Reinforced European Research Area Partnership for Excellence and Growth /* COM/2012/0392 final */

17 Lepori, B., van den Besselaar, P., Dinges, M., Potì, B., Reale, E., Slipersæter, S., Thèves, J., van der Meulen, B (2007). Comparing the evolution of national policies: what patterns of change?, *Science and Public Policy*, 34(6), 372-388.

18 Steen, J. v. (2012). Modes of Public Funding of Research and Development: Towards Internationally Comparable Indicators', OECD Science, Technology and Industry Working Papers, 2012/04, OECD Publishing.

19 Lepori et al., op.cit.

(government departments, research funding agencies, etc.) to steer research towards predetermined objectives. Consequently, the share of this funding model within total research funding has increased very substantially over the last 40 years in the EU.[20]

In parallel with this increase of project funding compared to institutional funding, the traditional dichotomy between these two funding models has increasingly been challenged by the emergence of a hybrid funding mechanism, which includes characteristics of both institutional and project funding. This hybrid mechanism is called Performance-Based Funding (PBF)[21] and is defined by five principles:

- **Research** must be evaluated. Evaluations of the quality of degree programmes and teaching are excluded.
- Research evaluation must be ***ex post***. This ex-post evaluation of research results is one of the main differences with the project funding modality, as project funding is based on an ex-ante evaluation of research proposals.
- Research **output** must be evaluated. Systems that allocate funding based only on PhD student numbers and external research funding are excluded.
- Government distribution of research **funding** depends on the results of the evaluation. *Ex-post* evaluations of university research performance used only to provide feedback to universities or to the government are not considered as PBF.
- The PBF system must be a **national or regional system**: intra-organisational funding allocation rules are not considered PBF.

On this basis, three main funding mechanisms related to performance may be identified. First some countries do not include any performance-based elements in their research funding system or they allocate funding exclusively based on education-related metrics or assessments (without research output considerations). Secondly, some other countries base their funding allocation on a set of quantitative and/or bibliometric criteria combined in a formula. The primary objective of the formula is to ensure equitable treatment of higher education institutions, by using the same criteria to evaluate performance. This approach enables transparency in funding decisions. The funding authorities typically define the variables and parameters in the formula, so as to closely align with the government's overarching higher education and research policy priorities. Thirdly, some countries allocate funding based on peer review exercises. This category can further differentiate between metric-based peer review and qualitative peer review.

In addition to these three main categories of PBF, an alternative option consists of the signing of performance contracts between universities and public funding bodies (e.g. ministries, funding agencies) to agree on a set of targets that universities or research centres need to achieve, in order to be eligible for part of the organisational level funding. Under this mechanism, the amount of core funding transferred to an institution is based on a negotiation between funding authorities and research-performing organisations.

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[20] Auranen, O., & Nieminen, M. (2010). University research funding and publication performance, an international comparison. *Research Policy*, 39: 822- 834. Lepori, B., van den Besselaar, P., Dinges, M., Potì, B., Reale, E., Slipersæter, S., Thèves, J., van der Meulen, B (2007). Comparing the evolution of national policies: what patterns of change?, *Science and Public Policy*, 34(6), 372-388

[21] Hicks, D. (2012). Performance-based university research funding systems. *Research Policy, 41*(2), 251-261. Zacharewicz, T., B. Lepori, E. Reale, and K. Jonkers. (2019). Performance-Based Research Funding in EU Member States—a Comparative Assessment. *Science and Public Policy* 46 (1): 105-15.

The PBF system can be applied to the total amount of public funding transferred to research-performing organisations or only to a percentage of this funding.[22]

4.1.2. Funding models of national research infrastructure

The European Commission defines research infrastructures as:

> "*Facilities that provide resources and services for the research communities to conduct research and foster innovation in their fields, including the associated human resources, major equipment or sets of instruments; knowledge-related facilities such as collections, archives or scientific data infrastructures; computing systems, communication networks and any other infrastructure of a unique nature and open to external users, essential to achieve excellence in R&I; they may, where relevant, be used beyond research, for example for education or public services, and they may be 'single sited', 'virtual' or 'distributed'."*[23]

While universities may provide RIs and facilities in addition to education, NRIs are dedicated to providing advanced research resources and related services on an international, national or regional level. NRIs are typically established and maintained by government agencies, research organisations, or consortia of universities and research institutions. In this context, funding of NRIs is focused on supporting the development and maintenance of the infrastructure, as well as the provision of high-quality research resources and services to researchers and other users (which can include businesses), in the country or region. The mechanisms of funding of NRIs differ widely across countries with some countries encouraging joint investment by the private sector (see example of Flemish funding model).

In Flanders (Belgium), for large infrastructures, the Flemish funding agency funding provides as a baseline 70% of total costs for RIs, implying 30% cofounding by partners. However, the maximum funding is 90% if the infrastructure is proposed by a consortium and this can be raised to 100% if there is an in-kind contribution of "third parties", which means private companies producing or selling large infrastructures/equipment (the third parties do not receive a subsidy).

- 90% of the subsidisable costs if the proposal is made by research groups from more than one subsidy-eligible body and it is demonstrated in the application that all applicants account for at least half of the amount they would have to pay if the remaining 10% of the subsidisable costs were proportionately distributed;
- 100% of the portion of the subsidisable costs to be funded by the university or university college itself if at least 25% of the eligible costs are borne by a body other than a higher education institution.

An example is given below for a €2m total cost investment involving three partners.

Body	% cost	% subsidy	cost to be borne
University	35%	100% (= € 700,000)	€ 0

[22] An EC study (EC, Jongbloed et al (2023)) quantified the degree of performance-orientation research funding in each EU Member State and categorised the modalities of research assessments.

[23] Regulation (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013 (Text with EEA relevance). ELI: http://data.europa.eu/eli/reg/2021/695/oj

Strategic research centre	35%	90% (= € 630,000)	€ 70,000
Third party (company)	30%	0%	€ 600,000

An example of a large RI developed and jointly operated by a consortium involving industrial partners is the HAXPES-Lab. The Hard X-ray PhotoElectron Spectroscopy (HAXPES) tool consists of an integrated (and automated) system including X-ray sources. HAXPES is a rapidly evolving analytical method providing much needed insight into material interactions at surfaces and buried layers and interfaces. A consortium composed of Flemish academic and industrial partners created an easily accessible HAXPES user platform to boost applied research in areas like batteries, photovoltaics, catalysis, corrosion prevention and semiconductor devices. The presence of the manufacturer of the tool within the consortium and the complementary research by the partners on the fundamentals of HAXPES also contribute to the further optimisation of this emerging technology and enables its quantitative application. The multiuser facility leverages the extensive analytical portfolio and knowledge base available within the consortium which is composed of: UHasselt, VUB, KUL, Imec, Toyota-BE, Solvay and Scienta Omicron.

The cost categories eligible for subsidies are as follows in Flanders:

- Equipment: Costs for research investments, i.e. the costs of purchasing and connecting the research infrastructure or purchasing the components for the construction of the planned research infrastructure, including the non-refundable portion of VAT. This also includes the upgrading, i.e. the substantial improvement of existing research
- infrastructure;
- Personnel costs for the development and construction of the research infrastructure. This also includes the personnel costs for upgrading the research infrastructure and the costs for the operational or maintenance personnel once the infrastructure is up and running;
- Operational costs consisting of maintenance costs over the entire depreciation period, i.e. the costs arising from maintenance agreements or research infrastructure upgrades and equipment repairs.

The overhead percentage applicable to research infrastructure projects is 10%. This overhead must be used primarily to cover the costs for modifications to buildings and connection costs relating to the research infrastructure.

With respect to personnel costs for the permanent maintenance and operation of the research infrastructure, account is made of the costs for personnel already in service at the host institution on a permanent or contractual basis, the current wage cost for that personnel will be included in the budget in part or in full as a cost eligible for subsidy (based on the total hours per month spent on permanent maintenance and operation by that personnel).

Costs for training, education and retraining of personnel on the use of the research infrastructure are eligible for subsidy. These are considered as maintenance costs, more particularly personnel costs for permanent maintenance and operation of the research infrastructure. To enable the operation of the research infrastructure, either competent personnel must be recruited or already employed personnel must be trained and/or retrained.

Figure 8: Joint public-private investment in RIs model – Flanders (Belgium)

Sources: https://www.fwo.be/en/fellowships-funding/research-infrastructure/large-scale-research-infrastructure/ and https://researchportal.be/en/project/high-energy-photoemission-easily-accessible-user-facility-surface-and-interfacial-analysis

The OECD (OECD, 2020) identified and analysed the tools and options used by countries for long-term planning, investment policies and life-cycle management of RIs. This analysis focused on how portfolio managers (at agency or ministry level) reconciled the need for flexibility in funding with financial constraints. To do so, two surveys were conducted of national funders, policy-makers and RI managers. The results emphasised that national

governments and agencies are implementing a wide range of approaches for funding and strategic planning. For example, Norway has a clear road-mapping process covering all NRIs and managed by the Norwegian Research Council, funding the capital and start-up costs, with operational funding coming from user research grants or institutional funds. In contrast, Australia releases a roadmap every five years and supplements it with an investment plan every two years. This investment plan is based on a strategic approach elaborated by national authorities and involves co-investment from state authorities and users.

Within this broad range of funding approaches, two different models from the Czech Republic and the Basque Country (Spain) may be used as case-studies, as they highlight two notable perspectives on evaluation and funding allocations. While the Czech Republic has developed a peer-review evaluation system to assess NRIs' activities and performance, the Basque authorities rely on a quantitative and indicator-based approach to evaluate the activities of regional research and technology organisations. In both cases, funding is subsequently allocated based on evaluation results.

In the Czech Republic, the R&D budget is allocated through two main funding categories, namely targeted support and institutional support. Institutional support is primarily intended for financing research institutions of the Academy of Sciences and other research organisations, based on their performance in the previous budget period. Targeted support, on the other hand, is meant for supporting specific objectives and programmes managed by the Ministry of Education, Youth and Sports (MEYS), the Technology Agency, or the Ministry of Trade and Industry. An example of such a programme is the large RI projects programme, which falls under the jurisdiction of the MEYS. Institutional support is also utilised to cover membership fees for ERICs and international organisations. In addition, the ERDF plays a crucial role as a significant source of funding for R&I. Between 2014 and 2017, both existing RIs and new proposals in the Czech Republic underwent a two-stage evaluation process by international scientific panels.

In 2014, the MEYS carried out a comprehensive assessment of all RIs, regardless of their funding source or lifecycle stage. The evaluation was conducted in two stages by an International Evaluation Committee, consisting of experts from six scientific areas (Social Sciences and Humanities, Environmental Sciences, Material Physics and Space, Informatics/e-infrastructure, Energy and Biomedicine). The first stage evaluated proposals based on the definition of research infrastructure, while the second stage assessed the quality of the RIs.

The definition of research infrastructure included three main elements: the operation of unique technological R&D facilities, nationwide importance and impact, and open access policies. Proposals that passed the first stage were further evaluated, based on several criteria related to their socio-economic impact; uniqueness of technological facilities; management and sustainable development strategy; open access policy; R&D strategy; cooperation with other research organisations and RIs 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; and potential for the development of new technologies.[24]

[24] Some criteria, such as the uniqueness of technological R&D facilities and open access policies, are found in both stages of the evaluation. While the first stage makes a preliminary assessment of the inclusion of the main characteristics linked to these elements, the second stage of the evaluation focuses on the quality of both uniqueness of technological R&D facilities (e.g. analysing the technological level and knowledge intensity of activities) and of open access policies (e.g. whether open access provides access to a broad range of potential users from the R&D community).

During the second stage, scientific panels of experts reviewed self-assessment reports from RI managers, assessment reports from scientific advisory boards, and conducted interviews with management representatives of the RIs. Panel evaluations are discussed during joint sessions coordinated by the head of the international evaluation committee. Prior to financial decisions, RI managers are asked to present and explain their budget proposal.

The evaluation resulted in 58 positively evaluated RIs, including 42 high priority RIs recommended for public funding by the international evaluation committee, according to a rating from A1 (highest priority) to A4 (lowest priority). These four performance-related groups indicated the priority for public funding in direct proportion to the quality-differentiated output of the evaluation. Following this classification, a landscape analysis was conducted by the expert working groups and consisted of "*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)".* On this basis, the determination on the allocation of funds is made by the government and carried out by the ministry.

More information about the Czech case is available through the InRoad project, *D3.3. Good practices and common trends of national research infrastructure roadmapping procedures and evaluation mechanisms.*[25]

Figure 9. Peer-review assessment system of NRIs in Czech Republic

In the Basque Country, around half of the income of RTOs (Research and Technology Organisations) comes from companies (via contract research). The other half is made up of public funding: around 20% is basic funding from the Basque government, and the other part, around 30%, is made up of competitive funding from R&D programmes (European, Spanish, and Basque). The main mission of RTOs is to contribute to the strength of the Basque industry and economy. RTOs are part of the 'Basque Network of Science, Technology, and Innovation' (RVCTI), created in 1997. The RVCTI is composed of different types of agents: 'singular agents', university research structures, centres for fundamental and excellence research, cooperative research centres, multifunctional technology centres, sectoral technology centres, health innovation centres, R&D organisations in the health sector, R&D units of companies, intermediation agents between supply and demand, and agents for the dissemination of science, technology, and innovation.

A decree from 2015 regulates the RVCTI, based on the strategy defined in the 2020 Science, Technology, and Innovation Plan (PCTI), the S3 strategy for the 2014-2020 period of the Basque Country. The objective was to increase the efficiency and results orientation of the RVCTI agents and to improve their value contribution to the productive and social fabric of the Basque Country, through collaboration and complementarity. To this end, the Basque government designed a results-oriented model based on a balanced scorecard that details the indicators, weights, and objectives to be achieved depending on the nature of each agent. This model aimed to develop a more market-oriented scientific and technological activity, to concentrate activity in the three areas of smart specialisation of the Basque Country (advanced manufacturing, energy, biosciences/health) in order to increase productivity and quality, to improve the excellence of all RVCTI agents, and to strengthen collaborative research.

The decree specifies for each type of agent the indicators in four main groups: R&D activity mix (basic research, industrial research, experimental development), the distribution of activity by S3

[25] This deliverable is available at: http://inroad.eu/wp-content/uploads/2018/12/D3.3_Good_practices_and_common_trends_of_national_research_infrastructure_roadmapping_procedures_and_evaluation_mechanisms.pdf Consulted on 26.04.2023.

specialisation area, excellence indicators (publications, patents, jobs created in technology-based companies), and interactions in the R&I system (private funding, collaboration among RVCTI agents, international cooperation). The two indicators of international cooperation relate to the percentage of funding received from the Horizon programme (or other European or international programmes) and the number of European (international) projects of the RTO in which they involve a partner (Basque) company.

Assessment indicators of research and technology organisations in the Basque Country

Category		Indicator	Unit	Weight	Objective
R&D activity mix		R&D activity - % expenditure on Fundamental Research - % expenditure on Industrial Research - % expenditure on Experimental Development	 % % %	10% 3.3% 3.3% 3.3%	 10% 60% 30%
Specialisation		- Percentage of R&D expenditure in Advanced Manufacturing -;Percentage of R&D expenditure in energy - Percentage of R&D expenditure in biosciences and health	% % %	10%	90%
Excellence	Basic research	-Scientific indexed publications -Scientific publications in the first quartile (Q1)	Nº Nº	2% 2%	20 10
	Industrial Research	-EP0 and PCT patent applications -Revenue from licences and patents	Nº €	12% 12%	3 400
	Experimental research	-New jobs created -Revenue attracted	Jobs €	6% 6%	20 3,500
Relationship model	Transfer to the market	-% Total private funding -Researchers transferred to Basque companies	% % Nº	5% 5% 5%	40% 50% 12
	Collaboration among RVCTI agents	-Co-supervision of doctoral theses -Co-authorship of scientific publications - Co-invention of patents	Nº Nº Nº	5% 5% 5%	8 8 1
	International collaboration	-% of international public funding -International projects with business presence	% %	5% 5%	15% 50%

Figure 10. Quantitative assessment of research and technology organisations in the Basque Country

Source: Reid, A. (2021) Unpublished case-study report.

4.1.3. Research funding in Greece

This section first presents the reform of research funding implemented in 2023, which introduced a form of performance-based funding for Greek universities. Secondly, it explains the current funding schemes of NRIs. Finally, it analyses the future funding needs of NRIs.

4.1.3.1. The introduction of PBF for Greek universities

In 2023, a reform of the funding mechanisms for Higher Education Institutions (HEIs), designed by the HAHE, was introduced and specifically focused on an annual allocation of 20% of institutional funding on the basis of performance-based criteria. This funding scheme is based on a five-step process, in which the HAHE evaluates universities' performance, while the responsibility for funding lies with the MERAS.

First, each HEI is requested to submit an activity report focusing on its achievements and including quality indicators each year. Each institution is asked to select three modules for its evaluations, consisting of one mandatory module and two out of four optional ones, and to provide values for each criterion included in these modules. Modules include (1) the continuous improvement of basic academic activities (compulsory), (2) research activity and excellence, (3) connection with society and the labour market, (4) internationalisation, and (5) quality of the university environment. This possibility for universities to choose the modules on which their performance will be evaluated is intended to account for the diversity of institutions, academic fields and orientation (e.g. basic or applied research).

Secondly, each HEI must calculate and document the value provided for each indicator. The calculations are based on the Integrated National Quality Information System (OPESP) data and other publicly available data at international and national levels, or on other sources of information of each institution for each criterion and indicator. The values of each indicator provided must be documented by specific back-up documents.

Thirdly, each indicator is evaluated and given a score, based on the method provided by HAHE. Fourthly, the evaluation of HEI performance reports and their related score is conducted by HAHE. Finally, a share of the 20% of institutional funding based on performance is calculated for each HEI, on the basis of the score previously obtained.

This PBF system implemented for the allocation of 20% of institutional funding to universities, and dependent on the calculation of a funding formula, is in line with funding systems implemented in a majority of EU countries.[26] This mechanism, and the different evaluation criteria it is based on, help to steer the activities of Greek HEIs towards national priorities, including research excellence as well as economic and societal impact. Within this funding scheme, the possibility for Greek HEIs to choose some of the categories on which their performance is evaluated considers the diversity of their activities and outputs and introduces some flexibility in the assessment.

4.1.3.2. Existing sources of funding for Greek NRIs

The funding sources of the NRIs were analysed in the background report of the 2022 PSF Country exercise (Strogylopoulos & Paliogiannis (2022 p.87-96)). Through a survey, each of the 28 Greek NRIs was asked to describe its sources of funding. The findings were:

- The ERDF co-financed EPANEK operational programme (2014-2020) was the primary source of support for all NRIs (all NRIs were in receipt of a grant from EPANEK).

