



EGI-InSPIRE

EGI SUSTAINABILITY PLAN

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Abstract

Sustainability is an essential consideration for e-Infrastructures and the Research Infrastructures and research communities that they support. Many of these Research Infrastructures and research communities frequently have research agendas measured in decades and need to be assured of the continued operational presence of the e-Infrastructures that they adopt to support their work, and the appropriate governance to evolve this operational presence in response to their changing needs and changing circumstances. EGI's strategy is to connect researchers from all fields of science across the whole digital European Research Area with the reliable and innovative ICT services they need to undertake their collaborative world-class and world-inclusive research. This report therefore focuses on the efforts and plans being undertaken to ensure that the services offered will be sustainably delivered and improved. This document also serves as an update to D2.13 – EGI Sustainability Plan from last year.



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IV. APPLICATION AREA

This document is a formal deliverable for the European Commission, applicable to all members of the EGI-InSPIRE project, beneficiaries and JRU members, as well as its collaborating projects.

V. DOCUMENT AMENDMENT PROCEDURE

Amendments, comments and suggestions should be sent to the authors. The procedures documented in the EGI-InSPIRE “Document Management Procedure” will be followed: <https://wiki.egi.eu/wiki/Procedures>

VI. TERMINOLOGY

A complete project glossary is provided at the following page: <http://www.egi.eu/about/glossary>
The following table provides a set of terms that are used in this document.



Term	Description
Researchers	Consumers of e-Science services that are supported by e-Infrastructures to perform their digital research; they are interested in services that can rapidly adapt and integrate with their workflows to conduct their research, achieve faster results, publish first and gain the recognition of their peers. They can be organised in research collaborations or Virtual Research Communities (VRCs).
Technology Providers	The technology area within the EGI ecosystem is built upon open-source or commercial software coming from technology providers within the EGI community and generic technology providers outside of it that are put together by platform integrators to meet the needs of particular research communities.
National Infrastructures	These include the NGIs that represent national activities within EGI and undertake national coordination duties through the resource infrastructure provider role. They have the responsibility to manage and deliver the operational infrastructure coming from the individual 'resource centres' within the country. They may also have the responsibility to act as platform operators for particular research communities ensuring that any research community specific services provided by the resource centres are operating effectively.
European Coordination	For EGI, the EGI.eu organisation provides the vehicle for community coordination, policy, governance, outreach, operation and interaction within the EGI ecosystem and with similar peer bodies in other e-Infrastructures in Europe and around the world.
Funding Bodies	The European Commission, national research councils or other organisations that define policies and funding schemes to support the digital research.



VII. PROJECT SUMMARY

To support science and innovation, a lasting operational model for e-Science is needed – both for coordinating the infrastructure and for delivering integrated services that cross national borders. The EGI-InSPIRE project will support the transition from a project-based system to a sustainable pan-European e-Infrastructure, by supporting ‘grids’ of high-performance computing (HPC) and high-throughput computing (HTC) resources. EGI-InSPIRE will also be ideally placed to integrate new Distributed Computing Infrastructures (DCIs) such as clouds, supercomputing networks and desktop grids, to benefit user communities within the European Research Area.

EGI-InSPIRE will collect user requirements and provide support for the current and potential new user communities, for example within the ESFRI projects. Additional support will also be given to the current heavy users of the infrastructure, such as high energy physics, computational chemistry and life sciences, as they move their critical services and tools from a centralised support model to one driven by their own individual communities.

The objectives of the project are:

1. The continued operation and expansion of today’s production infrastructure by transitioning to a governance model and operational infrastructure that can be increasingly sustained outside of specific project funding.
2. The continued support of researchers within Europe and their international collaborators that are using the current production infrastructure.
3. The support for current heavy users of the infrastructure in earth science, astronomy and astrophysics, fusion, computational chemistry and materials science technology, life sciences and high energy physics as they move to sustainable support models for their own communities.
4. Interfaces that expand access to new user communities including new potential heavy users of the infrastructure from the ESFRI projects.
5. Mechanisms to integrate existing infrastructure providers in Europe and around the world into the production infrastructure, so as to provide transparent access to all authorised users.
6. Establish processes and procedures to allow the integration of new DCI technologies (e.g. clouds, volunteer desktop grids) and heterogeneous resources (e.g. HTC and HPC) into a seamless production infrastructure as they mature and demonstrate value to the EGI community.

The EGI community is a federation of independent national and community resource providers, whose resources support specific research communities and international collaborators both within Europe and worldwide. EGI.eu, coordinator of EGI-InSPIRE, brings together partner institutions established within the community to provide a set of essential human and technical services that enable secure integrated access to distributed resources on behalf of the community. The production infrastructure supports Virtual Research Communities (VRCs) – structured international user communities – that are grouped into specific research domains. VRCs are formally represented within EGI at both a technical and strategic level.



VIII. EXECUTIVE SUMMARY

The main objective of the EGI-InSPIRE project is to move towards a sustainable e-Infrastructure for European and global researchers. As the project moves into its final year, sustainability plans have become increasingly coupled with EGI's long-term strategy to connect researchers from all fields of science across the whole European Research Area (ERA) with the reliable and innovative ICT services they need to undertake their collaborative world-class and world-inclusive research.

This report focuses on the analysis that has led to the strategic decisions regarding the services that will provide the highest value to a defined group of customers that best address their needs. This starts with understanding the current status of the European Grid Infrastructure and the environment in which it operates including political, social, economical and technological factors. These factors allow the identification of potential opportunities and issues to what is being provided and what services need to be developed to answer the needs. These needs are identified by grouping current and potential customers through the creation of research profiles.

Moving into the future, different scenarios for strategic planning are also described that includes defined activities within varying funding levels, the impact of each and potential risks and mitigation to those scenarios. These scenarios then lead to the grand vision of EGI in which each stakeholder must strive to achieve it. This will position EGI as the global leader of ICT services dedicated to scientific research and development.

The activities that have taken place over the last year to evolve EGI's sustainability plan and strategic direction, including risk assessments, have also been provided as part of the annex of this report. The structure follows the aspects covered in last year's report, which comprised organisational, technical, financial and legal aspects.

Overall, this report demonstrates how EGI can sustainability offer services through strategic planning that goes beyond financial issues and into areas such as instilling confidence that the service will be available for years to come, offering predictability for how services are provided and increasing user satisfaction with targeted services based on their individual needs with more efficient service management.

This updated sustainability plan provides increasing clarity to the current and future services that will answer the needs of an evolving IT and research landscape. The services will be available for European researchers and beyond for years to come and ultimately provide support in making every researcher digital in the ERA by 2020.



TABLE OF CONTENTS

1	INTRODUCTION	8
2	THE EUROPEAN GRID INFRASTRUCTURE	9
2.1	Current Status	9
2.2	EGI 2020 Strategy	9
2.3	Purpose and Value	10
2.4	Service Portfolio	10
2.4.1	EGI.eu Service Portfolio	10
2.4.2	EGI Partnership Service Portfolio	11
2.5	Analysis	11
2.5.1	PEST Analysis	11
2.5.2	SWOT Analysis	12
2.6	Risk Assessment and Management	13
3	EGI AND THE EUROPEAN RESEARCH AREA	14
3.1	Market Segmentation	14
3.2	Solution Portfolio	15
3.3	Summary	16
4	PLANNING SCENARIOS	19
4.1	Revenue Streams	19
4.2	Maintaining a production infrastructure	20
4.2.1	Activity	20
4.2.2	Required Funding Levels	20
4.2.3	Impact	21
4.2.4	Risks and Mitigation	21
4.3	Developing the production infrastructure	22
4.3.1	Activity	22
4.3.2	Funding Levels	22
4.3.3	Impact	22
4.3.4	Risks and Mitigation	22
4.4	A Grand Vision for Open Computing and Data Infrastructures in the ERA	23
4.4.1	Activity	23
4.4.2	Required Funding Levels	23
4.4.3	Impact	23
4.4.4	Risks and Mitigation	23
5	CONCLUSIONS	25
6	REFERENCES	26
7	ANNEX 1: EGI'S SUSTAINABILITY ACTIVITIES	27
7.1	Organisational	27
7.2	Technological	30
7.3	Financial	34
7.4	Legal	37
8	ANNEX 2: RISK ASSESSMENTS AND MITIGATION	39



TABLE OF FIGURES

<i>Figure 1: Strategic pillars within EGI Platform Architecture.....</i>	<i>15</i>
<i>Figure 2: EGI Ecosystem Overview.....</i>	<i>27</i>
<i>Figure 3: Relationships between roles of the EGI Ecosystem and Services.....</i>	<i>28</i>
<i>Figure 4: Brokerage Model Example: One-Stop-Shop.....</i>	<i>30</i>
<i>Figure 5: e-FISCAL HTC cost breakdown (median).....</i>	<i>35</i>

TABLE OF TABLES

<i>Table 1: PEST Analysis for EGI.....</i>	<i>12</i>
<i>Table 2: SWOT Analysis for EGI.....</i>	<i>13</i>
<i>Table 3: Market Segment Profiles.....</i>	<i>15</i>
<i>Table 4: Research Profiles to Solution Portfolio.....</i>	<i>18</i>
<i>Table 5: EGI Revenue Streams, Levels and Issues.....</i>	<i>20</i>
<i>Table 6: Maintaining a Production Infrastructure Risks and Mitigation.....</i>	<i>21</i>
<i>Table 7: Developing a Production Infrastructure Risks and Mitigation.....</i>	<i>22</i>
<i>Table 8: EGI Grand Vision Risks and Mitigation.....</i>	<i>24</i>
<i>Table 9: Stakeholders and Actors in the EGI Platform ecosystem.....</i>	<i>28</i>
<i>Table 10: EGI transition plan for EMI and IGE services.....</i>	<i>31</i>
<i>Table 11: Legal Entities to Coordination Services.....</i>	<i>38</i>
<i>Table 12: Risk Assessment and Management.....</i>	<i>39</i>



1 INTRODUCTION

Sustainability is a critical aspect in building the adoption of e-Infrastructures by the Research Infrastructures and research communities within the European Research Area (ERA). To ensure a sustainable infrastructure for decades to come, EGI's strategy is to establish an open ICT ecosystem that can attract research communities from across the whole digital ERA. This report focuses on the efforts and plans being undertaken to ensure that the services offered will be sustainably delivered and improved, which are presented in the following structure.

Section 2 provides the current status of the European Grid Infrastructure, its strategy for 2020, the purpose and value that it delivers through a defined service portfolio and a number of analysis and assessments that will ensure EGI will continue to provide the required services to a targeted customer base.

Section 3 defines the customer segments, the services that will be offered to answer specific needs and how each correlate.

Section 4 offers different scenarios for strategic planning that includes defined activities to varying funding levels, the impact of each and potential risks and mitigation. These scenarios lead to the grand vision of EGI in which each stakeholder must strive to achieve that will position EGI as the global leader of ICT services dedicated to scientific research and development in Europe and beyond.

The Annexes concentrate on the activities that have taken place of the last year to evolve EGI's sustainability plan and strategic direction including risk assessments.



2 THE EUROPEAN GRID INFRASTRUCTURE

2.1 Current Status

The European Grid Infrastructure (EGI) is a European wide e-Infrastructure that links geographically distributed computing and independently owned resources and data storage facilities through high-performance networks. EGI allows scientists to share resources (such as computer clusters or data sets) securely, analyse data efficiently and effectively at scale, and to collaborate with colleagues worldwide. EGI currently supports more than 22,000 researchers across an array of scientific disciplines, supporting in excess of 1.6 million computing jobs per day and offering data storage, transfer and open access.

The European Grid Infrastructure (EGI) was established in 2010 as a result of over a decade of investment by national governments and the European Commission. EGI is coordinated by EGI.eu, a not-for-profit foundation supported by the EGI-InSPIRE project and governed by the national stakeholders and early-adopting international research communities.

2.2 EGI 2020 Strategy

The EGI Strategic Plan “Seeing New Horizons: EGI’s Role in 2020” [R1], describes how EGI will evolve into a universal federated platform for supporting compute and data intensive research communities in both the public and private sectors. The strategic areas in which the EGI community has strengths and in which it will invest and develop to ensure its long-term future comprise:

- **Community & Coordination:** Continuing to develop the network of national interfaces (the NGIs) and European coordination body (EGI.eu) that provides governance and improvement in the human capital to the community and the ecosystem it supports through communication, outreach, support, policy and promotion across geographical areas, research domains, resource infrastructure providers and different technologies.
- **Operational Infrastructure:** EGI federates a European-wide operational infrastructure structured along geographical regions (normally countries) or research communities comprising over 315 resource centres providing a range of local services that currently provides uniform secure access to compute clusters, data storage or cloud infrastructure services.
- **Virtual Research Environments:** A key requirement to the wider scale adoption of e-Infrastructures is the ability for individual researchers and research collaborations to personalise the virtual research environments (spanning the low-level platform services to the user interface used by the researcher) needed by a particular research community to undertake their research.

Within each of these areas EGI has been identifying services that are provided and sustained by its national or research community stakeholders, and services that are delivered once at a European level through EGI.eu for the whole community. As part of this strategy, the services that are critical to the community need to be sustained by the community, while changes to these services or new services need to be developed under focused project funding.

This report therefore describes the strategic direction in which EGI is taking to ensure long-term sustainability for its current and potential users. Specific activities that have taken place over the last year to progress sustainability efforts are described in Annex 1: EGI’s Sustainability following the four areas outlined in last year’s report: organisational, technical, financial and legal.



2.3 Purpose and Value

EGI's main purpose is to support cutting-edge research, innovation, and knowledge transfer within Europe and the rest of the world. This is accomplished through a wide range of services described further below. The ultimate value that is delivered to researchers and scientists is:

- **Allows faster research results:** EGI helps scientists save time by dividing one big task into smaller, more manageable bits that can be processed in parallel across the infrastructure. The result is the same amount of work completed in a fraction of time.
- **Facilitates collaboration:** EGI allows research groups, institutions and universities, and labs to share data seamlessly across borders and continents as if every member had access to the same computer leading to a greater pool of information and expertise to solve research problems and reduce duplication.
- **Increases innovation and creativity:** EGI extends the limits of what is possible by enabling researchers to discover, access and reuse cutting-edge tools, resources, skills and competencies to achieve results otherwise not possible and stimulate open innovation.
- **Handles big data:** EGI allows multinational research infrastructures to share, manipulate and analyse Petabytes of data coming out of complex experiments and simulations through 340 Petabytes of disk and tape storage and 410,000 computing cores distributed over 315 resource centres across more than 55 countries¹.
- **Simplifies digital research:** EGI provides a suite of portals and science gateways that hide the complexity of distributed computing from researchers, lowering technical entry barriers and increasing productivity.

2.4 Service Portfolio

EGI offers a wide range of technical and infrastructure services that are distributed across Europe. These services are grouped into shared services provided by EGI.eu for the European cohesion of the infrastructure, and services provided nationally by the National Grid Infrastructures and locally by their resource centres to facilitate access and management of those resource centres.

2.4.1 EGI.eu Service Portfolio

EGI.eu acts as a shared service centre that supports cost-efficient coordination, integration, and marketing of EGI. The current service portfolio provided for EGI through EGI.eu and its external technical partners to the NGIs, Resource Providers and Researchers comprises:

¹ Figures comprise both EGI-InSPIRE and integrated providers [R17]

Coordination

- Project and Programme Management
- Operations Coordination
- Technology Coordination
- Security Coordination

Consulting and Support

- Specialised Consultancy Services
- Strategy and Policy Decision Support
- Policy Development
- Technical Consultancy and Support
- Helpdesk Support

Marketing and Outreach

- Marketing Services
- Outreach Services

Software Services and Platforms

- Training Marketplace
- Applications Database
- Repository of Validated Software

Core Grid Services

- Accounting Portal and Repository
- Catch-all Grid Services for small user communities
- Development of operations monitoring probes
- Grid Configuration Database (GOODB)
- Incident Management Tool (EGI Helpdesk)
- Message Broker Network
- Metrics Portal
- Operational Tools and Meta-service Monitoring
- Operations Portal
- Security monitoring tools
- Service Availability Monitoring (SAM) central services
- Tools (Grid Services) for Resource Centre certification

Summary descriptions can be found in Annex 1: EGI's Sustainability , with a full service catalogue in MS123 [R2] – soon to be published on the EGI website.

2.4.2 EGI Partnership Service Portfolio

Work is underway within EGI's Resource Infrastructure Providers (the NGIs and other organisations) and resource centres to formalise their own service portfolio according to a harmonised template. Many of the services provided by the Resource Infrastructure Providers interface into those provided by EGI.eu and support affiliated resource centres. It is the resource centres that primarily provide services direct to the researcher such as:

- **Data processing services:** offering high performance distributed computing resources.
- **Data storage services:** short and long-term storage through both disk and tape.
- **Data management services:** innovative tools and software for data access, usage and movement.