[26] For a comparative assessment of PBF evaluation practices, see summary table in the following document: European Commission, Directorate-General for Education, Youth, Sport and Culture, Jongbloed, B., McGrath, C., Boer, H.et al., *Final report of the study on the state and effectiveness of national funding systems of higher education to support the European universities initiative. Volume I*, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2766/885757

- The other main source of support for 61% of the NRIs is the allocation of funds individually obtained by the participating partners.
- Half (50%) of the NRIs have secured funding from various other sources, such as donations, grants, and contracts with public authorities.
- Around 43% of the NRIs use money from nationally funded projects.
- Around a third (32%) of the NRIs depend on their partners' institutional funding from the State budget, which covers permanent staff salaries and infrastructure expenses.
- Six NRIs (21%) use services provided by the partners as an additional source of support.
- Only four NRIs (14%), at the time of the survey in early 2022, had generated income from provision of services: Innovation-EL, EATRIS-GR, HELLAS-CH, and PlantUp.

4.1.3.3. Funding needs of Greek NRIs

An analysis of the funding needs of Greek NRIs was conducted for the PSF Country background report. It found that the acquisition and maintenance of equipment are a key financial concern for all NRIs, independently of their maturity stage, as 96% of NRIs highlight this as their most important issue. The increase of funding capacity to develop new services is considered equally important, because the same share of NRIs (96%) view it as a very important financial need. In addition, most NRIs mention that their financial sustainability is directly related to the employment of permanent staff (although temporary staff is considered equally important). This is a common problem in Greece, since new permanent or tenure positions are very limited. Overheads are also considered an important cost category.

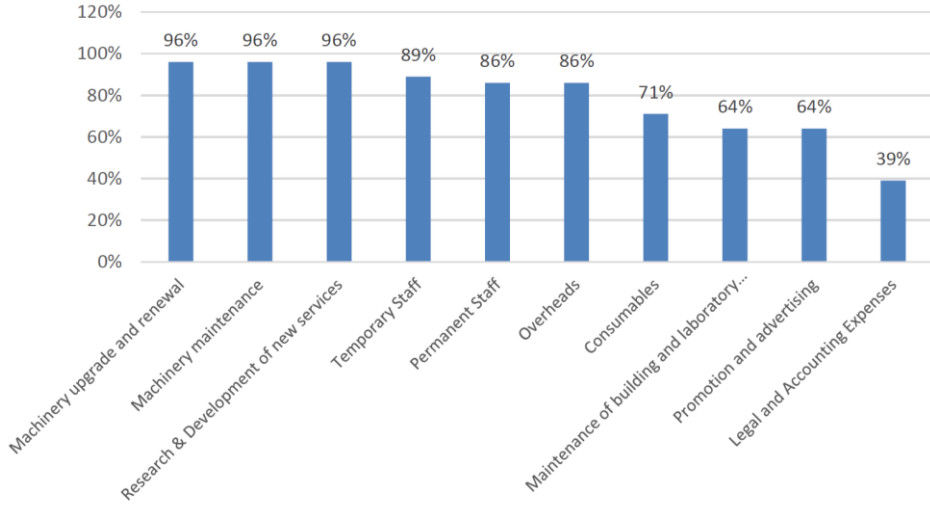

Figure 11. Percentage of NRIs ranking cost groups as "very important" or "quite important"

Source: Strogylopoulos & Paliogiannis (2022), p.97

All NRIs consider the promotion and advertising of their activity as an important financial concern, although not as the most important one. Nevertheless, participation in international networks and networking with European and other national RIs and innovative SMEs, is considered critical for their development

4.2. Overview of proposed actions to meet the PSF recommendations

The aim is to design a funding system to progressively enhance the performance and long-term sustainability of Greek NRIs. The implementation plan builds on international best practices for defining a sound assessment and funding framework. In addition, the plan considers the specificities of the Greek research funding structure and recent developments in the implementation of a performance-based funding system for Greek HEIs.

One main question arises when designing funding mechanisms to enhance performance: what is the general objective of these funding schemes? Beyond the capacity to deliver R&I outputs or to foster collaboration with private stakeholders, the key policy priority underlying the development of PBF instruments is to incentivise the elaboration of a long-term vision and the sustainability of NRIs. Long-term sustainability is defined by the European Investment Bank (EIB) as a compendium of practices aiming to (a) ensure strong governance, transparency and accountability for the use of public funds; (b) integrate high environmental, technical and social standards into business activities, by linking research to innovation outcomes; and (3) minimise risks and deliver results.[27] These practices were recently further described by the ERIC Forum Implementation Project[28].

Note: This scheme highlights the dimensions of an ERIC sustainability model. The colours of the various elements indicate the average level of expression of each element by the ERICs (green: the element is positively expressed; orange: the element is partly expressed; red: the element is marginally or not-at-all expressed;).

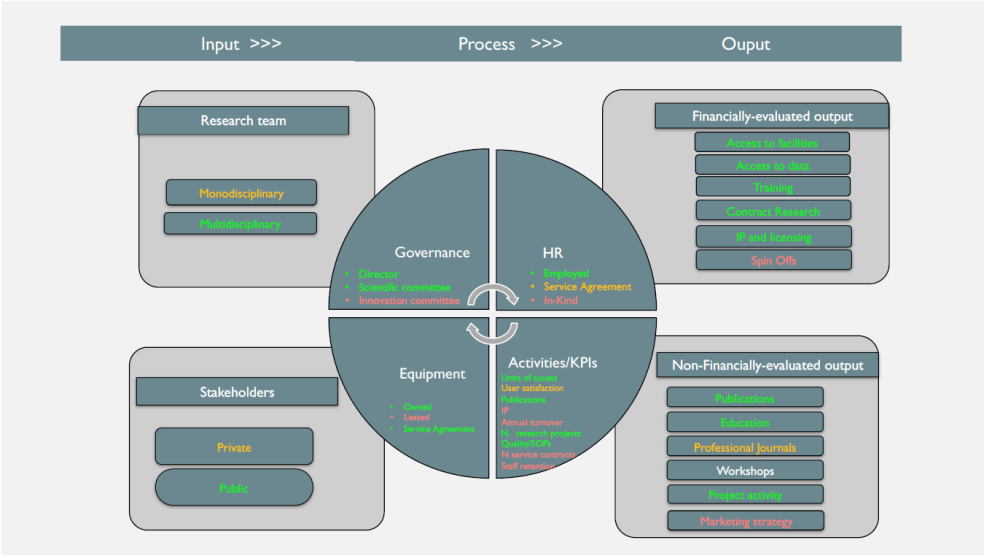

Figure 12. Research Infrastructure Sustainability Model Template

Source: ERIC Forum Implementation Project, D4.4 (2022).

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27 Antonella Calvia Goetz, EIB, 'Sustainability Issues in funding research infrastructure', presentation at the Symposium on European Funding Instruments for the development of Research Infrastructures, Madrid, 2016.

28 ERIC Forum Implementation Project, Report and proposal for a model sustainability plan for ERICS, Work Package 4 – Deliverable 4.4, 2022. https://www.eric-forum.eu/wp-content/uploads/ERICForum_Deliverable-4.4_Final_v2.pdf

This framework can be used for a qualitative analysis of RI sustainability. Though this framework was specifically designed for European-level (ERICs) research infrastructures, it provides useful insights for developing sustainability targets to be incentivised through a performance-focused funding scheme of Greek NRIs. In particular, it suggests an 'input-process-output' transformation process for value creation (ERIC Forum Implementation Project, D4.4, 2022, p.27).

On the input side, most ERICs favour multidisciplinary approaches, which enable them to tackle research questions from diverse angles as well as to attract researchers from different academic disciplines. This can significantly enhance RI activities and foster the overall 'productivity' of the RI system. A second issue about the sustainability of RIs is linked to the nature of their stakeholders. The public ownership of RIs is a common feature for the majority of ESFRI RIs, 94% of the ESFRI RIs' stakeholders are public, and only a few RIs have private stakeholders. This is also the case for all the Greek NRIs.

The process part of the model consists of four dimensions. The first one refers to the governance of RIs and underlines that most well-established RIs have developed similar governance mechanisms and bodies, typically comprising a strategic management board, a general director, and an internal scientific committee. The second dimension of governance is linked to the nature of human resources, as most staff of RIs should be permanent. This provides stability and continuity to the organisation, while allowing for consistent operations and the ability to build capacity over time. The third dimension of governance is linked to the ownership of the equipment, which is generally partly owned and partly in use through service agreements. Finally, the fourth dimension of governance refers to the main activities performed by RI. Service provision is the most typical activity and is generally divided between access to data, training services, access to facilities and research services. The second and third most typical activities of service provision are research and training, and, to a lesser extent, education.

In terms of output, the model distinguished between financially evaluated outputs and non-financially evaluated outputs. The former category refers to outputs linked to access to facilities or data, training, contract research, IP and licensing and to a lesser extent through spin-offs. Non-financially evaluated outputs refer to publications and educational or training activities.

On this basis, the implementation plan of a performance-based funding system for Greek NRIs is structured in a three-step approach. The first step is directly inspired from the ERIC sustainability model and aims to develop a long-term sustainability (LTS) plan for the NRIs though (a) the definition of LTS objectives and (b) the elaboration of a pathway to achieve them. The second step involves defining the funding scheme to enhance performance through the definition of (c) the share of funding tied to performance, (d) the periodicity of the assessment, and (e) the modalities of the assessment. Finally, the third step is the implementation of the PBF scheme through (a) the first phase of the evaluation (eligibility criteria), (b) the second phase of the evaluation (quality criteria), and (c) the funding decision.

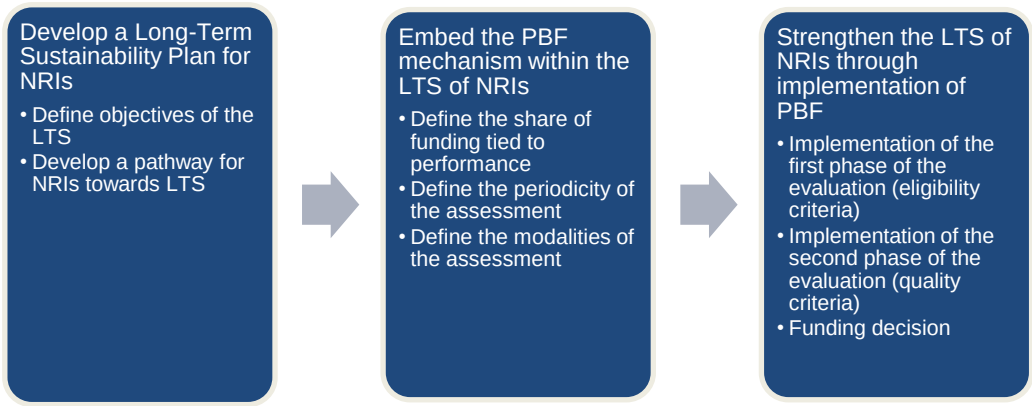

Figure 13. Implementation plan for the evaluation of Greek NRIs

Source: authors

4.3. Description of the proposed actions

Action 1.1	**Phase 1 – Define the objective of the Long-Term Sustainability plan**
Action owner(s)	GSRI
Timeframe	Second semester 2023
Resources	Human resources
Description of the action	Following the framework designed by the ERIC forum, the national LTS plan should focus on the definition of a general vision for Greek NRIs, including: • Inputs – A multidisciplinary approach of research activities should be incentivised. – Given the mainly public nature of the NRIs' stakeholders and the public funding, the NRIs should contribute to achieving national strategic goals. • Process – A clear governance framework and management structure including, at a minimum, a strategic management board, a general director/manager, and an internal scientific committee. – A human resource policy favouring the permanency of staff. – A set of NRIs' activities articulated around research services, access to data and facilities (including a clear access policy), training services and education. • Outputs. A set of NRIs' outputs linked to financially and non-financially evaluated outputs should be defined and may include: – Financially evaluated outputs: access to facility and data, training, contract research, IP and licensing, and spin-offs.

	– Non-financially evaluated outputs: publication, education, professional journals, workshop, research project activity, and marketing strategy.
Milestones	• The general vision for Greek NRIs should be released together with the next call for funding.

Action 1.2	**Phase 1 – Develop a pathway for NRIs towards long-term sustainability.**
Action owner(s)	GSRI and NRIs
Timeframe	Second semester 2023
Resources	Human resources
Description of the action	• Following the national Long-Term Sustainability plan for NRIs, this second action aims to develop a pathway towards sustainability with each of the six main groups of Greek NRIs.[29] To do so, we recommend the implementation of agreements with each NRI selected for funding during the 2021-2027 period. These agreements should include measurable performance standards through key performance indicators (KPIs) and performance targets to be reached. • A proposed NRI performance reporting template is included in annex 8.5. • The list of KPIs to be used to reflect the specific role of RIs in the national R&I system is included in annex 8.4 .
Milestones	• The KPIs will be agreed as part of the application for funding and contract negotiations for the new round of NRI funding. As outlined in implementation plan 2, guidance and support should be provided to the NRIs in selecting KPIs.

Action 1.3	**Phase 2 – Define the share of funding tied to performance**
Action owner(s)	GSRI
Timeframe	Second semester 2023
Resources	Human resources
Description of the action	• The performance bonus linked to criteria compliance should be high enough to be considered as an incentive and should steer the activity of NRIs. At the same time, the bonus should not exceed a threshold that would create too much uncertainty in a context in which Greek NRIs already exclusively rely on competitive project funding.

[29] The six groups refer to NRIs in the following categories: (1) agri-food, (2) energy, (3) environment and sustainable development, (4) health and pharmaceuticals, (5) physical science and materials, and (6) data and digital research infrastructures. NRIs falling under the seventh ESFRI grouping (social and cultural innovation) are included in category 6, under data and digital research infrastructures.

	• **We therefore recommend fixing this performance bonus between a minimum of 10% and a maximum of 20% of total funding.**
Milestones	• The level should be set prior to the release of the next call for funding.

Action 1.4	**Phase 2 – Define the periodicity of the assessment**
Action owner(s)	GSRI
Timeframe	Second semester 2023
Resources	Human resources
Description of the action	The periodicity of the assessment is a key feature to be considered when evaluating the performance of NRIs. It should be long enough to allow for the implementation of NRIs' activity, while not exceeding the funding period. Therefore we recommend a minimum of 2-3 years after the award of the grants and one to two years after the end of the funding period. The assessment should be aligned with the NRI peer review cycle, as defined below.
Milestones	• The periodicity of the assessment should be defined prior to the release of the call for applications for NRI funding (September 2023).

Action 1.5	**Phase 2 – Define the modalities of the assessment**
Action owner(s)	GSRI
Timeframe	Second semester 2023 to first semester 2024
Resources	Human resources
Description of the action	We recommend conducting a peer-review assessment of NRIs' performance. To conduct the evaluation, the GSRI will establish an International Evaluation Committee, which will be chaired by an impartial and internationally recognised expert in the fields of RIsand R&D policy. The remaining members of the Committee will also be experts in their respective R&D fields. The International Evaluation Committee will be composed of a chair and six scientific panels consisting of at least three members evaluating each group of NRIs in the fields defined in the PSF Country report: agri-food, energy, environment and sustainable development, health and pharmaceutical, physical sciences and materials, data and digital infrastructure. It would be advisable to have the same experts on horizontal aspects such as governance and digital/e-needs aspects across more than one domain. This would be similarly to the ESFRI procedure for project proposal evaluations and for the monitoring of landmarks. We recommend that every scientific panel of the International Evaluation Committee includes one Greek Member, so that the scientific panel may be provided with

	information about the RI landscape and R&I system in Greece. Chairs of the scientific panels should always be foreign.
Milestones	The modalities of the assessment should be defined by the end of 2023 or in the first semester of 2024.

Action 1.6	**Phase 3 – Application of the eligibility criteria during the selection process**
Action owner(s)	GSRI
Timeframe	By mid-2024
Resources	Human resources. International Evaluation Committee, composed of six scientific panels, plus a chair. Each panel should be composed of at least three experts (among which one Greek member). The evaluation may be done remotely.
Description of the action	The first stage of the evaluation relies on the assessment of eligibility criteria. The examination of these criteria aims to assess the nature of the applicant RI and whether it encompasses a Long-Term Sustainability plan. It should be tied to the funding decision made for the period 2024-2027. To do so, the eligibility criteria are organised in three main categories: • Operating a unique or a main R&I facility at national level with a clear vision and mission statement. • Managing the NRI in accordance with the national LTS plan for RIs, with the general vision for Greek NRIs; and with international best practices for access policy or commitment to develop a clear access policy for the upcoming funding period. • Demonstrating a positive effect on public services, culture, the economy, health, or the environment beyond the scientific community. Six scientific panels in the International Evaluation Committee should evaluate the fulfilment of the three eligibility criteria.[30] Applicants not complying with these criteria will be excluded from the second stage of the evaluation (action 1.7). The evaluation form design may be inspired by the 'Evaluation Form A' used by the Czech MEYS to assess the quality of Czech NRIs.[31]
Milestones	Funding decision made for NRI for the period 2024-2027 by the Ministry of Development and Management Authorities.

[30] While the evaluation of the eligibility criteria would ideally be performed by six different scientific panels and follow the categorisation of NRIs in six groups, it may be possible to reduce the number of panels for the first phase of the evaluation.

[31] The document can be downloaded at this address: https://www.msmt.cz/file/39360_1_1/ (consulted on 26.04.2023).

Action 1.7	**Phase 3 – Implementation of the second phase of evaluation (quality criteria)**
Action owner(s)	GSRI
Timeframe	By December 2026
Resources	Human resources. International Evaluation Committee, composed of six scientific panels, plus a chair. Each panel should be composed of at least three experts (among which one Greek member). Part of the evaluation of the KPIs may be done remotely; interviews of management representatives of each of the NRIs will be done in Greece.
Description of the action	The quality criteria should be based on the KPI defined in implementation plan 2 (section 5.2). The evaluation will be conducted in three steps: • First, each scientific panel will provide an assessment of each NRI performance on the basis of the KPIs and performance targets. As a complement to the evaluation of quality criteria, interviews of the scientific panels with management representatives of each NRI will be organised to complement the information included in each application. • Harmonisation of the evaluation results will be done in a cross-panel session, chaired by the head of the International Evaluation Committee • A 'consensus report', produced by each scientific panel and including an evaluation of the quality of each of the NRIs and recommendations for funding, should be provided to the relevant ministry/GSRI. The evaluation framework described above aims to provide a quality assessment of NRIs. NRIs will be classified according to this evaluation scale: **GROUP 1** The NRI stands out for its exceptional quality in terms of its uniqueness, novelty, significance, and influence on its users. The RI's relevance is crucial for the Greek R&I system, and it plays an essential role in contributing to national development priorities. **GROUP 2** The NRI shows high quality and potential, but it does not reach the highest standards in terms of its uniqueness, originality, significance, and impact on its user community. Nevertheless, the RI remains highly pertinent for the Greek R&I system's future development, significantly contributing to national development priorities. **GROUP 3** The NRI's quality enable the provision of good-quality services in its field. The NRI offers substantial potential for future use and is relevant for the Greek R&I system's future development. However, it does not play an essential role in contributing to national development priorities. **GROUP 4** The NRI's quality and potential allow it to make a contribution to the provision of services in its sphere. Nonetheless, due to its small user community, low significance, and limited relevance for the Greek R&I system's future development, the RI's impact is relatively minor. **GROUP 5**

Action 1.7	**Phase 3 – Implementation of the second phase of evaluation (quality criteria)**
	The NRI does not meet the necessary level for providing relevant services at national or international level, and it lacks the potential to become a significant element in the Greek R&I system's future development. **We recommend** aligning the evaluation scale to this funding framework: • NRIs in group 1 should be provided from 75% to 100% of the financial bonus. • NRIs in group 2 should be provided from 50% to 75% of the financial bonus. • NRIs in group 3 should be provided from 25% to 50% of the financial bonus. • NRIs in group 4 should be provided less than 25% of the financial bonus. • NRIs in group 5 should not be provided any additional funding.
Milestones	The second phase of the evaluation should be over by December 2026.