It will be essential to articulate not just the services that provide access to resources, but also the supporting activities and processes that are required to ensure effective service management and delivery. It is expected that the NGIs will collectively be able to offer a diverse service catalogue with a core set of similar services.

2.5 Analysis

In order to define detailed action plans to implement a long-term strategy, an analysis needs to be conducted to evaluate both the current state-of-play and potential opportunities. Therefore, the following sections provide an overview of this work including a PEST and SWOT analysis, risk assessment and scenario planning.

2.5.1 PEST Analysis

PEST analysis stands for Political, Economic, Social and Technological, which is a strategic analysis tool describing a framework of macro-environmental factors that any organisation has to take into consideration. It is designed to better understand market growth or decline, business position,

potential and direction for operations. The table below offers a PEST analysis for EGI. The factors listed are then classified as opportunities and threats in the SWOT analysis that follows.

<p>Political</p> <ul style="list-style-type: none"> • Multiple government funding agencies • Diversity in national priorities • Policy changes at national and European levels • Different legal frameworks prohibiting simple enforceable transnational contracts • Varying state-aid and competition laws 	<p>Economic</p> <ul style="list-style-type: none"> • Increased competition through the commoditisation of compute resources and data capabilities and the advent of the cloud • Government spending cuts • High cost of resources (human and IT) • Government spending outside national borders
<p>Social</p> <ul style="list-style-type: none"> • Consumer confidence that the services will be sustainable • Knowledge gap between scientific researcher and offered services • Consumerism leading to want for on-demand service provision • Demonstration of value-add to end-user 	<p>Technological</p> <ul style="list-style-type: none"> • Barriers to entry for new consumers • Reliance on 3rd party suppliers • Rapid changes in IT technology • Rapid changes in IT usage and requirements • Exponential increase of quantity of data

Table 1: PEST Analysis for EGI

The above table succinctly summarises the complex environment in which EGI operates. From a political perspective, EGI must tread carefully between national and European priorities, which can sometimes differ or be of varying importance. Economic considerations evolve around a balance between cost cutting measures and expensive requirements when providing services for conducting large-scale, cutting-edge research. For instance, a currently sensitive issue for national funding agencies is justifying expenditures outside of their national borders. Social issues are just as complex as technical issues. Current and potential users of EGI need to be ensured that the service in which they are investing will be available for years to come as large-scale research projects are measured in years, sometimes decades. In order to reach the long tail of science and research, EGI must meet the on-demand culture that cloud computing has brought to science to ensure its continued adoption. This means demonstrating the resulting value for any related investment. To minimise these effects, the technology needs to answer the needs of the users, which can be difficult with the rapid changes of both IT technology and how it is being used. Advances in technology are leading to new scientific achievements but have also led to the exponential growth in the quality and quantity of data. EGI has proven to scale to meet these challenges in the past, but needs to continue to innovate its solutions to meet its users needs in a more technically competitive future.

2.5.2 SWOT Analysis

Given the macro-environmental factors outlined in the previous section, a SWOT analysis (which stands for Strengths, Weaknesses, Opportunities and Threats) can be derived. The following table outlines these areas, which leads to the eventual long-term strategy and risk assessments and mitigation plans.

<p>Strengths</p> <ul style="list-style-type: none"> • Provides access to large-scale computing resources to help produce faster research results • Facilitates collaboration for sharing expertise and resources to minimising duplication of effort • Increases innovation and creativity through cutting-edge tools and resources to achieve results otherwise not possible • Handles big data coming out of complex experiments and simulations • Makes research easier with a suite of portals and science gateways that hide the complexity 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Current services are tailored to only a few research communities • Lack of a central process for resource allocation • Limited available capacity for resource bound researchers • Current access mechanisms are not ideal for the individual researchers or small collaborations • Lack of a shared priorities across nations that can slow down decision making process
<p>Opportunities</p> <ul style="list-style-type: none"> • Expand and evolve service offering so they can be used by more research communities • Facilitate the deployment of easy to use virtual research environments for individual research communities that integrates access to distributed ICT resources • Actively contribute to the implementation of the "Digital Agenda for Europe" and "Innovation Union" to enable the digital ERA • Generate a "network effect" in the digital research community 	<p>Threats</p> <ul style="list-style-type: none"> • Slow evolution to a more generic infrastructure can lead potential new research communities to build their own solutions or move to commercial providers • Economic crisis may impact on stability of partners thus endangering the whole initiative

Table 2: SWOT Analysis for EGI

The table identifies the strengths of EGI, which are in line with the overall value it provides as well as defines the areas of opportunities and weaknesses that will be the focus for new innovation and services. By extracting potential threats, then a risk assessment and mitigation plan can be developed to minimise potential negative impacts while maximising opportunities and growth.

2.6 Risk Assessment and Management

It is unavoidable that issues arise or deviations to the strategic vision do not go exactly according to plan, but by identifying the potential risks allows an organisation to better adapt and overcome problems thus reducing the impact. A common risk assessment classifies risks into main types, probability, effect, and corresponding mitigation and contingency plans. This structure and potential risks for EGI moving forward are further detailed in **Table 12** in Annex 2: Risk Assessments and Mitigation.

The main issues around sustainability resulting from the various analysis and risk assessments are ensuring and expanding the user base and financial stability. Therefore, the strategic direction of EGI focuses on providing the key services that will not only ensure the current user base, but also expand it towards the long-tail of science and taking the necessary steps to demonstrate the value-add of EGI to national funding agencies and research councils and the European Commission for continued support to achieve the goal of European-led, world-class research and innovation.

3 EGI AND THE EUROPEAN RESEARCH AREA

3.1 Market Segmentation

EGI's target market is drawn from the estimated 1.8M public sector and 1.0M private sector researchers within the European Research Area (ERA) and their international collaborators. While EGI's primary focus is on providing computational and data oriented services to these researchers to enable their data analysis, there are also a range of collaborative tools being made available which can facilitate their work. Typical user 'profiles' are described in the following table alongside the value that EGI can provide to each group, if applicable. An important component of sustainability and long-term service provision is the understanding that not everything can be provided for everyone, nor do they all need it, and therefore the identified services are designed to satisfy the needs of specific target groups.

Research Profile	Data Analysis Activity	Value provided by EGI	Example
Research Infrastructures	Data analysis is carried out through community wide frameworks customisable for individual researchers through services located in distributed resource centres, frequently dedicated to that research community.	EGI can assist in federating the distributed resource centres within the research infrastructure and can aggregate capacity by providing integrated access to shared resource centres in Europe.	WLCG
International Research Collaborations	The collaboration establishes a set of services that support their specialist data analysis activities by integrating services from within the collaboration.	EGI provides support for individual resource centres within the collaboration to deploy and deliver generic services.	WeNMR
Resource bound International Researchers	International research team may have access to various resources distributed resources but their capacity does not support their data analysis needs.	EGI can provide a mechanism by which the research team can be allocated resources pooled from across multiple NGIs.	EGI provides easy access to resource bound researchers.
National Research Collaborations	Large research groups accept that no facility is likely to meet all their needs, therefore integrated uniform access to these distributed frequently international resources is needed to significantly reduce barriers to access.	EGIs provides an easy mechanism for such research groups to establish virtual organisations that members can securely contribute resources to the collaboration across different administrative domains.	NGIs can operate a national VO to provide secure integrated resource access.
Resource bound National Researchers	A small research group <i>may</i> have their needs satisfied locally, but <i>could</i> also have demands for resources provided at a national, regional or European facilities.	NGIs provide either through a central facility or integrated resource centres a data analysis capacity open to their national research communities and associated support services.	Many NGIs provide a catch-all VO that serves this function

Research Profile	Data Analysis Activity	Value provided by EGI	Example
Capability bound Researchers	Individual researchers may have need of specific services to support their data analysis needs that cannot be provided locally.	EGI.eu or the local NGI may have services in their portfolio that would be of value to the individual researcher.	Use individual services in the EGI.eu or NGI portfolio.
Researchers	Individual researchers rely on the resources that they have within their research institute which meet their data analysis requirements.	No additional value can be provided by EGI.eu or its NGIs for such users.	N/A

Table 3: Market Segment Profiles

3.2 Solution Portfolio

An overview of EGI’s primary technical product offerings is provided below in **Figure 1** in the EGI Platform Architecture [R3]. Each pillar has been designed to meet the identified needs and issues of both the current and future research market and EGI as an infrastructure.