Action 1.8	**Phase 3 – Publication of evaluation results and funding decision**
Action owner(s)	GSRI
Timeframe	First semester 2027 – before the end of next funding period
Resources	Regulatory/administrative measures
Description of the action	The relevant ministry/GSRI will communicate to NRIs the results of the evaluation and the funding decision.
Milestones	The funding decision should be communicated before the end of the next funding period.

5. Implementation plan 2: a monitoring and evaluation framework for the NRIs

This section addresses the request for the development of a set of key performance indicators (KPIs) that reflect the role of the NRIs in the national R&I system, as referenced in recommendation 4.1.5 of the PSF Country Report.

5.1. Review of the state of the art in Greece compared to European and international practice

RIs are part of national, European and international R&I systems and their activities contribute to enhancing research capacities in specific fields. They also generate, through the experiments conducted or data curated and made available, research results that may be exploited by other researchers, businesses, the public sector, etc. In the context of an overall policy cycle (Figure 14), there is a need to set up the monitoring and evaluation framework of RIs':

- Progress to meeting performance targets set by the management team or by funding bodies, e.g. based on their inclusion in a national research infrastructure roadmap and/or following a call for funding applications; and
- Medium to long-term socio-economic impact (usually within the framework of objectives set by a national strategy, such as a S3).

Figure 14. Policy cycle for research infrastructures

Source: Griniece et al (2020).

Over the last decade, the European RI policy framework, including monitoring and evaluation (M&E) methods and tools, has been developed. This has happened notably under the European Strategy Forum on Research Infrastructures (ESFRI), as well as by initiatives and projects conducted and/or funded by the EC, the OECD and national governments.

5.1.1. ESFRI landmark monitoring and indicator framework

At European level, ESFRI provides the crucial governance framework that helps steer the RI policy cycle, including the monitoring of performance (KPIs, monitoring reviews). ESFRI defines monitoring as "*the continuous process of examining the performance of an RI including the delivery of outputs and supply of services to intended users*". Monitoring is often linked to an interim (and final) evaluation: the timing is usually related to the funding cycle of the RI rather than necessarily being linked to the lifecycle stage (see

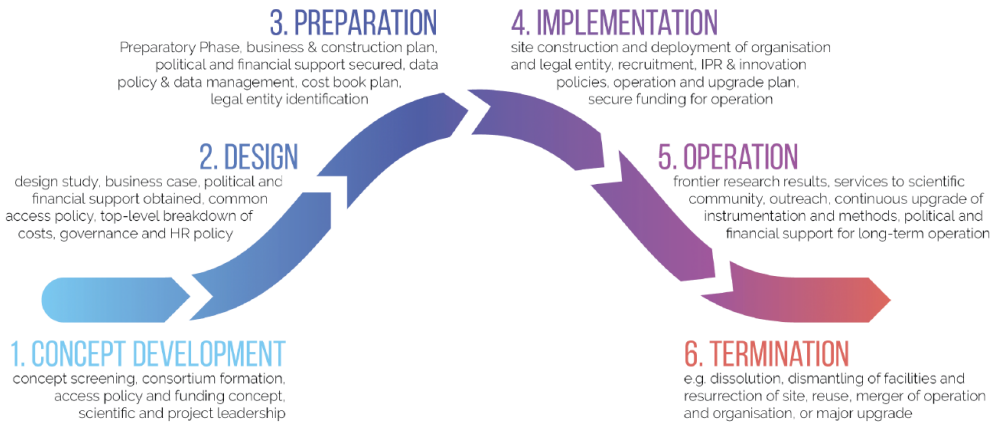

Figure 15).

Figure 15. ESFRI RI lifecycle model

Source: ESFRI Roadmap 2021 Public Guide

Since 2018, a number of ESFRI working groups have contributed to developing a monitoring framework[32] for the ESFRI Landmark RIs,[33] including an overall process, self-assessment and peer review reporting templates and KPIs.

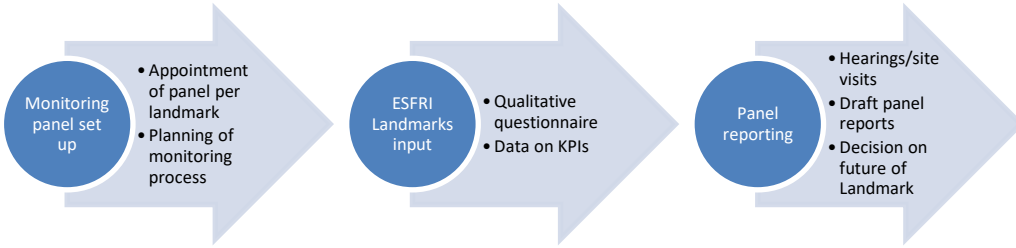

Figure 16. ESFRI Landmark RIs monitoring framework

Source: authors based on ESFRI material

[32] See: https://www.esfri.eu/monitoring

[33] The ESFRI Landmarks are RIs that were implemented, or reached an advanced implementation phase under the ESFRI Roadmap. See: https://roadmap2021.esfri.eu/projects-and-landmarks/

In 2019, an ESFRI Working Group developed a set of KPIs for monitoring[34] that were discussed in several working meetings and through a survey of the ESFRI community (policy-makers and ESFRI RI managers/coordinators) (ESFRI, 2019c).

Objective	*KPIs*
Enabling scientific excellence	*1. Number of user requests for access* *2. Number of users served* *3. Number of publications* *4. Percentage of top (10%) cited publications*
Delivery of education and training	*5. Number of master and PhD students using the RI* *6. Training of people who are not RI staff*
Enhancing collaboration in Europe	*7. Number of members of the RI from ESFRI countries* *8. Share of users and publications per ESFRI member country*
Facilitating economic activities	*9. Share of users associated with industry and publications with industry* *10. Income from commercial activities and the number of entities paying for service*
Outreach to the public	*11. Engagement achieved by direct contact* *12. Outreach through media* *13. Outreach via the RI's own web and social media*
Optimising data use	*14. Number of publicly available data sets used externally*
Provision of scientific advice	*15. Participation by RIs in policy-related activities* *16. Citations in policy-related publications*
Facilitating international cooperation	*17. Share of users and publications per non-ESFRI member country* *18. International trainees* *19. Number of members of the RI from non-ESFRI countries*
Optimising management	*20. Revenues* *21. Extent of resources made available*

Figure 17. ESFRI monitoring framework – key performance indicators

Source: ESFRI (2019c)

The ESFRI working group recommended that all KPIs should be adjusted to the objectives of RIs and fulfil the RACER criteria: relevant, accepted, credible, easy to monitor, robust. Each KPI should be accompanied by a reference sheet that provides a definition, data source(s), method of calculation, and other information concerning the calculation or applicability.

The ESFRI Landmark Monitoring 2022-2024 First Batch Report (ESFRI, 2023b) drew several conclusions from the early implementation of the monitoring framework. These include:

[34] https://www.esfri.eu/latest-esfri-news/report-esfri-working-group-monitoring-ris-performance

- RIs found the monitoring framework and monitoring report template useful both for their own needs and for reporting to authorities/funding agencies.
- Most RIs are still working with developing KPIs, at different levels, and some RIs will need to invest more in collecting and categorising relevant data. Most RIs have only started an effort to develop KPIs in recent years. Those with longer standing KPIs are adapting their KPIs in line with the ESFRI KPIs, while others are working to adopt KPIs suitable for their own needs.
- Some RIs have difficulties in selecting such KPIs suited to the activities of their organisations, so further training and guidance are required. It was also helpful that the panels could discuss the KPIs before the landmarks filled out the questionnaire, while prior discussion improved the quality of the monitoring exercises.
- Socio-economic impact is difficult to measure for many of the RIs, but they all provide some form of evidence.
- The main threat to RIs is long-term sustainability, e.g. in terms of insecurity about membership of organisations and the commitment of countries, as well as the available and secured funding, given strong competition for funding and uncertainty about the funding and support landscape (at national levels, etc.)
- From a procedural viewpoint, the monitoring panels timeframe proved too tight. For subsequent exercises, the planning of events and requests to RIs should be spread out a little more.

Overall, it can be concluded that the landmark monitoring framework and KPIs provide a good model for developing similar exercises at a national level, as in the Greek case.

5.1.2. RI impact assessment

The monitoring of KPIs during the RI project lifecycle provides a basis for the evaluation and impact assessment of RIs. While evaluation is not directly under the responsibility of ESFRI, ESFRI has recently published a policy brief on RI impact assessment (Kolar et al, 2023)[35] which builds on past work done by the OECD and through the Horizon 2020 RI-PATHS project[36]. It also cites national good practice including the previous PSF Country assessment study for Greece.

The impact assessment framework developed by RI-PATHS (Figure 18) distinguished between three 'spheres' for which the activities, outcomes and impact of an RI can be monitored and assessed. The monitoring of KPIs should help provide the data for the 'sphere of control' which the RI management should be able to track and assess over time. As the focus shifts towards outcomes and impacts, the data collected for the KPIs provides an evidence base which can be complemented through tracking other indicators, notably in terms of what is done with the research results produced on the RI, how the RIs activities influence skills available in the R&I system, etc.

The RI-PATHS project developed a set of indicators covering four impact areas (human resources, economy and innovation, society, policy) and three broad types of indicators:

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35 See: https://www.esfri.eu/esfri-policy-brief-impact

36 See: https://ri-paths-tool.eu/en

activity, outcome and **impact**[37]. The indicators, co-developed with RI managers, provide a good basis for identifying possible outcomes and impacts and designing impact pathways.

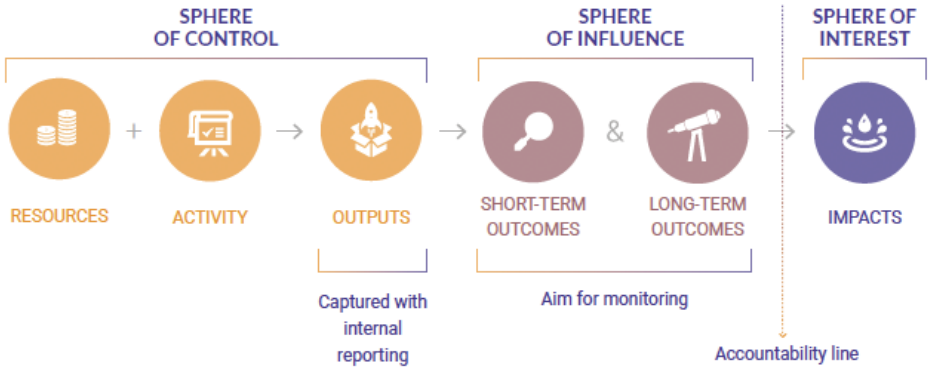
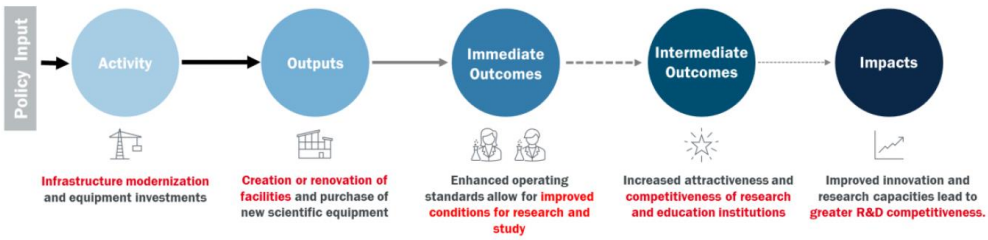


Figure 18. RI-PATHS impact assessment framework

Source: Griniece et al, (2020)

Likewise, an evaluation of investments in research and technological development infrastructures and activities supported by the ERDF, in the period 2007-2013, proposed a generalised theory of change of infrastructure investments for research.[38]

Figure 19. Theory of change of infrastructure investments for research



Source: EC DG REGIO (2021)

The framework was applied to several cases that developed more elaborated theory of change models (e.g. Italy below) to evaluate the impact of ERDF support for RIs.[39]

The study drew three main conclusions concerning past ERDF support for RIs:

- Insufficient administrative and institutional capacity, both at the level of the research institution and the responsible MAs. An over-long duration of the evaluation and project selection process, a high fluctuation of staff in responsible institutions, the untimely disbursement of funds, uncertainty and ambiguity regarding public procurement and

[37] See : https://ri-paths-tool.eu/en/indicators

[38] See: https://ec.europa.eu/regional_policy/en/information/publications/evaluations/2021/evaluation-of-investments-in-research-and-technological-development-rtd-infrastructures-and-activities-supported-by-the-european-regional-development-funds-erdf-in-the-period-2007-2013

[39] See: https://ec.europa.eu/regional_policy/sources/evaluation/eval2007/rtd-2007/rtd-2007-italy.pdf

other laws. All of these contributed to significant delays or negatively influenced implementation.

- A limiting factor was a lack of human resources available to manage and operate the newly acquired research equipment or to work in the new or modernised infrastructure. As a result, laboratories were not operational or they functioned at a significantly reduced degree, due to the inability to hire the staff to operate the instruments effectively. This limited the effectiveness of the investments for infrastructure and the purchasing of research equipment.
- Uncertainty regarding State aid rules affected the impact of the newly acquired research equipment and modernised infrastructure. In some settings, access to the infrastructure was at first not allowed for private sector use, while in other settings, it was strictly limited. The State aid regulations limited the potential to generate a more diversified use of the new infrastructure and the possibility of identifying new revenue sources. Moreover, the regulations hampered research organisations from using the infrastructure to engage in more pro-active knowledge transfer and cooperation with private sector partners, thereby reducing collaboration efforts.

While these findings concern the 2007-2013 period, it is noteworthy that these problems still exist in Greece, as the 2022 PSF Country Report underlined. While an effective M&E framework cannot solve all these issues, it should provide an 'early-warning' indication of difficulties in implementing NRI projects and meeting intermediate targets.

In particular, the Greek experience – as analysed in the PSF Country Report – is that, despite two rounds of revision (in 2014 and 2022[40]), the State Aid Framework for Research, Development and Innovation (RDI) continues to create difficulties for NRIs seeking to develop collaboration with, and generate revenue from, services to businesses. Guidance has been developed on applying the RDI State Aid Framework for research and knowledge-dissemination organisations (RDOs), including RIs in 2020, in the form of a set of 'decision trees' (Kebapci et al, 2020).

While the RDI State Aid rules were updated in 2022, the guidance remains essentially the same and Kaiser et al (2021)[41] provide more details and examples complementing the decision trees and a set of recommendations:

- Separate accounting: economic versus non-economic. It is mandatory for RDOs (including RIs) having mixed activities that there is no cross-subsidisation of economic activities with public financial means intended for their non-economic activities.
- Ancillary economic activities: if a RI with mixed activities can demonstrate that its economic activities are ancillary (i.e. that they do not account for more than 20% of the annual capacity of the RI and that they consume exactly the same inputs as the non-economic activities) and are clearly separated from non-economic activities, then the rules for direct State Aid do not apply to the public funding of that RI.
- Distinguish carefully between "effective collaboration" and "research on behalf of undertakings" for RDI partnerships between an RI and an enterprise, when funded by the enterprise. This is important because some of the effective collaborations could be wrongly understood as "contract research on behalf of undertakings" and then as

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40 See: https://competition-policy.ec.europa.eu/state-aid/legislation/modernisation/rdi_en

41 See: https://www.earto.eu/earto-paper-state-aid-on-rdi-the-right-way/

economic activities. This distinction is needed in order to demonstrate that economic activities do not account for more than 20% of the annual capacity of the RI.

Where a research infrastructure is used for both economic and non-economic activities, public funding falls under State Aid rules only insofar as it covers costs linked to the economic activities. Where a research infrastructure is both publicly and privately funded, and the public funding exceeds the costs for the non-economic activities, then the excess funding is considered to subsidise the economic activities. The presumption applies to the relevant entity for the specific accounting period concerned by the public support. Therefore, State Aid rules **require separate accounting for economic and non-economic activities**. Failure to do so makes all public funding subject to State Aid. RIs are advised to adjust their financial monitoring practices accordingly.

Monitoring of annual capacity is necessary if the research infrastructure needs to demonstrate that economic activities are of an ancillary character. Failure to do so would make all public funding for the economic activities subject to State Aid rules. The monitoring procedures required cover annual capacity of those inputs which are used for both non-economic and economic activities AND calculate the percentage of economic activities as opposed to non-economic. Depending on the nature of activity and the type of resources required, capacity can be calculated on the basis of

- time accounting – human resource capacity measured in employee working hours,
- inputs, such as material, equipment and fixed capital, and
- other elements relevant to the specific activity of the entity.

Figure 20. Monitoring to comply with State Aid rules for research infrastructures

Source: Kepapci et al, 2020

5.1.3. Monitoring and evaluation practice in other Member States

EU Member States with investments in RIs have developed processes and procedures for the monitoring and evaluation (M&E) of national RIs. However, detailed evidence on the types of KPIs applied is limited in publicly available documents. In most cases, the M&E process involves:

- A call for proposals (usually directed at consortia of partners, although in some cases single site/single institution applications are accepted) for new or further development of existing RIs serving the national research community and/or operating at international level.
- In the case of new 'very large' investments of national to European scale[42], an ex-ante 'impact evaluation' may be requested, including a cost-benefit analysis. Such a study may provide a baseline for KPIs used in tracking the development of the RI through lifecycle stages.
- Annual reporting both of quantitative financial and activity data (on KPI) and through an annual (narrative) report on activities and development of the RI.
- Periodic (mid-term) external reviews of the RI's performance (or maturity), often carried out by a panel of (international) peers, usually commissioned by the funding agency/ministry (and hence complementary to any international advisory panels the RI may have created as part of its own governance structure).
- In some cases, a socio-economic impact assessment, e.g. as part of the ex-post evaluation of ESIF-funded programmes' support for RI.

[42] See for instance, the impact assessment for the Einstein Telescope: https://www.einsteintelescope.nl/en/great-opportunity-for-the-region/

In the **Czech Republic**, as part of the process for applying funding as a large-research infrastructure,[43] each RI is required to make commitments to a set of indicators to be fulfilled during the future stages of the RI's implementation. The indicators below are the 'obligatorily defined outputs', pre-defined by the MEYS.

Type of outcome	Present	Planned
Publications from the RI's activities created by the RI's users (annually)	*number*	*number*
Publications from the RI's activities the RI's team members participated in (annually)	*number*	*number*
National / foreign users of the RI	*number / percentage*	*number / percentage*
Master students educated within the RI / subset from abroad	*number / number*	*number / number*
Ph.D. students trained within the RI / subset from abroad	*number / number*	*number / number*
Financial income from national resources (public/private)	*amount (million CZK/year) / amount (million CZK/year)*	*amount (million CZK/year) / amount (million CZK/year)*
Financial income from foreign resources (public/private)	*amount (million CZK/year) / amount (million CZK/year)*	*amount (million CZK/year) / amount (million CZK/year)*

Source: Czech Ministry of Education, Youth and Sports

In addition, each RI is expected to define a set of "indicators specific for the RI" to be defined at the RI's discretion depending on their field of research, maturity, etc.

In the **Netherlands**, the NWO funds the Research infrastructures: national consortia[44] programme, which aims, like the Greek NRIs programme, to strengthen the RI infrastructure available to the national research community. Funded Dutch RIs must be open to the entire research community working at accredited knowledge institutions (all universities and various research institutes). While there are no mandatory KPIs, proposals for funding are expected to provide a list of suitable KPIs, milestones and deliverables for the purpose of periodic reporting and an (interim) evaluation, which will enable transparent reporting on aspects such as technical and financial realisation and will clearly illustrate how the use of the infrastructure will benefit science, society and the economy.

In **Flanders** (Belgium), the regulation[45] governing the regional government's investment in 'large-scale research infrastructures'[46] requires monitoring of both scientific activities and outputs as well as of users of the infrastructure. The 'supervisors' (RI coordinators) must submit a scientific report to the Research Foundation Flanders (FWO):

- For ongoing projects: during the last year of the agreement, a scientific report indicating the progress status of the research and the project work still to be carried out, together with a list of scientific publications, if any.

[43] See: https://www.vyzkumne-infrastruktury.cz/en/roadmap-of-large-research-infrastructures-of-the-czech-republic/

[44] Applications can be submitted by national consortia from all scientific disciplines. Research with, and exploitation of, the infrastructure is not financed. NWO finances €1.5 – 10m and host institutes (consortia members) provide a 25% own contribution.

[45] See: https://www.fwo.be/en/fellowships-funding/research-infrastructure/large-scale-research-infrastructure/regulations-for-large-scale-research-infrastructure/

[46] See: https://www.fwo.be/en/fellowships-funding/research-infrastructure/large-scale-research-infrastructure/

- For fully completed projects: upon expiry of the agreement, a final report on the scientific activities, together with a list of publications related to the project, and the logbook (in electronic form) must be added.

The supervisor is required to maintain a logbook from the moment the infrastructure is operational until the end of the depreciation period, which includes these elements:

- The users of the research infrastructure;
- The use of the research infrastructure;
- The duration of use of the research infrastructure;
- User comments on the efficiency and effectiveness of the research infrastructure.

For the International Research Infrastructures (IRI) programme, proposals are required to describe:

- The impact and achievements already obtained or to be expected.
- The long- and short-term scientific, economic, societal and/or policy-relevant impact achieved or to be expected; quantify if possible and provide concrete examples.
- (Where applicable) demonstrate the results/output of previous research funding (i.e. key publications, patents, visibility, training, development of collaborations and projects, development of linkages with Flemish 'spearhead clusters', etc.) in the past four years.

The proposals are required to include five specific KPIs, wherever possible, with quantified targets for four years. These are expected to cover scientific and economic, societal and/or policy-relevant impact. For the next call, the FWO will probably require IRIs to use the ESFRI KPI as a framework.

In the **Portuguese** case, the monitoring of the implementation of the National Roadmap of Research Infrastructures of Strategic Interest (RNIE), as well as the analysis of the socio-economic return of RIs and the promotion of synergies with ESFRI, are the responsibility of the Research Infrastructures Monitoring Committee, established by the FCT[47] and composed of national experts only. In 2015, the FCT asked the Monitoring Committee to perform a first analysis of the maturity of the implementation of the 52 infrastructures[48] integrated in the RNIE, and their ability to serve the scientific community.[49]

The criteria used in the maturity assessment cover aspects related to the process of preparing and implementing a RI. They are also aligned with the assessment for inclusion of pan-European infrastructures in the ESFRI Roadmap. The criteria are: context analysis, governance and legal framework, articulation with users and other stakeholders, human resources policy, strategies for accessing and using and managing data, scientific impact, knowledge extension strategies and socio-economic impact, risk analysis, sustainability and alignment with public policies and societal challenges.

Following the assessment, three (6%) of the RIs were classified as having low maturity, 19 medium, 24 high and six very high. The assessment, carried out by panels of experts (31 experts in total), was based on a questionnaire sent to the national RIs as well as other materials. No mandatory KPIs appear to have been defined by the FCT and a more narrative approach to explaining impact on research, society and economy was adopted.

Figure 21. Example of evaluation and monitoring framework for research infrastructures

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47 Fundação para a Ciência e a Tecnologia (FCT) is the national public agency that supports research in science, technology and innovation in all areas of knowledge. It is a public institute under the responsibility of the Ministry of Science, Technology and Higher Education.

48 Initially 40 infrastructures were selected to access funding from the ERDF operational programmes through two tenders launched in 2016 and 2017, following which 39 projects were contracted for a total of €131.5m eligible public funding, to be implemented by 2021. A further 12 RIs were included in the revised national RI roadmap in 2019 and were covered by the maturity assessment.

49 See: https://www.fct.pt/en/financiamento/programas-de-financiamento/avaliacao-de-maturidade-das-infraestruturas-de-investigacao-de-interesse-estrategico/

Source: authors based on references provided

Beyond quantitative KPIs, the drafting of impact cases[50] is one approach that can help RI management teams illustrate the results that are derived from the use of the RI. These cases can be written up as input to annual or periodic (interim evaluation) reports[51] to illustrate impacts or impact pathways (i.e. progress made toward a specific type of impact). They can also provide input for promotional material for websites[52] or as the basis for videos,[53] etc., showcasing the RIs' societal relevance and impact. Use cases or case studies are a similar approach and can be focused on how scientific or industrial users have worked with the RI and used equipment or (open) datasets[54] to generate results or translate them into products and/or processes generating economic or societal value.

5.1.4. The existing monitoring and evaluation framework of Greek research infrastructures

During the 2014-2020 period, the monitoring of NRIs was essentially carried out at two levels by the management authorities of the EPANEK Competitiveness Programme, in line with the ERDF common indicators and reporting procedures. Only two KPIs were tracked across all 28 NRIs, based on data provided by the NRIs, by EPANEK-GSRI, in line with the ESIF regulations, namely:

- Number of researchers working in improved research centre facilities (full-time equivalents, FTE).
- Number of young researchers (FTE).

As summarised in the PSF Country Report, individual NRIs also set up their own KPI reporting frameworks, inspired by ESFRI (e.g. used by OMIC-ENGINE), RI-PATHs (e.g. HIMIOFOTS) or other EU-level RIs (e.g. CBMR applied KPIs in line with those adopted by EMBRC-ERIC). Moreover, as part of the PSF Country exercise, the NRIs were asked, via a survey, to rank the importance of a selected list of KPIs (mainly based on the ESFRI indicators). The diagram below summarises the share of NRIs ranking a set of possible KPIs as "Important" or "Very important".

[50] See for instance guidance here: https://www.ucd.ie/impacttoolkit/communicate/writinganimpactcasestudy/

[51] See for instance CERN's knowledge transfer highlights report: https://kt.cern/annual-report

[52] See for instance: https://www.syke.fi/en-US/SYKE_evaluation/Societal_impact_and_sustainability_leadership - https://www.nwo.nl/en/cases/granted-when-email-comes-your-heart-rate-shoots or https://www.infraportal.org.uk/browse-all-case-studies

[53] See for instance: https://www.cells.es/en/outreach/videos or https://www.youtube.com/watch?v=ivVORUxABiQ&ab_channel=NWOWetenschap

[54] See for instance: https://www.openaire.eu/case-studies or https://innovation.desy.de/for_industry/case_studies/index_eng.html

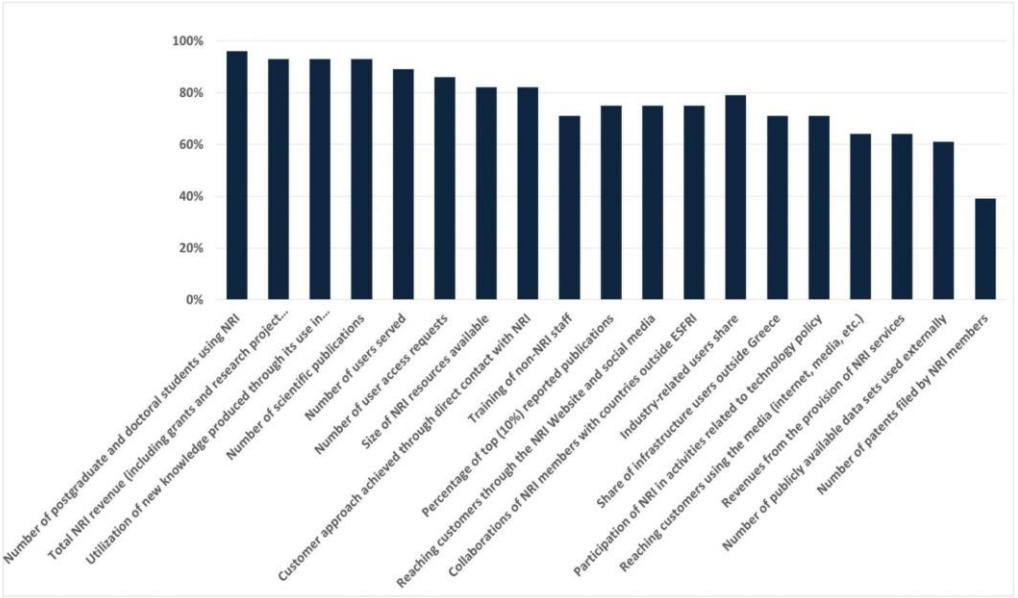


Figure 22. Percentage of NRIs evaluating each KPI as “very important” or “important”

Source: Strogylopoulos & Paliogiannis (2022)

The KPIs given the most importance, in the 2014-2020 period, reflect the focus on supporting young researchers (as a means to reduce the brain-drain from science and Greece), followed by total NRI revenue. Other high-ranked KPIs are the utilisation of knowledge generated by using the NRI and the number of scientific publications produced. Indicators related to RI-service uptake were also mostly highly ranked, such as number of users served and number of user access requests. However, very few NRIs generated revenues from access services, during this period, as reflected in the lower score given to the indicator ‘revenue from the provision of services’. The limited focus on ‘economic return’ is underlined by the low frequency of the indicator ‘number of patents filed by NRI members’.

Detailed responses to the open questions in the questionnaire suggest that NRIs are aware of the importance of attracting and serving users. Indicators such as number of user access requests, number of users served, number of postgraduate and doctoral students using the services and training of non-NRI staff are all core indicators reflecting the service provision function of an NRI and the need to inform and train a community of users.

From an OS perspective, it is noticeable that the indicator ‘number of publicly available data sets’ was scored lowly, with one NRI noting that “public data sets are not common practice for certain of our research topics”.

For the current 2021-2027 reporting period, the management authority (MA) for the Competitiveness Programme confirmed that they will apply the common output and result indicators of the ERDF regulation (listed in table 1 of annex 1 of the Regulation)[55] and have not created specific additional indicators. The table below presents the full choice of possible output and result indicators available for the specific objective Developing and enhancing R&I capacities and the uptake of advanced technologies under Policy Objective 1 (PO1) ‘A more

[55] Regulation (EU) 2021/1058 of 24 June 2021 on the European Regional Development Fund and on the Cohesion Fund. OJ of the EU, L231 of 30 June 2021.

competitive and smarter Europe by promoting innovative and smart economic transformation and regional ICT connectivity'.

Outputs	Results
RCO 01 – Enterprises supported (of which: micro, small, medium, large)	RCR 01 – Jobs created in supported entities
RCO 02 – Enterprises supported by grants	RCR 02 – Research jobs created in supported entities*
RCO 03 – Enterprises supported by financial instruments*	RCR 02 – Private investments matching public support (of which: grants, financial instruments)
RCO 04 – Enterprises with non-financial support	RCR 03 – Small and medium-size enterprises (SMEs) introducing product or process innovation*
RCO 05 – New enterprises supported	RCR 04 – SMEs introducing marketing or organisational innovation*
RCO 06 – Researchers working in supported research facilities	RCR 05 – SMEs innovating in-house
RCO 07 – Research organisations participating in joint research projects	RCR 06 – Patent applications submitted*
RCO 08 – Nominal value of R&I equipment	RCR 07 – Trademark and design applications
RCO 10 – Enterprises cooperating with research organisations	RCR 08 – Publications from supported projects
RCO 96 – Interregional investments for innovation in Union projects	

Figure 23. Common output and result indicators for ERDF 2021-2027 for policy objective 1

Source: ERDF Regulation (2021)

According to the MA, the common indicators that will be applied to the NRIs funded during 2021-2017 are:

- Researchers working in support research facilities (RCO 06) – output indicator.
- Nominal value of R&I equipment (RCO 08) – output indicator.
- Publications from supported projects (RCR 08) – result indicator.

For the first indicator, the MA indicated they would qualify the indicator by focusing on 'young researchers' without specifying how this term will be defined (e.g. age, qualification level, etc.). Potentially, other common output and result indicators could be also relevant, e.g. RCO 07 on research organisations participating in joint research projects, RCR 02 on private investments matching public support (e.g. if a private company co-invests in a NRI facility or equipment), or RCR 06 patent applications submitted. The indicators proposed by the PSF Open report could be added as additional indicators.

However, the ERDF common output and result indicators **do not provide an ideal framework for monitoring and assessing the performance of a NRI which is primarily expected to provide services to users** (academic researchers, private companies, public sector organisations), rather than producing publications, patents or product/process innovations itself. Hence, there is a need in designing the M&E framework to go beyond these indicators, or at least for a core group of 'mandatory' indicators (e.g. Czech example).

The GSRI organises periodic assessments of (11) research centres and institutes under its supervision, e.g. the Institute of Molecular Biology and Biotechnology (IMBB), the Athena Research Centre, etc. The assessments are carried out by a panel of international experts, who produce an evaluation report structured as follows:

- General assessment of the institute's performance and its standing in the international scene.
- Evaluation of the infrastructure and the operation of the facilities plus comments on planned developments.
- Evaluation of the recruitment practices, operational and financial management.
- Evaluation of the policies and practices for inclusion and diversity, gender equality and scientific integrity.
- Assessment of the national and international institutional collaboration potential.
- Evaluation of the innovation and application-related activities and IP protection practices.
- SWOT and recommendations on the planned directions and priorities.

The reports provide a peer-based narrative assessment, but use data derived from KPIs. The GSRI intends to develop a platform to which all GSRI-supervised research institutes will input data annually for the experts analyse it. The GSRI is in the process of defining the indicators and the indicators proposed by the PSF Open for the NRIs can feed into this process.

We recommend that all Greek research infrastructures, independent of their source of funding (ERDF, RRF, EIB, national budget, etc.), should be monitored and evaluated using the same common framework and process.

5.2. Overview of proposed actions to meet the PSF recommendations

The development of a set of KPIs was one of the recommendations of the PSF Country Report (EC, 2022), namely to: "*adopt a set of key performance indicators that reflect the specific role of RIs in the national R&I system"*. During the PSF Open kick-off meeting, the GSRI confirmed that KPIs will be used at a policy level, by the Greek authorities for:

(a) Assessing NRIs performance during interim and ex-post evaluations;

(b) Allocation of performance reserves (or additional funding awarded based on performance) (see implementation plan 1); and

(c) As input to the design of funding instruments according to the NRIs' lifecycle stage (e.g. with variations in eligible expenses, level of funding) (in support of implementation plan 1).

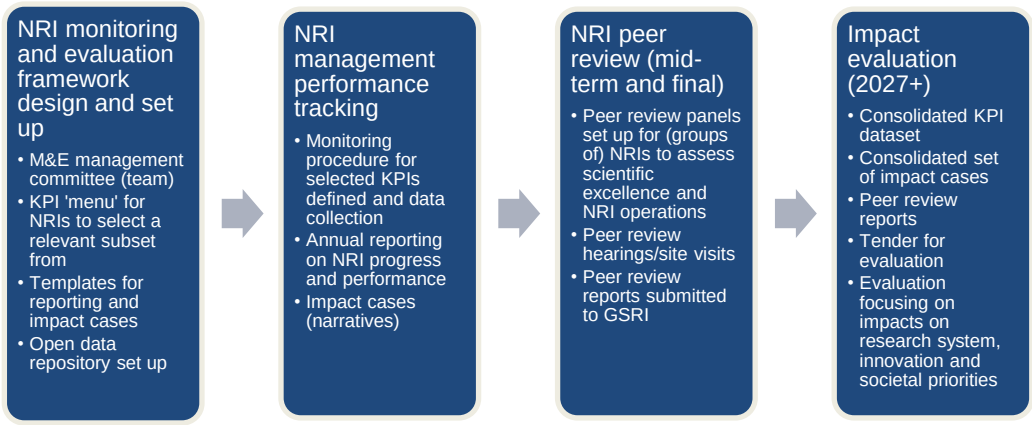
At an operational level, the KPIs should also be useable by the NRI for:

(a) Self-assessing their own progress on their contribution to national priorities; and

(b) Developing and implementing business models which envisage a diversified input of public funding, i.e. obtaining additional funding from different public programmes (national, regional and European) as well as recovering costs or generating revenue from service provision to users (businesses, public sector bodies, etc.).

The KPIs will be included in the NRI call for proposals as a framework, and applied, at a later stage, during the implementation of projects. Additionally, the GSRI requested that a methodology for the implementation of the KPI framework should be provided as part of the implementation plan. The implementation plan 2 framework is illustrated below

Figure 24. Overall framework for the implementation plan 2



The framework is split into four main steps, with specific actions foreseen for each step.

The monitoring and evaluation (M&E) framework requires the establishment of a 'governance structure'. **We recommend that a NRI Management team** be established (within the GSRI, but in close liaison with other ministries and agencies) with responsibility for supervising the monitoring and evaluation of the NRI and suitably resourced (two to three staff, budget for peer reviewers, evaluations, etc.) over the period 2023-2030. This will enable the M&E framework of the NRIs to be designed and implemented effectively. In addition to the M&E tasks, the NRI Management Team would be responsible for drafting and developing an updated national RI roadmap and landscape analysis (as recommended by the PSF Country report).

The GSRI has overall responsibility for research infrastructure policy. However, other ministries, agencies and bodies provide funding, have an interest in the performance of NRIs for their fields of activity, or have expertise that can be applied to supporting the development and monitoring and assessing the performance of the NRIs. Such a cross-departmental approach is in line with the shift towards a 'whole of government approach'[56] and recognises that NRIs may and should lead to results and impacts that contribute to a wide range of national policy priorities across various ministries. **We therefore recommend** that a cross-departmental **NRI supervisory committee** be formed. It would meet as required (but no less than once a semester) to review progress in implementing this plan and the development of the selected NRIs. The committee would receive reports and background information from the NRI management team, based on the monitoring of KPIs, etc.