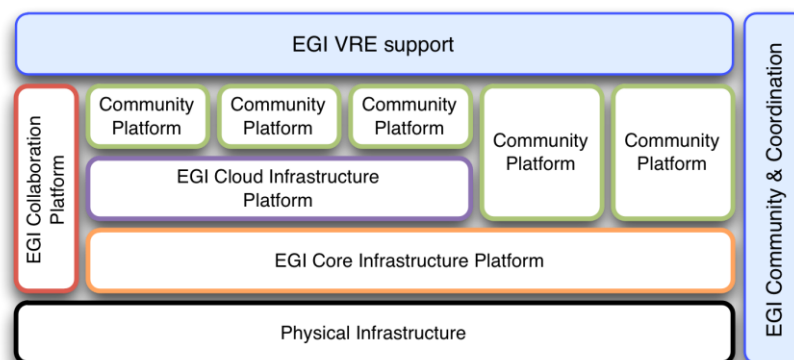


Figure 1: Strategic pillars within EGI Platform Architecture

Overall, EGI provides an extensible flexible operational infrastructure (encapsulated within the Core Infrastructure Platform) that is used as the basis for a federated Infrastructure-as-a-Service (IaaS) Cloud (the Cloud Infrastructure Platform). These two platforms support the deployment of Community Platforms through their deployment in a resource centre either directly on the bare metal or in a virtualised environment. The Virtual Research Environment exposed to researchers is constituted through software and services within Community Platform that may be shared (through initiatives such as SciencePAD, MeDIA, etc.) and can build upon operational services within the Core Infrastructure Platform and on generic services in the Collaboration Platform.

As a consequence of this architecture, EGI provides a framework that will host a range of flexible solutions, including both grid and cloud approaches, as needed by individual research communities. These solutions are built combining platforms, services and human activities provided by the EGI partnership and are as follows:

- **Core Infrastructure Platform:** EGI’s Core Infrastructure Platform is an integrated union between services coordinated by EGI.eu through its technical partners and services delivered by national or domain-specific resource infrastructure providers (e.g. NGIs or EIROs) that



delivers federated capabilities relating to accounting, monitoring, helpdesks and operational management.

- **Cloud Infrastructure Platform:** EGI's Cloud Infrastructure Platform is a 'community platform' (in that it builds on top of EGI's Core Infrastructure Platform) that is assembled by EGI.eu and its partners to provide a federated 'Infrastructure as a Service' Cloud that provides secure accounted for access to locally deployed cloud management frameworks.
- **Collaboration Platform:** EGI's Collaboration Platform is a collection of components that facilitate collaboration across the EGI community. These are typically tools and services, both social and technical, and involve direct user interaction. Services comprise a meeting planner, conferencing system, discussion forum and document repository as well as a software repository, application database and requirements tracker.
- **Community Platforms (VREs):** Community Platforms are built on top of EGI's Core or Cloud Infrastructure Platform that combine community specific components, tools and services. Community Platforms offers the ability for individual researchers and research collaborations to personalise their virtual research environments, which can be brought into production use either through local deployment (platform managed by the local resource centre based on a software release made by a single platform integrator) or remote instantiation (platform is encapsulated in a virtual machine that can be created and instantiated by the platform operator - on behalf of the research community). Some Community Platforms may be assembled and even operated by EGI.eu or directly by one of its partners, but a more sustainable and scalable solution is for other organisations (public or private) to assemble and operate Community Platforms directly on behalf of those that need it.
- **Peer Reviewed Resource Allocation:** EGI.eu as an organisation coordinates EGI, however, does not own any of the physical infrastructure resources. Therefore, allocation of these resources is subject to the approval of the national infrastructures or resource centres that own them. This can sometimes be a complex process, which often ties access of resources to contribution of own resources, slowing the rate of adoption. In addition, this model makes it difficult to demonstrate scientific impact as much of the scientific being conducted is not specifically known or needs to be manually sought. In response, EGI is developing a model and related processes for allocation of resources as a service to international collaborations [R4].
- **Pay-per-use Resources:** EGI is exploring the option of adding pay-for-use models that could provide a more market driven e-Infrastructure to support the digital European Research Area and increase sustainability and as a potential means of cost recovery. Such a model would allow the resource centres to generate an income based around their unused resources, and for EGI.eu and NGIs to take a fee as an intermediary in providing such a service.
- **Coordination Services:** Coordination Services (except for those technical coordination activities covered elsewhere) comprise activities such as governance, promotion, communication, strategy, policy, requirements, etc. that are delivered by complimentary services at both a European and National levels.

The impact of each and risk mitigation efforts are in Annex 2: Risk Assessments and Mitigation.

3.3 Summary

The previous sections outlined EGI's current and potential market segments through the creation of research profiles and offered a solution portfolio to meet the demand. The following table provides a summary of how each directly correlate.

Research Profile	EGI Platform ²	Resources ³	Coordination Services
Research Infrastructures	<p>Core: Direct consumer.</p> <p>Cloud: Direct consumer if deployed locally or on other resources.</p> <p>Collaboration: Direct consumer as used within their own Community Platform.</p>	<p>Own</p> <p>Possible Pay</p>	Partial
International Research Collaborations	<p>Core: Direct beneficiary through the VO.</p> <p>Cloud: Direct consumer, if deploying their own community platform on cloud-enabled resource centres in the VO.</p> <p>Collaboration: Direct consumer, if used to build their own Community Platform.</p> <p>Community: Direct consumer, if aligned to their data analysis model.</p>	<p>Own</p> <p>Allocation</p> <p>Possible Pay</p>	Optional
Resource bound International Researchers	<p>Core: Indirect beneficiary through the resource allocation.</p> <p>Cloud: Direct consumer, if deploying their own Community Platform on the cloud enabled resource allocation.</p> <p>Collaboration: Direct consumer, if used to build their own Community Platform.</p> <p>Community: Direct consumer, if aligned to their data analysis model.</p>	<p>Allocation</p>	Indirect
National Research Collaborations	<p>Core: Direct beneficiary through the VO.</p> <p>Cloud: Direct consumer, if deploying their own Community Platform on the VO's cloud enabled resource centres.</p> <p>Collaboration: Direct consumer, if used to build their own Community Platform.</p> <p>Community: Direct consumer, if aligned to their data analysis model.</p>	<p>Own</p> <p>Allocation</p> <p>Possible Pay</p>	Partial
Resource bound National Researchers	<p>Core: Indirect beneficiary through the resource allocation.</p> <p>Cloud: Direct consumer, if deploying their own Community Platform on their cloud enabled resource allocation.</p> <p>Collaboration: Direct consumer, if used to build their own Community Platform.</p> <p>Community: Direct consumer, if aligned to their data analysis model.</p>	<p>Allocation</p> <p>Pay</p>	Partial

² Direct consumer: a group that will directly interact with the services; Direct beneficiary: a group that does not directly use the platform's services but consumes the services provided by those that do; Indirect beneficiary: a group that relies on the existence of the platform or service for their own service(s).

³ Own: Resources are directly available under their own control. Allocation: Benefit from obtaining resources from a national/European Resource Allocation process. Pay: Pay-per-use is an option for regular/bursting usage profiles.



Research Profile	EGI Platform ²	Resources ³	Coordination Services
Researchers (with local resources)	N/A	N/A	N/A

Table 4: Research Profiles to Solution Portfolio

4 PLANNING SCENARIOS

Scenario planning is an additional means of analysis for strategic decision-making and for mitigating risks. The scenarios presented below have been extracted from a capability and cost analysis based on the EGI service portfolio. This analysis allowed EGI management to analyse the cost breakdown by Service Category, Service Name and Supporting Activity/Component separating each cost area between Maintenance, Operations, Development, Coordination and Support (staff). The capability of the service was then assessed in terms of the impact of not doing the activity by criticality, degradation of the infrastructure over time, no growth or expansion and no impact. Knowing the impact of not delivering these capabilities and the costs associated in their delivery was essential in determining which services needed to be sustained and to define from which revenue stream they could be supported. An open discussion was held and impact refined at the Evolving EGI Workshop in January 2013 [R7] and is currently supporting high-level decisions within the EGI Council.

The following scenarios look at three models where EGI is maintained at the most basic level from, additional services and improvements from increased support, and a possible 'grand vision' as to how EGI could develop over the next decade with the full support from both the European Commission, National Funders and the European Research Area. Each scenario describes the activities that would take place, the overall impact of those activities, the required funding to carry them out, and potential risks and migration to those scenarios.