We recommend that all NRIs should be required to report on a minimum set of KPIs. These will be additional to the three 'common indicators' required by the ESIF Management

[56] See: https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-whole-government-approach-research-and-innovation

Authorities for the Antagonistikotita (Competitiveness) Operational Programme.[57] The **obligatory set of KPIs to be tracked by all NRIs** should include:

- **Usage of the RI**: this may be measured by the NRI in terms of one or more of the following: number of users, usage ratio (annual hours equipment used/annual time theoretically available), and/or access and download of datasets. Wherever possible, the usage should be broken down by type of user: Greek or international; researchers from HEIs or research centres other than the host institution(s); researchers from the consortium institutions; private enterprises, public bodies, others (NGOs, etc.).
- **Training**: masters and PhD students educated and trained within the RI and indicating the number of hours of training received: broken down by nationality and distinguishing between students from the consortium institutions versus students from other HEIs (Greek or foreign).
- **Income**: (additional to funding from the Antagonistikotita OP) broken down by type of income (grant, charitable donation, payment for services, intellectual property licence payments, etc.), service provided, type of organisation providing the funding, whether from national, EU (programmes, other Member States' organisations) or non-EU countries' resources.
- **Publications**: the common ERDF result indicator is not fully suitable for a research infrastructure, since the NRI staff should be providing services to other researchers and not, as a main occupation, be carrying out research themselves. Therefore, it is recommended that the indicator should be retained but the NRIs should be required to differentiate publications authored by external users of the NRI and those in which the NRI's team members are (co-) authors. To this end, an appropriate policy of requiring users to acknowledge use of equipment, data and/or technical support provided by the NRI when publishing should be in place in all NRIs. An open access policy for publications should be respected and the share of publications generated by the usage of the RI that are open access should be reported.
- **Open Science**: in line with Action 6: NRI open science assessment of implementation plan 3, we also recommend that an appropriate KPI should be included to assess the NRIs' contribution to OS. Examples of metrics could include, e.g. measures to FAIRify data, use of certified repositories, publishing guidelines for users, participation in HOSI expert groups, implementation of HOSI recommendations, training, etc. The list of criteria for measuring performances should be jointly discussed and validated within HOSI (e.g. via an expert group on Monitoring). The EOSC Partnership Monitoring Framework could also be explored for inspiration on KPIs in the OS area.[58]

The set of obligatory KPIs is presented in table format in annex in section 8.4. **We recommend** that each NRI, as part of its funding application, provides a baseline situation (last full year of operation) as well as mid-term (end 2026) and final (2029 assuming N+2 operations) targets for each obligatory KPI. They may adjust the five core indicators to reflect their field of science and operations, but should justify any changes made to the above definitions.

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57 See: https://21-27.antagonistikotita.gr/

58 See: https://eosc.eu/sites/default/files/2022-05/Monitoring%20Framework.pdf

In addition, we recommend that NRIs should be free to define additional KPIs on which they want their performance to be assessed and similarly indicate baselines and targets. **We recommend** that each NRI adopts a limited number of KPIs, and not more than 10 KPIs.

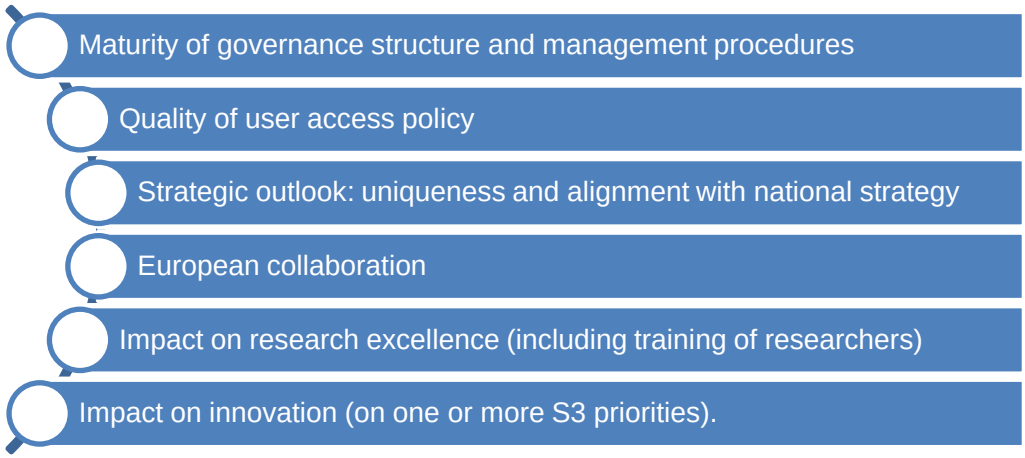

Figure 25. Performance reporting framework

Source: authors based on PSF Country Report

We recommend that the template for NRI reporting (mid-term and final reviews) are structured according to the six broad criteria developed by the PSF Country panel (see Figure 25). A proposed NRI performance reporting template is included in annex in section 8.5.

We recommend that, to complement the KPIs and ensure a qualitative and narrative approach to recording and presenting pathways to impact, the NRIs should provide at least two impact cases by mid-term and four by the end of the period. A template for impact case reporting is provided in annex in section 0.

A final recommendation is that the NRI management team should set up, or use a procurement procedure, to develop a NRI monitoring database. This database would enable all NRIs to report online their KPI performance, as well as to submit impact cases. This database should ideally include an open access repository of FAIR research data and digitally identified objects. The database should enable the NRI management team to generate reports and visualisations for specific NRIs or groups of NRI that can be used by the NRI Supervisory Committee, as well as by the peers and evaluators.

5.3. Description of the proposed actions

The following actions are proposed for the implementation plan:

Action 2.1	Establishment of the NRI Management Team
Action owner(s)	(Deputy) Minister for Development & GSRI
Timeframe	September-December 2023
Resources	2-3 staff members are assigned (or recruited if so required) within the GSRI to staff the NRI Management Team, plus appropriate budgetary funding allocated for full

	cycle of M&E (technical expertise, peers, external evaluation, etc.), administrative orders issued as per Greek legislation.
Description of the action	• At least 2 full-time equivalent staff assigned to supervising the implementation, monitoring and evaluation of the NRIs. The staff should either have past expertise in research infrastructure policy, RI management and a knowledge of evaluation of research and/or RI impact assessment. If so required, the staff should be provided with training on these topics. • Estimation of required financial resources for the period to 2029 for implementation of the M&E plan.
Milestones	• Approval of the required staff and financial resources. • Assignment or recruitment of staff.

Action 2.2	NRI monitoring and evaluation framework design
Action owner(s)	GSRI in co-operation with the relevant ministries, agencies and management authorities
Timeframe	Last quarter 2023 to end of first quarter 2024
Resources	Core GSRI NRI team staff plus experts from Ministry of Digital Governance. If required, technical expertise for designing the monitoring platform may be provided via a procurement contract.
Description of the action	• Approval of the composition of the NRI Supervisory Committee. We recommend that this committee should include at least representatives of the GSRI (chair), Antagonistikotita OP Management Authorities, HAHE, MERAS, the NCRTI and the HRIF. • Adaptation of the proposed reporting templates (annexed to this report) by the GSRI in consultation with the Antagonistikotita OP Management Authorities and in consultation with the NRI Supervisory committee. • Technical specifications for the NRI monitoring platform to be developed in partnership with the Ministry of Digital Governance (which is currently supporting the design of the platform for the NRI applications) and, if required, by an external consultant (procurement).
Milestones	• Establishment of the NRI Supervisory Committee – last quarter 2023. • Preparation of reporting templates and other procedural documents for the NRI reporting – in time for launch of projects (first quarter 2024). • Technical specification of the NRI monitoring platform approved – first quarter 2024.

Action 2.3	NRI on-going performance tracking
Action owner(s)	GSRI and coordinators of the funded NRI projects
Timeframe	First semester 2024 to completion of all projects (2028)

Resources	Approximately 1 day per month for NRI coordinators after initial set-up. Approximately 1 FTE at GSRI overseeing and managing reporting by NRIs on KPIs, etc. Additional technical support from Ministry of Digital Governance for updating, technical improvements, etc. of the monitoring platform.
Description of the action	• GSRI should organise a training workshop for all NRI coordinators on monitoring and designing impact pathways. • Each NRI coordinator should develop an internal M&E plan that includes developing specific impact pathways. • NRI coordinators should continually monitor and complete the reporting on specific KPIs, notably usage, etc. Depending on the indicator, this may mean monthly, quarterly or annual updates of KPI data. • Annual reports should be submitted by NRI coordinators to GSRI.
Milestones	• Training workshop on RI impact pathways and monitoring KPIs delivered (by third quarter 2024). • All NRI coordinators submit with first annual report their internal M&E plan, as well as proposed impact pathways. • Data on KPIs updated at least every six months by NRI coordinators to the NRI monitoring platform. • Annual reports submitted by NRI coordinators. • At least two impact cases submitted by mid-term and four by end of project.

Action 2.4	Greek National Research Infrastructure Monitoring Platform
Action owner(s)	GSRI, Ministry of Digital Governance
Timeframe	• Design phase – by mid-2024 • Operational – by end 2024
Resources	• Depending on the design specifications and hosting options, this may be handled by internal IT experts (e.g. at Ministry of Digital Governance) or outsourced (e.g. to GRNET). • The platform budget could be integrated in one of the NRI projects, in order to provide a single cloud-based portal for all NRIs to present services, datasets and to record data on KPIs.
Description of the action	• Development of a web platform enabling the NRIs to present a catalogue of services on a public facing site and give access to FAIR data and digital objects developed by researchers using the NRIs, plus an ‘extranet’ platform for reporting on KPIs and annual reports. • The platform should ideally be integrated as part of the Greek EOSC node (see action 3.8 below).
Milestones	• Monitoring platform operational by end 2024. • On-going technical improvements and updates during period to 2028 (end of NRI projects).

Action 2.5	Impact evaluation
Action owner(s)	GSRI and NRI supervisory committee
Timeframe	2027-2028
Resources	• Human resources: 1-2 project officers from GSRI (part-time) to oversee process. • Funding: approximately €250,000 tender for external evaluation (public procurement) plus budget for peers for panels (travel and allowance).
Description of the action	• Preparation of the terms of reference for the procurement tender to select an independent evaluation team. • The evaluation will build on the dataset developed through the NRI monitoring procedures set out in the previous actions, including the impact cases and reports of the peer review panels. • The evaluation findings should provide input for the design of the funding programme for NRIs for the next financial period.
Milestones	• Tender documents prepared by mid-2027. • Tender launched and supplier selected by end 2027. • Evaluation during the first semester 2028. • Final report published and recommendations presented – third quarter 2028.

6. Implementation plan 3: enhancing research digitalisation and open science practices in the NRI ecosystem

6.1. Review of the state of the art in Greece compared to European and international practice

6.1.1. Open Science as a national strategy

Over the last decade, open science (OS) has become a policy priority in Europe and is now the standard method of working under the European Commission's R&I funding programmes.[59] OS has also been embraced by EU Member States, which have adopted national plans and strategies aimed at making OS the default practice in the research ecosystem.[60]

The publication in June 2020 by a group of Greek academic, research, and infrastructure stakeholders of a National Open Science Plan and the establishment in February 2022 of the

[59] See https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science_en

[60] See for example, the Second French Plan for Open Science in France, the Open Science and Research initiative in Finland, the National Programme Open Science in the Netherlands, the National Action Plan for Open Research in Ireland, the National Strategy for Open Science 2023-2027 in Spain, or the Roadmap for Open Science in Italy, to name just a few initiatives.

Hellenic Open Science Initiative (HOSI)[61] – which aims to advance and implement this plan nationally – are positive developments. They will allow Greece to align with other well-advanced European countries.

The Greek draft plan for Open Science, which is currently being discussed by the Greek authorities (Ministry of Digital Governance, MERAS, and GSRI), provides a sound basis for setting up a National Open Science Strategy.

The draft plan is far-reaching, encompassing many aspects of the Greek research and OS ecosystem. It covers four key areas of the OS ecosystem (open access to publications, open access & reuse of research data, development and management of research software, and open access to NRIs and e-Infrastructures).

The draft plan lists 62 actions to be undertaken. These range from infrastructure developments and investments (in platforms, aggregators, repositories, services, etc.) to educational and research policies (on curricula, skills, incentives & rewards for researchers, etc.), as well as funding (creating of a national fund for OS) and legislative measures (change of Greek research and intellectual property law).

To be realised, the draft plan will require the involvement and buy-in of many stakeholders, including researchers, universities and research organisations, research funding organisations, libraries, and scientific publishers.

The Hellenic Open Science Initiative was created in the aftermath of the first publication of the plan and has the objective to ”formulate the national strategy, along with initiatives and actions, for implementing Open Science in Greece by updating and specifying the ‘National Plan for Open Science’ (…).”[62]

Currently, HOSI has 14 members, including research and library organisations, and technology providers. It has a small ‘organising committee’, consisting of a representative of a research organisation (ATHENA RC), an e-Infrastructure provider (GRNET) and a library organisation (HEAL-Link). This committee prioritises topics for discussion by the ‘general assembly’ and the three ‘working groups’, which have been established on training, software, and the OS plan itself. HOSI operates on the basis of voluntary contributions from its members, without any central budget.

In other countries, where OS policies have been successfully implemented for several years, such as France or Finland, we find a comparable organisation of the activities, with a central group of stakeholders (or organisation) tasked with coordinating actions undertaken by the wider community.

In France, representatives from higher authorities (ministries, research organisations, funding agencies, etc.) are directly involved in the actual steering of the initiative. Finland, in a more bottom-up style, gives a large role to the ‘community of practitioners’, with little, if any, steering from central authorities.

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61 https://www.openaire.eu/blogs/introducing-the-hellenic-open-science-initiative-hosi

62 Ibid. Another key objective of HOSI is to manage Greece’s national representation in the EOSC Association

In both cases, an organisation has been empowered to effectively implement a set of agreed actions and tasks – with a clear mandate, executive power, and financial support. These elements appear to be lacking in HOSI and so they should be made more explicit. Indeed, these elements will be critical for HOSI, as they would enable it to effectively steer the implementation of the actions laid out in the national plan.

The French Committee for Open Science – involving higher authorities and decision makers at all stages

In France, the implementation of the national plan is delegated to a specific committee – the **Committee for Open Science** – which includes a **Steering Committee** consisting of high-level representatives from ministries, research agencies and universities. This gives some authority to the Committee, which is entrusted to make decisions concerning the most strategic aspects of the plan and to decide which calls and initiatives should be financed.

A **National Fund for Open Science** supports the overall initiative, and therefore provides the financial means to realise the actions set out in the plan. This fund was allocated €5m per year during the first plan and grew to €15m per year during the second.

This Committee is supported by a **Permanent Secretariat for Open Science**, led by a **National Coordinator for Open Science**, and including several senior representatives from ministries, universities and other stakeholders. The Secretariat is responsible for preparing the Steering Committee for Open Science's work and ensuring its decisions are implemented.

The Secretariat also coordinates the work of five **Colleges** (on Publications, Research Data, Europe and International, Skills and Training, Software and Source Code), and two **Expert Groups** (on Open Scientific Publishing and Legal Affairs), which provide guidance on specific topics. It also oversees the ouvrirlascience.fr website.

Finally, a **Forum for Open Science**, consisting of over 300 professionals from higher education and research organisations, supports the Committee by contributing the experience in the field of professionals from higher education and research institutions. The Forum provides a space for dialogue, sharing and building shared expertise.

Figure 26. Open science in France

The Open Science and Research Initiative in Finland: Open Science for and by the Research Community

The Open Science and Research Initiative in Finland is a good example of how the drafting and implementation of OS policies can be effectively managed by the research community.

In Finland, the Ministry of Education and Culture has delegated the coordination of the **National Open and Research Initiative** to the research community itself, with the coordination responsibility assigned to the Federation of Finnish Learned Societies (TSV), which includes 295 societies and four academies from all branches of arts and sciences.

Experts Panels from the research community are responsible for drafting policies related to open scholarship, open data, open access to research publications and open education. Expert panels can decide to establish **Working Groups** on specific topics.

These policies are then approved by a **Steering Group** made up of members appointed by the key organisations in the Finnish research community (representing universities, research funding and performing organisations, e-Infrastructures, libraries, and various other stakeholders). Each organisation is then responsible for implementing the policies locally.

A **Secretariat**, hosted by TSV and funded by the Ministry of Education and Culture, supports the activities and organises events related to expert work in OS. The Secretariat carries out the monitoring of OS and research and it maintains international relations between experts in OS. Around 3-4 FTEs are allocated each year to run the Secretariat and its activities.

The National Steering Group for Open Science and Research

- Members appointed by the key organisations in the Finnish research community.
- Drafted (2019) and accepted (2020) *the Declaration for Open Science and Research.*
- Accepts policy documents.

Expert panels

- Membership is open. The panels had c. 500 members in total in 2022.
- Draft the policies for the four areas: the culture of open scholarship, open data, open access to research publications, and open education.
- Accept recommendations drafted by working groups.

Working groups

- Draft the recommendations.

Secretariat for the National Open Science and Research Coordination

- Supports the national coordination of OS and research.
- A part of the Federation of Finnish Learned Societies.
- Funded by the Ministry of Education and Culture.

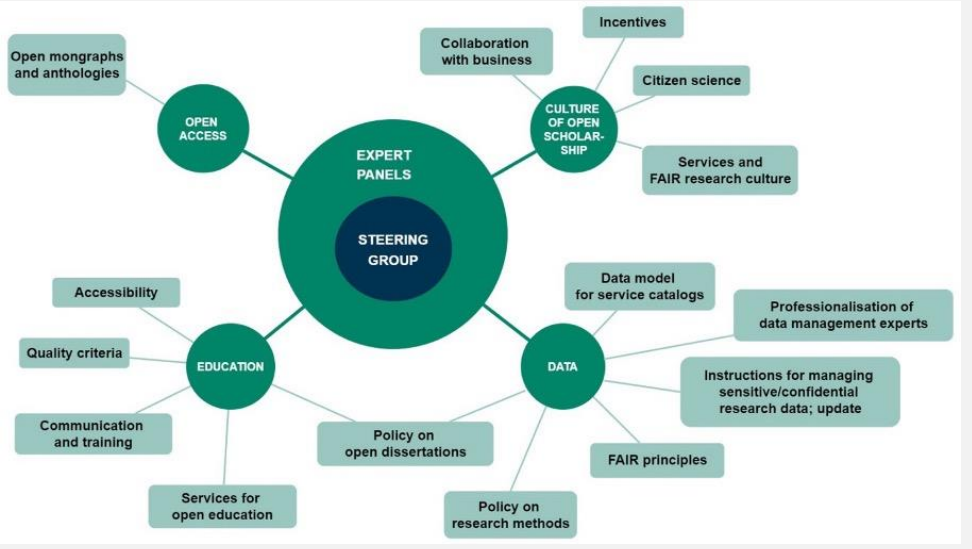

Figure 27. Open Science and research data in Finland

6.1.2. The role and contributions of NRIs to Open Science

Open science practices are often discussed at the level of individual researchers, but the role of research facilities and infrastructures in fostering an OS ecosystem is equally critical. This

role is increasingly recognised in national strategies and national roadmaps, as new requirements for RIs are emerging.

Some of these requirements concern *access and usage policies*. For example, the **Research Council of Finland**, which is funding Finnish RIs, recommends in its strategy document for NRIs that "*research infrastructures shall make their usage policies easily accessible and provide customer-friendly services for all those interested in their services*".[63]

Access policies may include different access modes – which may not be all open to all[64] – but they should be made clearly visible to the (potential) users in order to increase the usability and impact of research infrastructures, and as a way of supporting OS.

In the **Czech Republic**, the existence of an open access policy is an evaluation criterion for large RIs in the national roadmap, together with other criteria such as management, expertise, research results or budgets. Open access policy is defined by the Czech MEYS as "*the manner of organising open access to the capacities that a large research infrastructure offers to its user community*".[65]

As most national RIs generate data – some in very large volumes – a number of national strategies are also encouraging RIs to ensure that the data they generate is properly managed according to well-defined *data management policies*.

For example, **Slovakia** requires as part of its evaluation process for joining the national roadmap that "*research infrastructures should have a data management policy that supports the concept of open science, in which research methods, data and results are well documented and publicly available. In this context, the research infrastructure must have a data management plan that includes information on data acquisition and processing, data storage and data ownership*".[66]

Other countries, such as the **Netherlands**, also require national RIs to submit a data management plan at proposal preparation phase.

Denmark goes one step further. The Danish Agency for Higher Education requires, in negotiations on new grants for national research infrastructures, that research data produced via the new and existing RIs should comply with the FAIR principles.[67] This is a strong requirement, especially since making data FAIR has a cost and requires significant work, investment, and support for RIs.

The Danish e-Infrastructure Cooperation (DeiC) published in 2021 a *National strategy for data management based on the FAIR principles* to help research institutions meet the

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63 Academy of Finland, *Strategy for National Research Infrastructures in Finland 2020-2030*, 2020.

64 See European Commission, Directorate-General for Research and Innovation, *European charter of access for research infrastructures: principles and guidelines for access and related services*, Publications Office, 2016.

65 Ministry of Education, Youth and Sports, *Roadmap of large Research Infrastructures of the Czech Republic for the years 2016-2022*, update 2019.

66 Ministry of Education, Science, Research and Sports of the Slovak Republic, *Roadmap of research Infrastructures – SK VI Roadmap 2020-2030*, March 2021.

67 Danish Agency for Higher Education and Science, *Danish Roadmap for Research Infrastructures 2020*, February 2021.

requirements for FAIR data. This strategy lists a series of principles for a data management practice compliant with the principles.[68] It covers many aspects of the FAIR ecosystem and includes recommendations on merits, skills, technical infrastructure, tools, and funding, but primarily addresses these aspects at the level of individual researchers and research institutions, rather than at the research facility level.

Another path taken by national strategies has been to recognise the role of national infrastructures as *promoters* of OS and FAIR data. In addition to ensuring that the data generated meets the requirements of OS and FAIR data, RIs have a role to play in "transforming the practices" and converting their users to the new paradigm. Hence, RIs may be required to demonstrate the efforts they are making in doing so.

In its call for applications to join the national RI roadmap 2021-2024, the Academy of Finland stipulates that "*the research infrastructure must offer feasible guidelines, practices or incentives/demands for researchers in order to support open access to research data*".[69]

France goes further by encouraging national infrastructures to request open-source publications, data, and source code and to offer support to researchers in these fields. In particular, it invites infrastructures "*to include in their access conditions the principles of open access publication, and of opening by default of data and source code" and "to formalise their open science policies by making a strategic document public*".[70]

It is in the interest of the NRIs to fully embrace OS, as this will increase their visibility and impact, which in turn will support their long-term sustainability. However, a successful open science strategy cannot solely rely on the goodwill of research facilities. Clear requirements and incentives, defined as part of the selection process and continuous evaluation of the RIs, must be put in place to help achieve a concrete change of practices.

Efficient *monitoring* of the progress is also critical for the effective development of OS practices. Finland provides a very good example of how this monitoring process can be organised in close collaboration with the research community.[71]

An important point to remember for policy-makers, however, is that any new requirements will have a cost. As rightly stated by the European Commission's expert group on FAIR data, these requirements should be "met with appropriate investments in infrastructure and services to make them feasible to implement and sustain".[72]

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68 DeiC, National strategy for data management based on the FAIR principles, 2021.

69 Academy of Finland, *FIRI 2023: Roadmap Research Infrastructures 2021-2024 and International Memberships,* 2023.

70 MESRI, *Second French Open Science Plan. Generalising Open Science in France 2021-2024,* 2021.

71 Open Science Coordination in Finland, Federation of Finnish Learned Societies, *Monitoring Model for Open Science and Research – Principles and Practices*, 2022. Other examples of monitoring, in the context of EOSC include: EOSC Partnership – Monitoring and Reporting: https://eosc.eu/monitoring-reporting, and Monitoring Framework for National Contributions to EOSC (2022): https://zenodo.org/record/7410762#.ZF1oFi9BxpR

72 European Commission's Expert Group on FAIR Data, *Turning FAIR into Reality. Final Report and Action Plan*, 2018.

6.1.3. The role of IT infrastructure

The topic of infrastructure – and more precisely e-Infrastructure – is intimately linked to OS, with the latter relying extensively, and increasingly, on the use of digital technologies. Digital transformation is changing the practice of research by offering new tools to access, analyse, share and preserve research data. Open science builds on this transformation, enabling increased discoverability and easier access and reuse of scientific content. The e-Infrastructure needs – or e-needs – of RIs have long been emphasised by ESFRI, which sees e-infrastructure as an integral part of the RI ecosystem and a key enabler of the digital strategy of the European RIs.

In 2018, ESFRI included in its roadmap a recommendation to coordinate EU Member States and European investments on e-Infrastructures in order to support FAIR data management.

For the 2021 Roadmap, ESFRI added a specific section on 'e-needs' to the proposal submission questionnaire, asking all applicants to outline their data management plan and data access policy, the type of e-infrastructure services they needed and how these services would be implemented, as well as how the RI would contribute to the development of the European and global e-infrastructure landscape.[73] Precise expectations and requirements were also set according to the lifecycle of the RI, from the design phase to the preparation, implementation, operation, and termination of the RI (ESFRI, 2019a).[74]

Anticipating and assessing the e-needs of RIs in the ESFRI Roadmap

For the ESFRI 2021 Roadmap, a section on 'e-needs' was included in the proposal submission questionnaire, as part of the scientific case assessment of RIs. The other sections were scientific excellence, pan-European relevance, socio-economic impact, and user strategy & policy:

Section 5: e-needs

5.1. Outline the Data Management Plan (DMP) and data access policy of the RI. If applicable, describe how data would become accessible to the public.

5.2. Describe and quantify what e-infrastructure services - e.g. resources for storage, computing, networking, tools for data management, security, access, remote analysis, etc. - your RI will need.

5.3. Describe how the e-infrastructure services needed by your RI will be implemented, specifying the potential need of external e-infrastructure resources and the relations to external e- infrastructures.

5.4. Describe the compliance with the FAIR principles and how the RI will contribute to the development of the European and global e-infrastructure landscape at all levels (institutional, regional, national, international) - including the e-infrastructure commons and the European Open Science Cloud (EOSC).

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[73] ESFRI, *Strategy Report on Research Infrastructures, Roadmap 2021, Proposal Submission Questionnaire*, 2019.

[74] ESFRI, *Strategy Report on Research Infrastructures, Roadmap 2021, Public Guide*, 2019.

5.5. In case of a specific (non-horizontal) e-infrastructure, describe the interface with existing communication networks and technical design of your RI.

A list of 'key minimal requirements' was also provided to the applicants, corresponding to the different phases of the Research Infrastructure's lifecycle.

Design

- Vision on e-infrastructure requirements, including access policy and security measures ready.
- Interfacing with communication networks or distributed calculation or HPC/HTC.

Preparation

- Conceptual design of e-infrastructure ready.
- Contributions of e-infrastructure resources at all levels (institutional, regional, national, international) described.
- Access policy and Data Management Plan (DMP) outlined.
- Compliance with FAIR principles.

Implementation

- Technical design of e-infrastructure ready and approved.
- Draft operational planning for e-infrastructure service delivery.
- Agreements with parties delivering core e- infrastructure services (Central Hub) drafted.
- Access policy and DMP approved, including plan for sustainability of data.
- Security policy defined and approved.
- Implementing FAIR.

Operation

- Operational plan ready and approved.
- Agreements with service provisioning parties signed.
- DMP implemented and security policy deployed.
- Operational application of FAIR.

Termination

- Deployed sustainability of data beyond decommissioning.

Figure 28. Anticipating and assessing the e-needs of research infrastructures in the ESFRI Roadmap

Sources: ESFRI (2019a) and ESFRI (2019b)

At the national level, several countries are also urging RIs to anticipate their e-infrastructure requirements at an early stage. In the **Netherlands**, the National Roadmap for Large Research Infrastructures (LRI) lists the planning of IT infrastructure as one of the "basic conditions" for all LRI proposals and encourages RIs to collaborate with SURF (the national IT centre) for the provision of this infrastructure: "*It is important to demonstrate that there is a realistic plan for the deployment of IT resources (hardware, software, and data) and the necessary expertise. Proper arrangements should in addition be made to ensure that*

externally required capacity (such as from SURF), is available and committed."[75] Other countries, like **Finland** and the **Czech Republic**, have chosen to list their national IT infrastructure in their national roadmap for RIs, presenting it as a cross-cutting infrastructure supporting all RIs with advanced computing, data management and network capabilities.

While e-infrastructures may offer RIs from all disciplines open access to the advanced digital capabilities, resources, and expertise they need to collaborate and to carry out data- and computing-intensive science, *persistent identifiers* and *repositories* are among the critical services that RIs will need to improve FAIR data management practices. Together with policies, data management plans, and standards, they form the essential components of the FAIR ecosystem.

The European Commission's Expert Group on FAIR data underlines that the implementation of a FAIR ecosystem also necessitates a number of data services and technical components to be in place in the broader ecosystem that enables FAIR. The realisation of FAIR data relies on, at minimum, the following essential components: policies, Data Management Plans, identifiers, standards and repositories. The Expert Group recommends that Member States and funders should support research communities to adopt and coordinate data standards and mechanisms for FAIR sharing, as well as making strategic investments in technology, services and tools to support FAIR data in a coordinated, interoperable and cross-disciplinary way.

The key components of a FAIR ecosystem

Figure 29. The key components of a FAIR ecosystem

Source: EC Expert Group on FAIR Data, Turning FAIR into Reality, 2018

A persistent identifier (PID) is a long-lasting reference to a digital resource. It is a label which gives a unique name to an entity: a person, place, or thing. Unlike URLs, which may break, a persistent identifier reliably points to a digital entity.[76] PIDs are assigned to many aspects of the ecosystem including data, software, institutions, researchers, funders, projects, and instruments.

[75] Dutch Research Council (NOW), *National Roadmap for Large Research Infrastructures, 2021*, February 2022,

[76] https://support.orcid.org/hc/en-us/articles/360006971013-What-are-persistent-identifiers-PIDs-

The use of PIDs by RIs – for research data and software – is often seen as one of the critical actions which underpins effective data sharing, together with the use of metadata and open formats. PIDs come under different types (e.g. DOI, URN) and are relatively easy to implement.

At the European level, organisations like DataCite[77] and EUDAT[78] can help RIs to implement a PID infrastructure. The EUDAT service (B2Handle) allows data providers to register and mint PIDs, which can be integrated within data repositories and other data management platforms: this service is operated by GRNET.

Repositories are critical for storing and managing data and metadata; they also offer services to support access and reuse. They may also take responsibility for long-term data stewardship by curating data and metadata – and making data FAIR.

Some repositories will have deep domain knowledge and offer services to specific research communities, playing a key role in the provision and preservation of FAIR data. Others have a more generic collection policy and may offer stewardship services based on geography or institution.

The EC Expert Group on FAIR data recommends that researchers use domain repositories where they exist; and generic repositories where there is no relevant disciplinary repository available or where the generalist repository provides a specific service that is not available in relevant disciplinary repositories (such as linking the data to a publication). Researchers should also preferably deposit in certified repositories.[79]

One of the key questions for RIs is whether they should invest time and effort in building their own domain-specific repository – to deposit the data they generate and/or encourage their users to deposit their data in this repository. Or whether they should rely on a generic solution provided by a third party.

In many disciplines, there exist trusted thematic repositories. These have a long record of managing and curating valuable research data, sometimes from multiple sub-domains, and to which RIs may point for depositing data.

For example, in the biomolecular domain, ELIXIR recommends 12 databases/repositories for the deposition of experimental data.[80]

In the social sciences, CESSDA lists over 40 trusted domain repositories which are relevant to its field of research. Some of these repositories are directly managed and curated by CESSDA members and form the CESSDA archives. These archives satisfy strict requirements regarding data quality and trustworthiness, and they conform to international standards of data documentation and accessibility.[81] In Greece, the Greek Research

[77] https://datacite.org

[78] https://eudat.eu

[79] EC Expert Group on FAIR Data, Turning FAIR into Reality, op.cit.

[80] https://elixir-europe.org/platforms/data/elixir-deposition-databases

[81] https://dmeg.cessda.eu/Data-Management-Expert-Guide/7.-Discover/Data-repositories-as-data-resources

Infrastructure for Social Sciences (So.Da.Net) is the local CESSDA node providing a depositing service for archiving and disseminating Greek social science data.

Building a thematic repository takes time and requires expertise and long-term investment. Collaboration with national e-Infrastructures may provide some opportunities for RIs to leverage IT expertise and capabilities to operate the repository and enhance it with additional services.

When no thematic repository is available, RIs can decide to point to generic repositories. A few generic repositories provide services at European level and can host data coming from all disciplines.[82] Some RIshave selected these repositories as their default repository for storing some of their data. Several Member States have also chosen to develop their own *national* multidisciplinary repository.

In **France**, Research Data Gouv[83] was created as part of the second plan for OS, with funding from the French National Fund for Open Science (FNSO)[84]. The project involves research organisations and universities and is steered by the Ministry of Higher Education and Research. It aims to provide a sovereign, multidisciplinary data repository to complement the national and European infrastructures already used by some scientific disciplines.

Currently under development, and hosted by INRAE, Research Data Gouv is expected to offer a catalogue that signposts users to data hosted on other trustworthy sites, and a single location to promote visibility for all French research data.

In terms of funding, Research Data Gouv is expected to receive €7m of funding from the French National Fund for Open Science for the first three years. This investment will be divided between the development of the data repository and registry and setting up data management clusters as close as possible to researchers all over France.

In **Finland**, Fairdata[85] provides a series of services for the storage, discoverability and long-term preservation of research materials and associated metadata, as well as support and advisory services for digital preservation. The scope is significantly broader, especially with the inclusion of long-term preservation services, and so is the overall budget. The services are funded by the Finnish Ministry of Education and Culture and are operated by CSC, the Finnish national IT Centre for Science.[86]

The HELIX initiative,[87] a joint effort from Athena RC and GRNET to provide a multidisciplinary repository service for Greek scientists, bears some similarities with the French and Finnish initiatives. HELIX positions itself as “an integral building block for all national research infrastructures, offering its services in a horizontal manner to thematic and domain-specific

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[82] For example, Zenodo and B2share.

[83] See: https://recherche.data.gouv.fr/en

[84] See: https://www.ouvrirlascience.fr/national-fund-for-open-science/

[85] See: https://www.fairdata.fi/en/

[86] Other countries such as Ireland have also committed to developing a national shared data storage service for active data. According to the National Action Plan for Open Research 2022-2030, the objective is to start with a pilot for a small number of research groups, with the aim to grow it into a national service.

[87] See: https://hellenicdataservice.gr/main/

infrastructures and communities."[88] The project was funded by the ESIF through the 'Competitiveness, Entrepreneurship, and Innovation' Operational Programme and received around €3.8m of funding to develop its activities for the period 2018-2022.

Establishing national, multidisciplinary repositories is not a trivial task and should be carefully planned, including how they relate to and complement other existing repositories. As for any research data repository which aims to cater for researcher's data over a long period, long-term commitment and clear mandates from the funders are critical for building confidence from the users and sustaining data services.

6.1.4. Training & skills

Open science practices require systemic change, which can take several years. In addition to making strategic investments in infrastructure and tools to support FAIR data in a coordinated, interoperable, and cross-disciplinary way, it is critical to invest in skills and training, targeting both researchers and data managers operating at research facilities.

In its final report, the EC Expert Group on FAIR data highlighted the necessity to work on skills and capacity building. It also recommends developing new data scientists, embedded in research projects, and data stewards who will ensure the management and curation of FAIR data.[89]

In many countries where an active OS programme has been put in place, Member States and funders have chosen to address that aspect by working on education curricula and research assessment.[90]

While these changes target primarily individual researchers, some measures also target staff at research infrastructures. The Second French Open Science Plan is the most explicit on this topic, by encouraging infrastructures "to recruit professionals responsible for processing, quality checking, describing and preserving data".

Some disciplines have made great progress already in the sharing and reuse of research data, and they benefit from active European networks providing training and examples of best practices to follow.

In Greece, research infrastructures can also rely on a solid network of experts on open access – in particular, through the OpenAIRE network – and infrastructure – via GRNET, to support them in their digital and FAIR strategies.

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88 Ibid

89 EC Expert Group on FAIR Data, Turning FAIR into Reality, op.cit.

90 See for example Ireland, France, and Finland.

6.2. Overview of proposed actions to meet the PSF recommendations

The panel's recommendations for OS and digitalisation are designed to facilitate the development of OS practices and FAIR data management within the Greek research infrastructure ecosystem. The recommendations do not address the full spectrum of OS, but instead target the elements that are most relevant to RIs and will help them to improve their OS practices and contribution to the OS agenda. The recommendations are structured in three main lines of action.