4.1 Revenue Streams

Before considering each of the different scenarios a number of different revenue streams are potentially available to develop and sustain EGI – EGI.eu and its NGIs. An essential part of EGI's strategic plan is to ensure that funds for the routine operation of the infrastructure are sustained from stable sources (preferably from within the EGI Community) in order to ensure current and future users of the infrastructure of its sustainability. The funds needed to change and expand the service portfolio will be sought through fixed-term projects, after which the enhanced service portfolio will have to be sustained through community funds. This strategy ensures that EGI only commits to introducing services into its portfolio that it can sustain long-term.

In the short-term, the operation and maintenance of the services will be the responsibility of EGI's Community Funds with targeted European-funded projects focusing on innovation, policy, international cooperation and promotion. These revenue streams summarise as:

- Community funds for operations, maintenance and infrastructure coordination.
- Targeted projects for European coordination, innovation, policy, international cooperation and promotion.
- Pay-for-use models to adapt to different funding models and/or researchers without access to own resources.
- Strategic partnerships for in-kind effort around areas of mutual benefit (e.g. software, consultancy).
- Professional services for delivering specific services from the portfolio to research infrastructures, or expert technical consultancy to an external independent project.

Further details can be found in Annex 7.3.2.

The current income of EGI is summarised below with the current and estimated future potential levels and the main issues seen in reaching them.

Revenue Stream	Current Level	Potential Level	Issues
Community Funds	€1.6M/yr. ⁴	€2M	Justifying expenditures outside of national borders. Demonstration of European value-add.
National Public Funds	€78M/yr. ⁵	€80M/yr.	Minimal increase potential as high-level of support already provided coupled with gov't budget cuts.
European Public Funds	€6.25M/yr. ⁶ €1M/yr. ⁷	€10M/yr.	Requires full commitment from European Commission to realise an open compute and data infrastructure to support the ERA by 2020.
Pay-For-Use	N/A	TBD	Diversity in policy and legal issues between countries including varying state-aid and competition laws.
Partnerships	€10M/yr.	€20M/yr.	Current reduction in funded projects towards the end of FP7 in virtual research environments increases internal development requirements, community effort/support or reliance on commercial products/services. Horizon 2020 should rectify this current under funding.
Professional Services	N/A	€50K/yr.	A major potential "customer" for EGI would be offering consultancy or paid services to organisations and other EC funded projects within the NGIs ⁸ .

Table 5: EGI Revenue Streams, Levels and Issues

4.2 Maintaining a production infrastructure

4.2.1 Activity

The federated production infrastructure currently provided by EGI would continue to operate through the coordination provided by EGI.eu and the Core EGI Activities, which include all of the critical and many of the tasks that prevent the degradation of the infrastructure. Individual NGIs would continue to operate and contribute their own national resources into EGI if these activities were sustainable on an individual national level.

4.2.2 Required Funding Levels

Funding levels provided by the EGI Community for central coordination continue at approximately the current level of around €1.6M annually contributed to EGI.eu through the participation fee. Approximately 50% of this funding is spent on Core EGI Activities at EGI.eu and 50% spent externally funding Core EGI Activities with external partners who match these external funds with their own internal effort. In addition, all NGIs would continue to fund their own internal hardware costs and

⁴ Annual Memberships fees paid to EGI.eu

⁵ €338M total estimated costs of EGI over 4 years; minus EC Contribution

⁶ €25M EC contribution through the 4-year EGI-InSPIRE project

⁷ EGI.eu revenue as partners in EC-funded projects and specialized consultancy received

⁸ EC constraints regarding subcontracting within a project currently inhibit EC projects as a source of revenue. Some NGIs would not be able to engage in such a model due to their own statutes or employment structures. However, professional services are one of the areas being explored within the long-term strategy of EGI.eu to understand if it can move beyond being an "internal" service provider to the NGIs and resource centres.

employment of necessary support staff. The national funding that purchases the physical hardware and employs the personnel required to operate and maintain the infrastructure would be expected to continue.

4.2.3 Impact

Any technical development activity beyond essential critical maintenance activities essential to the continued operation of the critical technical services would stop. Accounting, monitoring, helpdesk, security, support and other central services would continue to be operated. The coordination that EGI.eu provides across the production infrastructure, marketing and communications, strategy and policy, user support at a European level would continue, but in many areas at substantially reduced levels.

For instance, the quality of the bi-annual Forums could only be maintained with a greater effort commitment by the local host or with significantly increased registration fees. EGI.eu could still engage in European level policy discussions but would have minimal additional effort to participate or lead in policy developments. The technical support given to new communities would be reduced to just an advisory capacity that would rely on any available local NGI resource.

Effectively, the status quo would be maintained but with very little opportunity for coordinated development and growth, as the staff at EGI.eu would reduce by around 50%. Therefore, the medium- to long-term future competitiveness of EGI would be greatly compromised.

4.2.4 Risks and Mitigation

Risk and Description	Rationale	Mitigation and Contingency
Reduction in membership fees paid	Lack of clear European Commission engagement and support shifts national priorities inward or to other areas.	The EC supports the “Europeanisation” of the infrastructure and innovation development to support and promote research thus garnishing national support.
Users loose faith	A volatile environment forces users to more stable solutions under their own direct control even if they do not answer all of their needs (e.g. commercial providers).	Improving service management for better service delivery increasing efficiency and predictability. Solidifying government support to communicate to current and potential users with confidence.
Services need upgrading	Evolving scientific needs or user requirements not answered by stagnant technology/solutions.	Best effort to gather those areas of the community with invested interest to deliver a solution from best-effort or other resources.
Burden on national level too great	Minimal central coordination and service support greatly increases burden on NGIs.	Selected services are targeted at the most crucial areas to ensure EGI remains a trans-national infrastructure.

Table 6: Maintaining a Production Infrastructure Risks and Mitigation

4.3 Developing the production infrastructure

4.3.1 Activity

EGI as a community would engage in European level activities to reinforce, structure and support an open distributed computing and data infrastructure such as an EGI Compendium, engagement in EC policy activities, a dedicated team for event organisation, the promotion of supported research activities, support of EGI’s human networks and development of their human capital through training and events, technical consultancy for engaging with new research communities, incremental development of the operational tools, coordination of a federated cloud infrastructure and active engagement with other European and international e-Infrastructure activities. Activities would ensure response to EU priorities and initiatives such as the Digital Agenda and Innovation Union.

4.3.2 Funding Levels

With annual funding from the European Commission of (~€2.5M) into European-level innovation and support action projects matching the annual funding also being contributed by the EGI Community (~€2.4M) for European coordination in additional to dedicated national funds, a number of additional activities beyond those described in the previous scenario would be possible.

4.3.3 Impact

With moderate EC co-funding and existing EGI Community funding the incremental development of EGI would be assured. There would be capacity for incremental service innovation in both operational and non-operational areas, but in only limited services with the highest level of priority. New capabilities, such as EGI’s Cloud Infrastructure could be brought into production and limited support provided to promote its adoption and use. This level of funding would allow EGI to continue as a service but would limit its potential impact within the ERA and to drive uptake in the long-tail of researchers.

4.3.4 Risks and Mitigation

Risk and Description	Rationale	Mitigation and Contingency
Slow development of services cannot keep up with market	Lack of investment impacts service development first with effort only available to maintain and operate service.	The EC supports the development and innovation to support and promote advanced technologies and continued use.
Failing to reach long-tail	No concentrated effort for wider outreach means focus can only be provided to large-scale research communities.	EGI Champions scheme has started to answer this need, but increased effort is required for wider outreach activities.
Decline of national support	National governments already support a large percentage of infrastructure operations. Reduction or minimal support from EC for trans-national and global innovation reduces importance thus lowering national priority.	Ensuring innovation and development with a mix of national and European priorities will ensure continued support.

Table 7: Developing a Production Infrastructure Risks and Mitigation



4.4 A Grand Vision for Open Computing and Data Infrastructures in the ERA

4.4.1 Activity

Establish by 2020 a distributed open compute and data infrastructure comprising a 1M Core Federated Cloud and 1 Exabyte of Federated Cloud Storage across Europe that is able to support the data analysis activities of ‘long-tail’ researchers within the ERA. This distributed facility would be supported by a network of national and regional centres (to help with application porting technical consultancy and training), investment in operational tools to manage an open computing and data infrastructure, innovative generic and domain specific services that can be operated ‘as a Service’ to researchers, creating a ‘Platform as a Service’ that will allow researchers to create their own personalised virtual research environment for their data analysis tasks, all of which can be deployed at scale to meet their needs on the allocated cloud resources. Such an investment would help to make every researcher in the ERA digital by 2020.