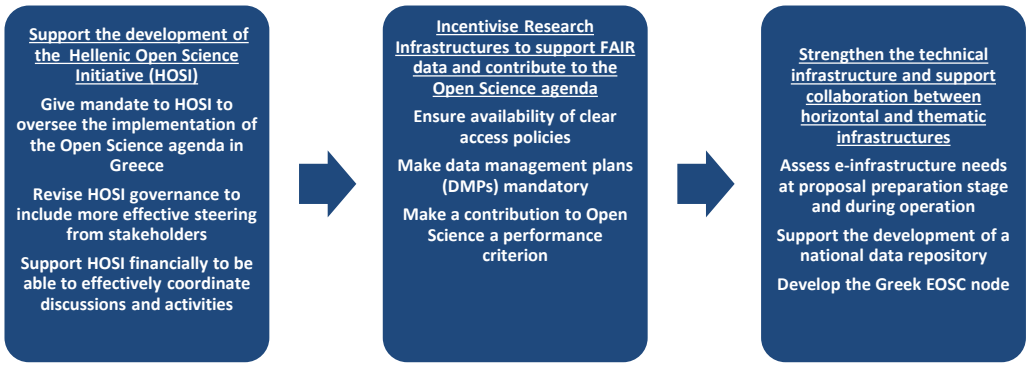

Figure 30. Main lines of action of the implementation plan 3

1. Support and develop HOSI as the Greek forum for open science, where policy and technical developments are being discussed and overseen

The PSF panel recommends supporting and developing the HOSI as a key vehicle for discussing, agreeing, and overseeing the future policy and technical developments that are needed to foster open science practices in the Greek research ecosystem. The draft national plan for open science, currently being discussed by the Greek authorities, includes many relevant ideas for improving open science practices. This plan could form the basis for a thorough action plan, whose implementation details could be discussed, agreed, and monitored within HOSI, with the support of the relevant ministries and authorities. A number of actions must be taken to reform the current structure of HOSI, so as to ensure it has the means to effectively play this role (see actions 1, 2, and 3).

2. Incentivise NRIs to support FAIR data and contribute to the open science agenda

A successful open science strategy cannot only rely on the goodwill of research facilities. NRIs should be incentivised to provide FAIR data through clear requirements set as part of the national roadmap selection process and through continuous evaluation and monitoring (see actions 4, 5 and 6).

3. Strengthen the technical infrastructure and support collaboration between thematic and horizontal infrastructures and services

Open science increasingly relies on the use of digital technologies, for accessing, analysing, sharing and preserving research data. This calls for greater collaboration between all stakeholders, in particular RIs and e-Infrastructures. However, progress is not only about developing technical solutions, but also about defining the right organisational, collaboration and business model required to ensure a sustainable collaboration (see actions 7 and 8).

6.3. Description of the proposed actions

Action 3.1: HOSI Mandate	Give mandate to HOSI to oversee the implementation of the Open Science agenda in Greece
Action owner(s)	GSRI, Ministry of Digital Governance, MERAS
Timeframe	Q3 2023 / Q4 2026
Resources	Regulatory/administrative measures
Description of the action	HOSI should be given a clear mandate from the relevant Greek authorities to oversee the implementation of the Open Science agenda in Greece. We recommend following the Finnish example, where the research community has been entrusted to draft open science policies and implement them locally. This will ensure maximum participation from the stakeholders: ultimately, they are the ones responsible for implementing the actions. In such a model, an efficient monitoring system should be put in place, in order to follow the implementation of the agreed policies. Such a system will help the stakeholders to monitor their own open science activities and compare their situation with others; it may also be used by the funding authorities to assess the contribution to the Open Science agenda of the research community and its organisations. We recommend that such a monitoring system be developed by the research community itself, as part of HOSI, via the creation of a separate Expert Group on Monitoring.
Milestones	Q3 2023: Decision from Greek authorities on HOSI role and mandate. Q4 2023: Revised national plan for open science agreed by HOSI. Q1 2024: Expert Group on Monitoring established. Q1 2025: First assessment of OS policies implementation in Greece.

Action 3.2: HOSI Governance	Revise HOSI Governance to include more effective steering from stakeholders
Action owner(s)	HOSI, GSRI
Timeframe	Q3 2023 / Q3 2024
Resources	Regulatory/administrative measures

Action 3.2: HOSI Governance	Revise HOSI Governance to include more effective steering from stakeholders
Description of the action	The governing and management structure of HOSI should be revised to include more effective steering from stakeholders and stronger leadership. In particular, we recommend to: a) Enlarge the steering group to include universities and research funders (such as GSRI). This will ensure a wider stakeholder base for HOSI and maximise its outreach. It is essential that all stakeholders who are expected to have a role to play in the development of open science in research and education are represented in the initiative and participate in the definition of the policies that will ultimately impact them. Representatives should have a certain level of seniority and a capability to make decisions on behalf of their organisation. b) Appoint a national coordinator who is entrusted to coordinate HOSI activities and is supported by a dedicated Secretariat. If for some reason the current bicephalic structure (President / Vice-President) must be kept, HOSI must seek to appoint leaders who will strive to achieve consensus within the community. A clear division of roles and responsibilities between the current President and Vice-President functions must also be agreed upon. c) Set up new Expert Groups on priority topics (starting with Monitoring). The establishment of Expert Groups is a means to increase the participation of the wider community in the work of HOSI and will strengthen its capacity of action.
Milestones	Q3/2024: 50% of the Greek universities have joined HOSI. Q1/2024: new terms of reference clarifying the role of the different management bodies are approved. Q1/2024: new Expert Groups have been established.

Action 3.3: HOSI Funding	Support HOSI financially to be able to effectively coordinate discussion and activities
Action owner(s)	GSRI
Timeframe	Q3 2023 / Q1 2024
Resources	Funding measures
Description of the action	HOSI should be supported financially to be able to effectively coordinate discussion and activities. We recommend allocating at least 2 FTE to support the work of the coordinating organisation. We suggest investigating the possibility to earmark the corresponding budget from the next NRI programme, as a transversal activity of the programme. We also advise GSRI to investigate the possibility to require from all NRI-funded projects that they allocate experts' time to HOSI activities (e.g. a contribution to Expert Groups) and include a specific task and budget for it in their proposal and work plan. The task, which could be similar for all projects, could be entitled 'Liaison with HOSI and contribution to Open Science'. The panel estimates

Action 3.3: HOSI Funding	Support HOSI financially to be able to effectively coordinate discussion and activities
	that a contribution between 0.3 and 0.5 FTE per RI would suffice to effectively contribute to HOSI activities. Nonetheless this should not preclude submission of higher amounts.
Milestones	Q3 2023: funding of HOSI has been agreed at GSRI level.

Action 3.4: NRI Access Policies	NRIs should develop and make available clear access policies
Action owner(s)	NRIs, GSRI, HOSI
Timeframe	Q3 2023 / Q2 2024
Resources	Regulatory/administrative measures
Description of the action	NRIs should be asked to specify their access and usage policies at proposal preparation stage and make them visible to their users during their operation. This recommendation echoes the Greek national plan for open science under preparation, a plan recommending that “access policies (to national research infrastructures, e-Infrastructures, and digital services) are clearly stipulated, documented, and are publicly available to all, without discrimination”. We recommend that such access policies are described in any application for funding, with a commitment from NRIs to publish these policies on their website so they are visible to any visitor of the site. These policies should include information access units, access modes, terms and conditions, support, and data management policies, etc. When access to the infrastructure or its services is restricted, justifications should be provided by the relevant NRI. HOSI should review periodically how this recommendation has been implemented across the NRI ecosystem.
Milestones	Q1 2024: access policies are available on more than 70% of NRIs’ public websites.

Action 3.5: NRI Data Management Plan	NRIs should submit a data management plan as part of the application process
Action owner(s)	NRIs, GSRI
Timeframe	Q3-4 2023
Resources	Regulatory/administrative measures

Action 3.5: NRI Data Management Plan	NRIs should submit a data management plan as part of the application process
Description of the action	NRIs should be required to submit a data management plan as part of the application process. This DMP should include information details about procedures and resources needed for data collection, documentation, access, sharing, storage, and long-term preservation, etc. At the initial stage, we recommend that GSRI duplicates the Core requirements for Data Management Plans template developed by Science Europe[91] and includes this template in the upcoming call. In a later stage, a HOSI Expert Group on DMP could be established to further define the scope of DMPs and related requirements for Greek NRIs, and to establish guidelines for supporting NRIs in writing and implementing their data management plans.
Milestones	Q3 2023: requirement to specify DMP is part of the NRI application call.

Action 3.6: NRI OS Assessment	NRIs' contribution to Open Science should become a performance criterion
Action owner(s)	GSRI, HOSI
Timeframe	Q3 2023 / Q4 2025
Resources	Regulatory/administrative measures
Description of the action	NRIs should describe how they contribute to the Open Science agenda and this contribution should become a metric (or KPI) for measuring a NRI's scientific case (as part of the application process) and effective performance (as part of the regular reviews and discussion between the NRI and GSRI). Examples of metrics could include e.g. measures to FAIRify data, use of certified repositories, publishing guidelines for users, participation in HOSI expert groups, implementation of HOSI recommendations, training, etc. The list of criteria for measuring performances should be jointly discussed and validated within HOSI (e.g. via the Expert Group on Monitoring).
Milestones	Q3 2023: requirement to specify OS contribution is part of the NRI application call.

Action 3.7: NRI e-Infra needs	Assess e-Infra needs at proposal preparation stage and during operation
Action owner(s)	GSRI, GRNET, ATHENA RC, HOSI

[91] See; https://www.scienceeurope.org/media/urspcz0a/se-rdm-template-1-core-requirements-for-data-management-plans.docx

Action 3.7: NRI e-Infra needs	Assess e-Infra needs at proposal preparation stage and during operation
Timeframe	Q3 2023 / Q4 2025
Resources	Regulatory/administrative measures
Description of the action	NRIs e-Infra needs should be assessed at application preparation stage. We recommend introducing a specific section on 'e-needs' following the ESFRI template (see above implementation plan), where NRIs should describe the types of e-Infrastructure (computing, data management, etc.) services and resources that they will need to pursue and develop their activities. This section should be elaborated in collaboration with relevant e-Infrastructure providers, e.g. GRNET and ATHENA RC. Specific attention should be paid to services that support open science practices, e.g. PIDs and other data management services. NRIs should be encouraged to discuss with GRNET prior to submitting their request for funding, so as to encourage dialogue and agreements between NRIs and GRNET over the use of e-Infrastructure resources. Proper arrangements must be made to ensure that externally required capacity is available and committed. For some services, this might require the participation of e-Infrastructure providers in the actual proposals and projects. GSRI should also encourage the NRIs to maintain these plans and roadmaps for the required e-Infrastructure, in collaboration with GRNET and other relevant e-Infrastructures. NRIs and GRNET should increasingly work together on piloting and prototyping new functionalities and services, in order to help refine the definition of the e-Infrastructure requirements for the NRIs and corresponding roadmaps for their implementation.
Milestones	Q3 2023: requirement to describe 'e-needs' is part of the NRI application call.

Action 3.8: EOSC	Support the development of the Greek EOSC node
Action owner(s)	GSRI, GRNET, ATHENA RC, HOSI
Timeframe	Q3 2023 / Q4 2025
Resources	Funding, regulatory/administrative measures
Description of the action	The development and operation of national e-Infrastructure supporting RI needs is of critical importance. The panel recommends strengthening the development of a Greek EOSC node relying on GRNET infrastructure capacity and on the expertise of the wider Greek open science and research community. The Greek EOSC node should provide a set of digital services (computing, storage, persistent identifiers, repositories, etc.) that support open science and the digitalisation of research infrastructures. We suggest establishing a new Expert Group, as part of HOSI, to plan and oversee the development of the node and raise awareness of EOSC and open science activities across the whole Greek research community. The development of the Greek EOSC node will require significant and long-term investment, which cannot be fully covered by the upcoming NRI call. Therefore, we suggest exploring other ways of funding this activity, separately from the RI budget. However, it is important that the collaboration with e-Infrastructures and the national EOSC node is clearly seen as a requirement for all RIs (see recommendation #7

Action 3.8: EOSC	Support the development of the Greek EOSC node
	about urging NRIs to discuss with GRNET and other e-Infrastructure providers, prior to submitting their request for funding).
Milestones	Q1 2024: Expert Group on EOSC established.

7. Cross-cutting conclusions and recommendations

The Greek network of national research infrastructures (NRI) that was launched during the period 2014-2020 is to be followed by a second round of investment during 2021-2027. By encouraging enhanced co-operation ('clustering') within the Greek R&I system, the NRI programme provides a foundation for long-term sustainability of NRIs through improving accessibility to their infrastructures, equipment and research data and reinforcing the quality and effectiveness of their services to users.

The review of the state of the art in Europe and Greece for the three topics addressed by this report suggest that the Greek research infrastructure policy is moving in the right direction and that the planned policy interventions are in line with practice in other, well performing, EU Member States (the Czech Republic, the Netherlands, etc.). If the three implementation plans set out in this report are executed in a timely manner, this should further help to keep Greece amongst the front runners in the EU and will contribute to the European Research Areas (ERA) policy agenda Action 8 to 'strengthen sustainability, accessibility and resilience of research infrastructures in the ERA', as well as reinforcing Greek performance on Action 1 on 'open sharing of knowledge and re-use of research outputs through the development of the European Open Science Cloud.

There remain a number of issues that were not addressed in detail in this report given the agreed scope. These will require due attention in the coming years by the Greek NRI stakeholders and government bodies.

The funding of Greek research infrastructures depends on public sector resources and notably funding provided through EU programmes and financial instruments (including ESIF, the EIB, the R&I FP and more recently the RRF). While there has been a sustained increases in Greek public R&D expenditure (rising to 0.76% of GDP in 2021, which is equivalent to the EU average)[92], the public funding is largely secured through ESIF funding rather than the national budget. Post-2027, there is no guarantee that EU funding to Greece will be of the same order of magnitude as it is (e.g. if Ukraine and Moldova accede to the EU there will be a reallocation of ESIF funding to the newcomers).

Over the coming 3-5 years, there is a need for the development of a research infrastructure funding scenario that gradually scales up national budgetary means made available to the Greek R&I institutions. The example of the Czech Republic, where a more balanced mix of national and ESIF funding is used to fund R&I investments may be a useful 'learning case' for the Greek authorities to study in order to develop in time for the next period a sustainable public sector funding framework.

This multi-annual financial plan for NRIs should be a core element of of the future national research infrastructure roadmap, which should take as a starting point the existing landscape (NRIs and other RIs operating in Greece), to define Greek RI needs to a 2030 plus horizon (as was recommended in the previous PSF Country Report). It is not sufficient to list the selected NRIs as a 'roadmap' but rather see them as a core element of a developing RI landscape that should be designed to contribute to meeting the needs of Greek researchers, innovation and technology development and societal challenges.

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92 See: https://ec.europa.eu/eurostat/en/web/products-eurostat-news/w/DDN-20230804-2

Such a plan should also take account of the need to encourage energy saving and efficiency measures by the NRIs as well as means to ensure stable supply of equipment and materials for the operations of the NRIs[93]. Indeed, the contribution of the NRIs to improving Greek (and EU) 'technological sovereignty' should be considered. The European Parliament (STOA, 2021) has defined technological sovereignty 'as the ability for Europe to develop, provide, protect, and retain critical technologies required for the welfare of European citizens and prosperity of businesses, and the ability to act and decide independently in a globalised environment'. A low importance given to IP protection may hinder NRI sustainability and should be addressed through action to support NRIs to develop appropriate policies.

Moreover, as underlined by the European Commission's 2023 country Report on Greece (EC, 2023a), cooperation between public research bodies and the private sector is insufficient to effectively support knowledge and technology transfer. In particular, public expenditure on R&D financed by business enterprise (5.12% of total public expenditure of R&D in 2020) is lagging behind the EU average (7.45%). Hence, additional options for leveraging increased private co-investment in NRIs should be explored (see the example of Flanders in Figure 8, see also Bucar et al, 2023). This may include further consideration of the form of legal entity adopted over time by NRI so as to facilitate public-private partnerships in research and technology infrastructures.

The report has underlined the need for a broader awareness of the potential contribution of NRIs to supporting policy implementation across various government ministries and the public sector. The adoption of a 'whole of government' approach by involving a group of stakeholders ministries in steering the NRI development may help to ensure better buy in (joint-investments, etc.) and uptake of NRI services. NRIs should be encouraged to develop stakeholder engagement strategies that address a broad range of users and contribute to addressing societal challenges faced by Greece.

[93] See: https://www.esfri.eu/latest-esfri-news/esfri-report-energy-supply-challenges-ris

8. Annexes

8.1. Annex 1 – Interviewees/participants in meetings

National Research Infrastructure representatives

- Dr. Dimitrios KLETSAS, An Open-Access Research Infrastructure of Chemical Biology and Target-Based Screening Technologies for Human and Animal Health, Agriculture and the Environment (OPENSCREEN-GR)
- Dr. Panagiotis KONSTANTOPOULOS, Greek Infrastructure for Digital Arts, Humanities and Language Research and Innovation (APOLLONIS)
- Mrs. Despina MICHOU, National Digital Infrastructures for Research (HELIX)
- Dr. Georgios DRAKATOS, HeLlenic Plate Observing System (HELPOS)
- Prof. Charalambos SAVAKIS, Managing and Analyzing Biological Data (ELIXIR-GR)
- Prof. Constantinos MATHIOPOULOS, Synthetic Biology: From omics technologies to genomic engineering (OMIC-ENGINE)
- Prof. Zisis SAMARAS, Centre of Excellence for Future Vehicle Environmental Performance (FuveP)
- Dr. Apostolos LINARDIS & Dr. Dimitra KONDYLI, SoDaNet in Action (SoDaNet)
- Dr. Athanassios MACHIAS, Coordinator of PHILIA
- Dr. Georgios DRAKATOS, Coordinator of HELPOS
- Dr. Leonidas PERIVOLIOTIS, Coordinator of HIMIOFoTS
- Georgios AGGELOPOULOS, the Coordinator of INVALOR
- Dr. Panagiotis KASAPIDIS on behalf of the Coordinator of CMBR
- Prof. Nikos MICHALOPOULOS, Coordinator of PANACEA
- Dr. Eleni PAPAIOANNOU on behalf of the Coordinator of PROMETHEUS
- Giorgos KOLLIAS, Coordinator of INFRAFRONTIER-PHENOTYPOS
- Evangelia CHRYSSINA, Coordinator of INSPIRED
- Dimitrios KLETSAS, Coordinator of OPENSCREEN-GR
- Charalambos SAVAKIS, Coordinator of ELIXIR-GR
- Petros SFIKAKIS, Coordinator of pMED
- Nektarios TAVERNARAKIS, Coordinator of BIOIMAGING-GR
- Dr. Sissy KOLYVA, on behalf of the Coordinator of BBMRI-GR
- Dr. Constantin TAMVAKOPOULOS, Coordinator EATRIS GR
- Dr. Vassilios KILIKOGLOU, Coordinator of INNOVATION.EL
- Dr. Sotirios CHARISSOPOULOS, Coordinator of CALIBRA
- Prof. Demetrios ANGLOS, Coordinator of HELLAS-CH
- Prof. Constantinos FOUNDAS, Coordinator of Detector Development and Technologies for High Energy Physics
- Panagiotis KONSTANTOPOULOS, Coordinator of APOLLONIS
- Dimitra KONDYLI, Coordinator of So.Da.Net / CESSDA_GR
- Prof. Amalia POLYDOROPOUOU, Coordinator of EN.I.R.I.S.S.T.
- Prof. Alexios-Leandros SKALTSOUNIS, on behalf of the Coordinator of PLANTUP
- Prof. Georgios THEODORIDIS, Coordinator of FoodOmicsGR
- Prof. Maria KANELLAKI, Coordinator of Food Innovation RI
- Prof. Constantinos MATHIOPOULOS, Coordinator of OMIC-ENGINE