4.4.2 Required Funding Levels

Building on the annual EGI Community funds to the central operation and coordination of the critical services (~€2.4M), additional annual funds from the European Commission (~€10M) would be used to invest in the human capital, an innovative virtual research environment that can be delivered as an easy to use ‘Platform as a Service’ to data researchers across Europe, and a federated compute and storage cloud that can be used to by these researchers for their data analysis activities.

4.4.3 Impact

The investment from the European Commission would be invested in building up the human network across Europe and the human capital within it through training and outreach activities. This reinforced human network would form the basis for the national and regional ‘centres of excellence’ that would assist local researchers in fully benefiting from the open computing and data infrastructure available within Europe. This initiative could be kick started by the direct investment in physical infrastructure across Europe and the integration of these individual facilities into a distributed federated cloud infrastructure for compute and storage. This would require innovation at three levels: in the technologies needed to federate and integrate clouds, in the generic and domain specific services needed to undertake high-throughput data analysis on a cloud infrastructure, and the development of a simple programming abstractions within a ‘Platform as a Service’ model for a virtual research environment for data analysis that would be essential in lowering the barriers to distributed data analysis needed for researchers in the ERA to undertake excellent science.

4.4.4 Risks and Mitigation

With the full weight of support from both national funding agencies and the European Commission, EGI would become *the* e-Infrastructure in Europe for providing integrated ICT services to the whole of the European Research Area. This would include radical innovation opportunities and expansion and full realisation of EGI as the most advanced grid and cloud provider dedicated to scientific research and development.

Risk and Description	Rationale	Mitigation and Contingency
Political issues with aligning layers of e-Infrastructures	Networking, HPC and HTC are harmonised in many countries, however is handled separately on a European level (entities, structures, processes). To	Exploration in this area started with the investigation of the ERIC legal framework for EGI and will continue to be explored through Horizon 2020.

Risk and Description	Rationale	Mitigation and Contingency
	provide an integrated service offering via e-Infrastructures, there needs to be closer collaboration in the future.	
Globalisation reduces impact of EGI	Global service provision means that researchers can gain access to resources from an increasing market size. Competition on a global scale means European must continue to stay relevant and competitive.	EGI is working closely with XSEDE in the US for improving collaboration. EGI has signed an MoU with the Asia-Pacific for joint collaboration and EGI is reaching out to Latin America with the support of the CHAIN-REDS project.
IT Service management is not mature enough to handle long-tail	With exponential increase of users requires mature service management processes and advanced automation tools.	EGI.eu is working with FedSM expert consultants for improving service management within EGI based on ITIL best practices. Increasing ITSM maturity will continue to be a focus for EGI moving into the future.

Table 8: EGI Grand Vision Risks and Mitigation



5 CONCLUSIONS

EGI's grand vision is to become *the* e-Infrastructure of distributed, open compute and data services comprising both an Infrastructure-as-a-Service as well as a multi-platform infrastructure that will facilitate innovation and development across the whole European Research Area. This vision will ultimately require full support from the whole community that combines national and European level investment.

This document has showcased the value that EGI provides to a variety of research groups while demonstrating the long-term strategy to ensure the sustainability of the infrastructure on which so many researchers depend. It defines a structured service portfolio that includes current and potential solutions that could meet the needs of specific user groups. In addition, this plan has been defined through strategic analysis in a number of areas taking into consideration a wide range of factors such as political, social, economic and technological. Through scenario planning and risk assessments, EGI will be able to better adapt to the majority of future changes and evolve alongside the changing IT and research landscape.

During the final year of the project, efforts will continue to improve the management and delivery of its current services and focus on targeted areas of development such as the federated cloud infrastructure.



6 REFERENCES

R 1	Seeking New Horizons: EGI's Role in 2020 - https://documents.egi.eu/document/1098
R 2	MS123 EGI Global Task Review - https://documents.egi.eu/document/1566
R 3	MS514 EGI Platform Roadmap - https://documents.egi.eu/document/1624
R 4	Demonstrating Excellent European Science on EGI's shared resources – https://documents.egi.eu/document/1415
R 5	EGI Resource Allocation Task Force - https://wiki.egi.eu/wiki/Resource_Allocation_Task_Force
R 6	EGI Pay-for-Use Pilot Group - https://wiki.egi.eu/wiki/EGI_Pay-for-Use_Pilot
R 7	Evolving EGI Workshop - https://go.egi.eu/Evolving-EGI-WS-2013
R 8	Exploring how researchers can pay for EGI Resources - https://documents.egi.eu/document/1391
R 9	EGI Collaborations - http://www.egi.eu/community/collaborations/
R 10	TCB Requirements management process - https://documents.egi.eu/document/440
R 11	European Middleware Initiative (EMI) - http://www.eu-emi.eu/
R 12	Initiative for Globus in Europe (IGE) https://www.ige-project.eu/
R 13	e-FISCAL Cost Analysis Tools - http://efiscal.eu/tools
R 14	EGI Compendium 2012 - Questionnaire - https://documents.egi.eu/document/1653
R 15	D2.11 EGI.eu Transition Plan to ERIC - https://documents.egi.eu/document/1339
R 16	Post-EMI/IGE support for Technology Providers - https://documents.egi.eu/document/1499
R 17	EGI Usage Stats - https://www.egi.eu/infrastructure/operations/figures_and_utilisation/index.html

7 ANNEX 1: EGI'S SUSTAINABILITY ACTIVITIES

This third project year's sustainability plan focused on the analysis around EGI's strategic direction and the services needed to ensure the long-term sustainability of the infrastructure and the researchers who use it. Over the last year a number of activities have taken place to develop these strategies and mature the processes and procedures around the infrastructure in overall support of the sustainability efforts. The following sections outline these activities and the progress made following the four areas outlined in last year's report: organisational, technical, financial and legal.

7.1 Organisational

Over the past three years, the organisational structure of EGI has not only stabilised, but has matured as well. The concept of becoming an open ICT ecosystem, has been at the forefront of a structural movement from monolithic project based system to a collection of cooperating independent technology providers, resource infrastructure providers, research communities that are supported by national (NGIs) and European (EGI.eu) coordination bodies.

In addition to the roles and functions of the EGI ecosystem that provide the foundation of a sustainable infrastructure, it is also the organisational services that are provided in support. The following section highlights these areas of community and coordination services that are provided in support of the open ICT ecosystem.

Given the distributed nature of EGI and its organisational structure, to ensure that services are delivered reliably, how these entities interact and how the services are provided are also key components to sustainable service delivery. Therefore the final section looks at how EGI is improving the management of the services and the processes and procedures that are there, missing or need improvement to maximise efficiency and optimise effort and resources.

7.1.1 EGI Ecosystem roles and functions

No changes have been made in the organisational structure of the EGI Ecosystem as shown in **Figure 2**. However, work over the last year has been around clarifying these roles in line with the evolution of the EGI as three distinct platforms. The resulting roles are further described below while definitions of each role can be found in VI: Terminology.

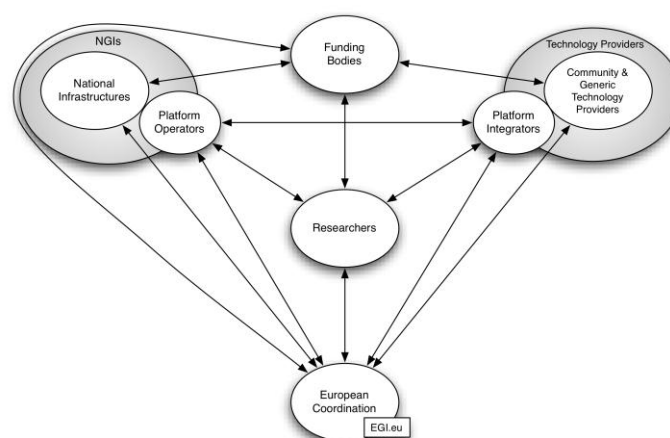


Figure 2: EGI Ecosystem Overview

The main changes or clarifications within the EGI ecosystem have been around separating the roles and functions between stakeholders and actors. Those who have invested interest and steer the strategic direction of the infrastructure and the functions that carrying out specific technical duties.

Stakeholder	Actor Name	Actor Verb
Research Community	Platform Owner	Own
National Infrastructures	Platform Contributor	Contribute
European Coordination	Platform Packager	Package
Technology Providers	Platform Deployer	Deploy
Funding Bodies	Platform Operator	Operate
	Platform Users	Use

Table 9: Stakeholders and Actors in the EGI Platform ecosystem

Further details of these roles and who each fit with in the specific EGI platform can be found in the EGI Platform Roadmap [R3]. The following diagram shows a high-level view on where various actors play distinct roles that tie together the overall EGI2020 Strategy.