Managing Authority of the Operational Programme 'Competitiveness, Entrepreneurship & Innovation'

- Dr. Aggeliki FETSI
- Mrs. Eleni KRITIKOU
- Mr. Efthimios KOUTROUKIS
- Mr. Minas DIAKOLIOS
- Mrs. Eleni ZOGGOU
- Mrs. Sophia LIAPA
- Mrs. Eleni PAPADOPOULOU
- Georgios MARGARITIS
- Dr. Emmanouel KALOGERIS
- Evangelia VAVASSI

Representatives of selected organisations

- Stefanos KOLLIAS, National Infrastructures for Research and Technology (GRNET)
- Ognjen PRNJAT, National Infrastructures for Research and Technology (GRNET)
- Kostas KOUMANTAROS, National Infrastructures for Research and Technology (GRNET)
- Evangelia D. CHRYSINA, National Hellenic Research Foundation (NHRF)
- Elli PAPADOPOULOU, Hellenic Open Science Initiative (HOSI)
- Spiros ATHANASIOU, Hellenic Open Science Initiative (HOSI)
- Lia OLLANDEZOU, HEAL-Link Consortium (Hellenic Academic Libraries Link)
- Vangelis Karkaletsis, NCSR Demokritos
- Dimosthenis SARIGIANNIS, President & General Director, NHRF
- Yannis IOANNIDIS, former Greek ESFRI delegate
- Prof. Spyros ANASTASIADIS, Greek ESFRI delegate
- Dr. Paraskevi SACHINI, Director of NDC
- Prof. Ioannis EMIRIS, President & General Director, 'Athena' RC
- Dr. Vangelis KARKALETSIS, NCSR Demokritos
- Prof. Dimosthenis SARIGIANNIS, President & General Director, NHRF
- Prof. Yannis IOANNIDIS, Greek ESFRI delegate
- Dr. Paraskevi SACHINI, Director of NDC

General Secretariat for Research and Innovation (GSRI)

- Mrs. Iro ANASTASOPOULOU, Cabinet officer of the Deputy Minister of Development and Investments
- Dr. Agni SPILIOTI, Head of the Planning and Programming of Policy Actions for RTDI Directorate
- Dr. Antonios GYPAKIS, Head of the Policy Planning Department
- Dr. Efthimios SAKELLARIOU, Policy Officer of Dept. of the Policy Planning Department
- Mr. Vasileios GOGGOLIDIS, Head of the Innovation Action Planning Department
- Dr. Maria CHRISTOULA, Head of International Scientific and Technological Cooperation Directorate
- Dr. Petros SAMPATAKOS, Officer of the of International Scientific and Technological Cooperation Directorate
- Mrs. Argyro KARAHALIOU, Officer of the of International Scientific and Technological Cooperation Directorate - Greek ESFRI delegate
- Dr. Fenia Adamidou, Head of the General Secretary for Research and Innovation Cabinet

Policy-makers

- Mrs. Evaggelia SOFOULI, Head of Directorate for Research and Technology Bodies Supervision (Recovery and Resilience Fund)
- Prof. Serko HAROUTOUNIAN, Chairman ELGO “DIMITRA”, Ministry of Agriculture
- Mr. Panagiotis CHATZINIKOLAOU, CEO ELGO “DIMITRA”, Ministry of Agriculture
- Prof. Periklis Mitkas, President of The Hellenic Authority for Higher Education
- Dr Nikos Mouravlianski, Ministry of Digital Transformation
- Prof Spyridon ARTAVANIS-TSAKONAS, President of the National Council for Research, Technology, and Innovation (NCRTI)
- Dr. Aristos DOXIADIS, Vice-President of National Council for Research, Technology, and Innovation (NCRTI)
- Dr. Katerina Kouravelou, Hellenic Foundation for Research, and Innovation (HFRI)

PSF Open Expert Panel

- Alasdair REID
- Thomas ZACHAREWICZ
- Damien LECARPENTIER
- George STROGYLOPOULOS
- Susana ELENA-PEREZ

DG R&I, European Commission

- Vladimir MANOLOV

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8.3. Annex 3 – Greek NRIs funded during the 2014-2020 period

National Research Infrastructure	NRI full title	# of partners	Approved Budget (€)	Website
Food Innovation	Infrastructure on Food Bioprocessing Development and Innovation Exploitation	6	3,000,000	https://www.foodinnovations.gr/
FoodOmicsGR	A consortium for comprehensive molecular characterisation of food products	8	2,998,998	http://foodomics.gr/
OMIC-ENGINE	Synthetic Biology: from omics technologies to genomic engineering	9	4,000,000	https://www.omicengine.com/
PLANT-UP	Upgrading the Plant Capital	7	3,865,625	http://plant-up.com
FuVEP	Centre of Excellence for Future Vehicle Environmental Performance	3	3,662,591	https://fuvep.com
PROMETHEUS	A Research Infrastructure for the Integrated Energy Chain	2	3,680,263	
CMBR	Centre for the study and sustainable exploitation of Marine Biological Resources	7	4,000,000	https://cmbr.hcmr.gr/
HELPOS	Hellenic Plate Observing System	8	3,965,844	
HIMIOFoTS	Hellenic Integrated Marine and Inland Water Observing Forecasting and Offshore Technology System	7	3,991,975	https://www.himiofots.gr
INVALOR	Research Infrastructure for Waste Valorisation and Sustainable Management of Resources	7	3,899,713	https://www.invalor.org/
PANACEA	Panhellenic infrastructure for atmospheric composition and climate change	14	3,999,950	https://panacea-ri.gr
RePHIL	Hellenic Research Fleet / reconstruction of the research vessel PHILIA	2	3,133,006	https://www.rephil.eu
BBMRI-GR	Strategic expansion of the Greek Biobanking Infrastructure	9	497,000	http://biobank.bioacademy.gr/
BIOIMAGING-GR	A Greek Research Infrastructure for Visualising and Monitoring Fundamental Biological Processes	11	4,000,000	https://bioimaging.g
EATRIS-GR	Infrastructure for preclinical and early-phase clinical development of drugs, therapeutics and biomedical devices	7	499,000	http://htri.gr/
ELIXIR-GR	Managing and Analysing Biological Data	17	3,991,000	https://www.elixir-greece.org/
INFRAFRONTIER	The Greek Research Infrastructure for Molecular and Behavioural Phenotyping of biological model organisms for chronic degenerative diseases	3	4,000,000	https://www.infrafrontier.gr/
INSPIRED	The National Research Infrastructures on Integrated Structural Biology, Drug Screening Efforts and Drug target functional characterisation	14	3,819,000	https://www.inspired-ris.gr/
OPENSCREEN-GR	An Open-Access Research Infrastructure of Chemical Biology and Target-Based Screening Technologies for Human and Animal Health, Agriculture and the Environment	7	3,025,00	https://openscreen.bio.demokritos.gr/
pMedGR	The Greek Research Infrastructure for Personalised Medicine	3	4,000,000	https://www.precisionmedicine.gr
INNOVATION.EL	National Infrastructure in Nanotechnology, Advanced Materials and Micro / Nanoelectronics	7	4,000,000	https://innovation-el.net
DeTANeT	Detector Development and Technologies for High Energy Physics	3	500,000	
CALIBRA	Cluster of Accelerator Laboratories for Ion Beam Research	1	3,422,200	http://www.inp.demokritos.gr/calibra

National Research Infrastructure	NRI full title	# of partners	Approved Budget (€)	Website
HELLAS-CH	The HiPER, ELI and LASERLAB Europe Synergy & IPERION-CH	12	3,997,016	https://hellasch.iesl.forth.gr
APOLLONIS	National Infrastructure for Digital Arts, Humanities and Language Research and Innovation	11	4,000,000	https://apollonis-infrastructure.gr/
ENIRISST	Intelligent Research Infrastructure for Shipping, Supply chain, Transport and Logistics	11	2,974,891	https://www.enirisst.gr/
HELIX:	National Digital Infrastructures for Research	3	3,859,823	https://hellenicdataservice.gr/main/
SoDaNet	CESSDA_GR - The Greek RI for social sciences	7	1,066,340	https://sodanet.gr/

Source: PSF Country Report Greece (EC, 2022)

8.4. Annex 4 – Table of obligatory KPIs for NRIs 2021-2027

Category	Indicator(s)	Detailed indicators	Periodicity
Research Infrastructure usage	Usage of the NRI	For NRIs providing access to facilities/equipment: • Number of requests for use received and granted. • Total annual usage hours by users external to NRI consortium partners as % of total available usage hours. Broken down by academic users, business users (and other user types depending on the NRI) and whether Greek or internationally located. For resource/data NRIs one or more of the following : • number of registered users of collections or data services, • Number of downloads of datasets or digital resources. Broken down by academic users, business users (and other user types depending on the NRI) and whether Greek or internationally located.	Annually plus cumulative over 3-5 years period (depending on length of grant). Targets set for the KPI may evolve over time – e.g. in year 1 a lower number of users, rising year-on-year, etc.
Training and education	Number of students using and being trained at the NRI	Number of masters and PhD students who have been trained at or performed some of their studies/research at the NRI. Each student should only be counted once per year (not per access). The indicator can also further quantified by the number of training hours at the NRI provided (per student). Data should be broken down by: • Masters / PHD / others (e.g. short courses for industrial researchers). • Distinguishing between students funded/hosted by NRI consortium partners and external to NRI students • by nationality (Greek or international).	Annually plus cumulative over 3-5 years period (depending on length of grant)
Income	Income generated by the NRI additional to ERDF grant	Total income generated broken down by source: • grant (e.g. Horizon Europe, other national or regional programmes, etc.), • charitable donation, • payment for services provided • intellectual property licence payments, etc.), • others (to specify).	Annually plus cumulative over 3-5 years period (depending on length of grant). Ideally, this KPI should be framed within a financial plan indicating how the NRI will raise increasing levels of additional revenue over the lifetime of the ERDF funded project.

Category	Indicator(s)	Detailed indicators	Periodicity
		By type of organisation providing the funding: public, private, NGO, etc. Where funding is provided by business, categorise by the relevant S3 priority. By share of income from Greece, other EU Member States', EU level programmes (Horizon Europe, etc.) or non-EU countries.	
Publications	Number of publications acknowledging use/services provided by the NRI	Number of publications based on research performed using facilities and (digital) resources provided by the NRI. Distinguishing between publications authored by researchers of the NRI consortium partners and external researchers. Over time this indicator can be further refined, e.g. to track the percentage of open access publications, the percentage of publications in the top (10%) cited publications in the same field and the percentage of publications co-published with industry.	Annually plus cumulative over 3-5 years period (depending on length of grant). Assumes that the NRI has in place a requirement for users to cite usage/services of NRI and/or monitoring in place of publications by users. This may provide a basis for a bibliometric analysis but only after a sufficient time period (5 years)
Open Science	Number of publicly accessible datasets used externally	Number of data sets produced as a result of researchers using the NRI that are subsequently accessed by other users. For date NRIs, number of datasets (digital objects), metadata, software, etc. made available to users, For NRIs that do not yet have publicly accessible datasets, alternative indicators may be used that measure progress towards making open research data available.	Annually plus cumulative over 3-5 years period (depending on length of grant

8.5. Annex 5 – Indicative template for periodic reporting by NRIs

This template is provided as a possible framework that could be used by the NRIs for preparing an annual or periodic (mid-term, final) report.

1. NRI identity card

NRI full name	Insert name
Date NRI created	Insert date
Coordinator	Institution
Coordinator contact	Name and email
Partner institutions	List of institutions (including where relevant industry partners)
NRI website	Provide a web site URL
Member of ESFRI RI or other international RI	If yes – indicate which one(s) and from what date
Mission / objectives	Short description of the expected contribution of the NRI to research, education, economic and sustainable development goals.
Main facilities, equipment and services provided	List of core facilities, services etc. – this can be done by pointing to an available catalogue of services.
Funding received to date	Indicate amount by period

2. Governance structure and management procedures

This section should provide an overview of the NRI's governance and management structures and highlight actions taken to ensure effective strategic and operational management.

- Governance and strategic management

An organisational chart should be included highlighting the main governance bodies and management structure. Discuss the contribution of these governance bodies to the NRIs strategic planning, etc. and annual planning and reporting procedures.

- Operational and financial management.

Describe the management arrangements put in place to ensure an effective functioning of the NRI including measures taken to improve long-term financial sustainability (cost minimisation, e.g. energy, and coverage, revenue generation, etc.). Highlight any challenges or issues arising since the last report and solutions proposed.

- Policies and practices for recruitment, training, health & safety gender equality and scientific ethics.

Describe developments in the above policies to ensure the NRI operates in line with required research career and other relevant guidelines and good practices.

- Environmental policies – discuss action taken to limit or reduce the environmental impact of the NRI operations.
- Risk management and mitigation policy – present actions identified to anticipate and mitigate identified risks.

3. Quality of user access policy

Describe the measures (e.g. catalogue of services, promotional actions) taken to ensure that potential users are aware of the NRIs services, equipment, data, training or software resources, etc.

Explain the access procedure for users (single point of access, assistance to users for applications, registration procedures, etc.) and how user access is decided (scientific committee, fee based, etc.).

Are there specific measures in place to attract younger or female researchers ?

What action has been taken to inform and provide access to users based in other EU Member States (and third countries) ?

Comment the KPIs related to usage – including the importance of business/industrial users.

4. Strategic outlook/position of the NRI in the Greek R&I system

Discuss the position of the NRI in the Greek R&I system notably in terms of the unique nature of the facilities, equipment or data services available. Highlight areas for possible co-operation with other Greek research infrastructures or facilities or other NRI.

What action has been taken to develop a community of researchers in the scientific field(s) that the NRI operates in – e.g. organisation of scientific workshops, etc. – and to develop further a broad-based user community

Discuss the extent of business/industrial interest in the research being carried out at the NRI or in the industrial usage of the NRI facilities, equipment, datasets, etc.

5. European and international collaboration / position of the NRI

This section should assess the progress made in improving the European and international visibility of the NRI.

- Transnational access

Describe measures taken to encourage use and access for non-Greek researchers to the NRI facilities.

- Participation to or collaboration with ESFRI Landmarks/ERICs and EOSC

Describe the participation of the NRI (consortium partners) in activities of European level RIs including actions related to the EOSC.

- Involvement of the NRI (consortium partners) in Horizon Europe projects or other EU programmes

Present and explain how the NRI is being positioned within EU funded projects or inter-regional co-operation in order to promote the NRI's expertise and services.

- Other international collaboration – e.g. with third (non-EU) countries or international organisations, etc.

Describe any other international collaboration activities with non-EU partners.

6. Contribution to improving research excellence and education

- Contribution to research performance in the field of the NRI

Explain the nature of support provided to researchers and how this has contributed to enhancing research excellence and research careers in Greece and internationally. This may be illustrated by specific examples. The contribution to gender equality in research should be highlighted.

- Education and training of students, researchers and other users

Describe briefly the progress made in implementing educational activities for masters and doctoral (PhD) students as well as short-term specialised training provided to researchers and other users such as from business. Highlight impact on gender equality in science.

- Activities undertaken to improve research data management and promote open science.

Give the NRIs data management plan, describe what action the NRI has taken during the period to further improve and enhance FAIR data management and open science practices.

7. Impact on innovation - economy and society

This section should present the NRIs contribution to specific national priorities, notably the smart specialisation strategy priorities or other thematic strategies. This could be based on the identification and description of a number of 'impact pathways' linked to KPIs or impact cases.

- Innovation and application-related activities and intellectual policy (IP) practices.

Describe actions taken to ensure that research carried out at the NRI is translated into commercial or societal applications. Where possible provide examples or quantify the impact through KPIs. Explain how IP policies are designed to optimise impact.

- Contribution to policy development or implementing in specific fields – e.g. environment, health, mobility, energy, etc.

Describe the contribution of the research carried out at the NRI on specific policy fields and to meeting specific national development objectives, or contributing to sustainable development goals (SDGs).

8. Key performance indicators – progress compared to targets

KPI	Target value	2024 achieved	2025 achieved	2026 achieved	2027 achieved

*add lines as required

9. Impact cases

Annex impact cases illustrating impact of different types – using the impact case template.

8.6. Annex 6 – Indicative template for impact cases

Title of impact case study: insert an appealing short title

1. Media ready summary of the impact (indicative maximum 100 words)

This section should briefly describe the specific impact elaborated in the impact case study. This should be written in a way that it can be read as a stand-alone summary (e.g. placed on a website, etc.) and include one or more photos[94].

2. Type of impact area (select one or more)[95]

- Human resource (training of researchers, new skills,
- Economy and innovation (product and process innovations,
- Societal (including environmental improvements, social well-being, health, etc.)
- Policy (impact on policy including contribution to policy-making, support regulatory change, etc.)

3. Impact details

This section should provide a narrative, with supporting evidence, to explain:

- how the research infrastructure services underpinned (made a distinct and material contribution to) the impact
- the nature and extent of the impact.

The following should be provided:

- A clear explanation of the process or means through which the RI services have led to, underpinned or made a contribution to the impact. For example, the way in which the RI provided specific support to a researcher (research team) to conduct an experiment, or to a business for testing products, processes, etc., how the RI supported the dissemination of knowledge (e.g. research data management, open science methods), how the RI provided training or support to influence users or beneficiaries of the research conducted at the RI, or how the RI provided support so that research results came to be exploited, taken up or applied.
- Details of the beneficiaries – who or what community, group or organisation has benefitted, been affected or impacted.
- Details of the nature of the impact – how they have benefitted or impacted on specific business, societal or public policy developments.
- Evidence or indicators of the extent of the impact described, as appropriate to the case being made.

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94 See for example : https://www.infraportal.org.uk/case-study/energy/3d-vision-camera-system-integrated-with-ai

95 See: https://ri-paths-tool.eu/en/impact-areas

- Dates of when these impacts occurred (provide a timeline from the first moment the RI provided services to users until the results being reported on were achieved).

4. Sources to corroborate the impact (indicative maximum of 5 sources)

This section should list sources that provide corroboration of specific claims made in the case study. Sources provided in this section should not be a substitute for providing clear evidence of impact in section 4 but should provide additional material or evidence (e.g. publications, links to news articles or policy papers, photos/images). This could include testimonials from users, etc.

5. For further details

Insert a link to the website of the NRI and the contact details of the person from whom further details can be provided.

In person
All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing
Europe Direct is a service that answers your questions about the European Union.
You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696,
- via the following form: european-union.europa.eu/contact-eu/write-us_en.

Online
Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications
You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents
For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

EU open data
The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

Building on the findings of the previous PSF Country review, this report presents a set of actions designed to enhance the long-term sustainability and performance of the Greek national research infrastructures, including boosting their contribution to open science and research data practices. The report develops three implementation plans based on a review of good practice at European and national levels and sets out a series of practical step-by-step procedures to ensure effective public-private investments into Greek research infrastructures during the period 2021-2027.

Studies and reports

Publications Office
of the European Union