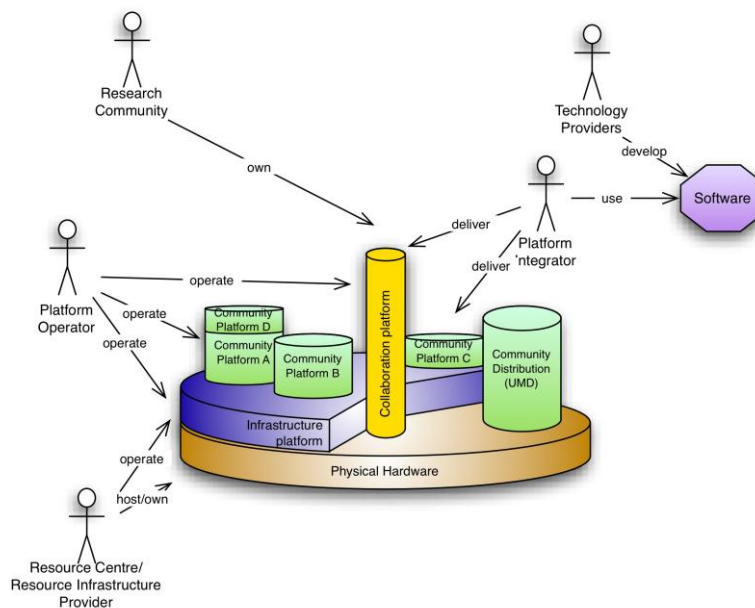


Figure 3: Relationships between roles of the EGI Ecosystem and Services

7.1.2 Community & Coordination Services

Community and coordination is the first of three pillars of the EGI2020 strategy and is what binds EGI at a European level while also helps expand EGI. The activities taking place to coordinate and develop the EGI community are valuable in bringing together individual national activities taking place across Europe into a coherent European activity to support EU2020 objectives of an integrated ERA.

Specific services comprise:

- Coordination:** offers project management and planning to ensure that activities are aligned with strategies developed through the EGI Council and EGI.eu Executive Board and provides other support activities such as administration, finance, secretariat and collaboration tools. The other essential aspect of coordination is services provided across operations, technology and security. This comprises leading management bodies, coordinating integration,

managing suppliers, provisioning software as well as defining activities plans, roadmaps and documentation.

- **Consultancy and Support:** provides technical advice for the best solution, helps get applications up and running, and offers support mechanisms such as an applications database to leverage work in similar areas and general user support. Technical support is also provided via the EGI Helpdesk with scaling levels of support and follow-up. Strategy and decision support is also provided across strategic themes and trends, whether for EGI management trying to make informed decisions, a site administrator looking to understand the impact of developments on the infrastructure, technology providers looking for new opportunities, and project managers reviewing product roadmaps. Policies are also needed to govern the provision of a high-quality distributed-computing production-oriented infrastructure, which includes development of EGI specific policies such as acceptable use or security policies as well as liaison with external policy bodies.
- **Marketing and Outreach:** aims to communicate the work of EGI and its user communities to new and existing user communities, journalists, general public, grid research and standards communities, resource providers, collaborating projects, decision makers and governmental representatives. This is done through marketing tools such as the project website, wiki site, materials and publications, media and public relations, social media channels and attendance at events in order to market EGI to new users. Dedicated outreach activities are also provided through areas such as event organisation providing a platform for current users to showcase their research, new users to learn more about what can be done, coordinate local champions to increase enthusiasm, develop collaboration agreements and support client relationship management through an online interface.

Community and coordination has also been a dedicated track at EGI community events (Technical and Community Forums) covering topics such as global cooperation with the US and Latin America, outreach and promotion through EGI Champions and material, and strategy and policy developments in areas like service management, federated resource allocation and pay-for-use models.

7.1.3 Service Management Improvement

If EGI is to continuously evolve as a sustainable service provider, management of those services will need to continuously improve as well. Better service management will directly impact two areas of sustainability in offering more predictable service delivery and more efficient use of organisational resources. A strong step in this direction took form in EGI.eu's client role within the FedSM project for assessing the maturity of service management.

The previous service decomposition as "tasks" in the EGI-InSPIRE DoW have taken form within a new service portfolio, however, the management of these services, processes and procedures are often tied to the EGI-InSPIRE project. Part of EGI's sustainability efforts is to move service management out of a project-based model. This will allow for more easily repeatable and predictable service delivery. Any future project support would then be modelled based on already existing procedures.

Therefore, starting from the service portfolio, EGI.eu has started to analyse the service management maturity of EGI by conducting a self-assessment following a specific set assessment framework developed and supported by FedSM experts. The minimum set of requirements has been established through a tailoring of ITIL and ISO20000 best practices for federated e-Infrastructures.

The ITIL framework has been mentioned in a variety of EGI documents and referenced as a strategic area for improving service management across EGI. ITIL is the most widely accepted approach to IT service management and the de facto standard for operating computer centres in the industrial sector providing a cohesive set of best practices, drawn from the public and private sectors internationally.

Over the next year, EGI will continue to increase the maturity of its service management processes in the areas of operations, policy and software delivery. The service portfolio will also expand to include the NGI technical services that are user facing so to build a wider service definition covering the EGI partnership.

7.1.4 Brokerage Models

There are specific services that are provided by EGI.eu to the NGIs (EGI's resource infrastructure providers), which in turn the NGIs provide to their affiliated resource centres and end users. The most appropriate model that describes this relationship is a brokerage model. The majority of services are provided as part of a package delivered from annual membership fees. New resource providers could either pay into the membership fees or could choose the services that they are most suitable for them in which a service contract and agreements would be signed and payment made.

Three generic brokerage models have been defined to structure the relationships between the parties depending on the desired level of interest: Independent advisor (current EGI.eu); Matchmaker (including some form of resource allocation); and One Stop Shop (includes handling of financial transactions of broker services i.e. pay-for-use). Further details regarding brokerage models can be found at [R8].

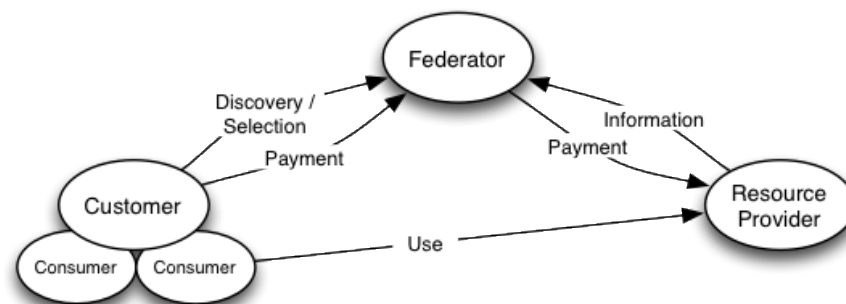


Figure 4: Brokerage Model Example: One-Stop-Shop

7.2 Technological

Sustainability from a technological aspect takes two forms. One is the technology required in order to provide the current set of services as well as the services part of the medium- to long-term strategy such as the core infrastructure platform, cloud infrastructure platform and community platforms within the virtual research environments used by individual research communities. The other is around managing the technology supply side, as EGI does not develop the technology deployed to access the resources located at its federated resources centres in the production infrastructure. This means that all upgrades and new programmes are produced elsewhere by independent technology providers with EGI carrying out limited development in the area of integration. As there are no plans for EGI to move beyond current efforts, the community needs to prepare for software provisioning and form collaborations with product teams and platform integrators to ensure that the needed technology is delivered both with a high-quality and sustainably.

7.2.1 Technology Providers

EGI is currently working six technology providers on a variety of different areas [R9]. Agreements, interaction and requirements are handled through the Technical Collaboration Board (TCB), which is managed by EGI.eu. Through this board, the rationalisation and prioritisation of requirements lead to technology developments by the independent technology providers.

The main goal of the TCB is to take the requirements gathered by the User Community Board (UCB) and the Operations Management Board (OMB), negotiate with the current or potential technology providers and to assess the new software's quality. The TCB also makes sure that all new software deployed in the infrastructure conforms to the community's standards to ensure interoperability (further detail on the process can be found here [R10]).

One of the main issues has been around two of the major technology providers, European Middleware Initiative (EMI) [R11] and Initiative for Globus in Europe (IGE) [R12] projects that are coming to a close. A result from a number of meetings over the last year in preparation was a dedicated document prepared to drill down to the technical details of software provisioning, understand how the various activities will contribute and be published in the UMD as well as identifying where EGI.eu can provide coordination activities and where these activities need to come from the Technology Provider or the User Community [R16].

Looking at the specific services that EMI and IGE are currently providing to their affiliated Product Teams, means that EGI.eu has to decide which of the services should be further sustained, at which level, and which will have to be discontinued. An overview of EGI.eu's transition plans for current Technology Provider services is provided in the table below. Overall, most of the activities will continue to exist by being incorporated into existing EGI services. EGI.eu may or may not adjust its available effort levels as required, based on assessed added value for EGI.eu, and on demand from Integrated and Contributing Technology Providers. However, some activities (e.g. Project Management, Quality Control Coordination, etc.) will be discontinued since these are simply not applicable in this framework.

Service	Transition, Effort	EGI.eu Integration
Technical Coordination	Incorporated	TCB subordinated body
Release Management	Incorporated	TCB subordinated body
Repository Management	Incorporated	EGI Software Repository
Certification Testbed	Equivalent	Part of TP service offerings
Software Engineering Coord.	Discontinued	
Quality Assurance Coordination	Incorporated	Part of EGI Quality Criteria for Software Verification & Staged Rollout
Quality Control Coordination	Discontinued	
User Support Coordination	Incorporated	Integrated/included in EGI Helpdesk
Dissemination	Incorporated	Existing EGI Dissemination
Training Coordination	Incorporated	EGI Training Marketplace, EGI fora
Sustainability & Exploitation	Reduced	Focus on Integrated components; software and services of the Infrastructure Platforms (Core, Cloud) will be provided for reuse
Project Coordination	Discontinued	

Table 10: EGI transition plan for EMI and IGE services

7.2.2 Technology Services

The second pillar of the EGI2020 strategy is the operational infrastructure comprising 3 infrastructure platforms: Core, Cloud and Collaborative. This will ensure support for the currently deployed commonly used functional services and their evolution in demand to the use from current and new



research communities, help pan-European research infrastructures scale out the uniform operation of their functional services across Europe and integrate the institutional private clouds emerging in the public sector with public clouds coming from the commercial sector to provide a uniform capability to new research communities to deploy and operate the virtual research environments they need across Europe.

Specific services comprise:

- **Software Services and Platforms:** EGI releases the Unified Middleware Distribution (UMD), which is a subset of the software releases from Technology Providers. Software is released in UMD only once it has been verified as compliant to established EGI quality requirements and tested in a production environment. Therefore a number of activities go into providing a repository of validated software such as providing a software provisioning infrastructure, defining and maintaining software acceptance criteria and its verification, rolling out all software components through staged rollout. Other platforms provided for the community comprise an Applications Database to facilitate the reuse of scientific software, developer tools and off-the-shelf solutions from scientists and scientific programmers to save time when using scientific applications at a large scale, or when porting software to EGI and a Training Marketplace for both advertising and searching for training events, online training materials, training resources and university courses that are related to EGI.
- **Core Grid Services:** includes the core technical grid services and technical tools that support EGI's daily operations such as the Accounting Portal and Repository; Catch-all Grid Services for small user communities; development of operations monitoring probes; GOODB; Incident Management Tool (EGI Helpdesk); Message Broker Network; Metrics Portal; Operational Tools and Meta-service Monitoring; Operations Portal; Security monitoring tools; Service Availability Monitoring central service; Tools for Resource Centre certification.

The third pillar of the EGI2020 strategy is around providing virtual research environments as a key requirement to the wider scale adoption of e-Infrastructures. This ability for individual researchers and research collaborations to personalise their virtual research environments needed by a particular research community to undertake their research will increase the attractiveness and uptake of EGI.

Specific mechanisms by which these community platforms can be brought into production use:

- **Local Deployment:** The Community Platform is managed by the local resource centre based on a software release made by a single platform integrator. This is the current mode of operation used in EGI where most centres deploy a single Community Platform.
- **Remote Instantiation:** The Community Platform is encapsulated in a virtual machine that can be created and instantiated by the platform operator (on behalf of the research community) on the virtualised resources provided by the resource centre.

7.2.3 Solution Portfolio

7.2.3.1 Core Infrastructure Platform

Impact: The Core Infrastructure Platform is fundamental in operating a production infrastructure composed of distributed services federated for secure sharing. As such, Research Infrastructures are direct consumers as they use the platform to integrate the services from their own community platform deployed in their resource centres. International and national research collaborations (resource bound or not) are direct beneficiaries of the platform as they rely on their resource infrastructure providers in the NGIs and EIROs to federate the services that they depend on within their domain specific services.

Risks/Mitigations: The Core Infrastructure Platform needs to be able to federate services coming from different community platforms. Over the last 3 years work within EGI has integrated services



across over five community platforms (i.e. gLite, ARC, UNICORE, IaaS, & desktop grids) and is already proven to operate at scale – both in terms of volume and number of resource centres.

7.2.3.2 Cloud Infrastructure Platform

Impact: The Cloud Infrastructure Platform allows individual resource centres to delegate the deployment of local site services to authorised individuals on the resources that they have access to. Research Infrastructures, who generally have direct control of their affiliated sites, may not require a cloud infrastructure as services from their community platform may be deployed directly by the local site. For other research profiles, international and national research collaborations whether resource bound or not, the Cloud Infrastructure Platform allows the individual researcher or research collaboration to deploy their own community platform if they wish to do so and had the expertise available.

Risk/Mitigations: The Cloud Infrastructure Platform needs to interoperate across different cloud management frameworks and be fully integrated into the Core Infrastructure Platform. Prototyping activities over the last 18 months have eliminated or quantified many of the risks within this area, but further innovation is needed to bring this platform into full-scale production use.

7.2.3.3 Collaboration Platform

Impact: The Collaboration Platform facilitates collaboration across research communities and their domain-specific community platforms. It creates synergies between research communities by encapsulating services that are common across multiple communities and are not critical to the operation of the EGI production infrastructure, therefore are outside of the Core and Cloud platforms. The EGI Collaboration Platform complements the other platforms and contributes to their efficient use. Its services can contribute to the effectiveness of all from a global research collaboration to an individual researcher.

Risk/Mitigations: The Collaboration Platform is an end-user service, which requires a focus on usability and improving both quality and functionality. This means that effort must be made in gathering user feedback that moves to technical prioritization and development. Some tools, such as the applications database, rely on direct community submission of content. The risks that come with this model can only be mitigated by increasing ease of use and promotional activities that demonstrate the value-add.

7.2.3.4 Community Platforms (VREs)

Impact: The personalisation of virtual research environments is a key requirement to the wider scale adoption of e-Infrastructures. By allowing individual research communities to generate, deploy and operate their own individual Community Platforms, by incorporating services from other their own communities, will increase the attractiveness and uptake of EGI to these communities.

Risk/Mitigations: With the end of the EMI and IGE, EGI needs to consider the continuation of its services and deployed platforms beyond these projects. While UMD was deployed as one Community Platform across the whole of EGI in the future separate more individual Community Platforms may be deployed next to a probably much smaller UMD. Currently, EGI is engaging in closer conversations on future collaborations with a number of Technology Providers that have engaged with EGI over the past three years and is developing a roadmap and migration plans in preparation [R16].

7.2.3.5 Peer Reviewed Resource Allocation

Impact: A peer reviewed resource allocation process would allow researchers at a European or a National level who are constrained by the resources they can access locally gain access to the resources they need. By applying for a resource allocation at a national (through the NGI) or



European level (by applying through EGI.eu) through a peer review process would allow them to access additional resources remotely when required. Resource bound researchers at a national or European level would be able to use pooled resources within the NGI (for a national resource allocation) or within EGI (for resources allocated at a European level by federating NGI resources). Overall, federated resource allocation would attract new users that are currently resource bound. It would make it easier to demonstrate scientific impact of the resources used and foster a virtuous cycle among new scientific communities, EGI, NGIs, Resource Centres and funding agencies to attract new funding to strengthen and expand EGI according to the needs of those scientific communities

Risks/Mitigations: There are several issues around a peer reviewed allocation process that need to be resolved prior to implementation. Each issue has been defined and is being discussed within a dedicated Task Force [R5].

7.2.3.6 Pay-per-use Resources

Impact: This approach would offer the opportunity for potential new researchers who need rapid access to new/additional resources or the ability to rapidly respond to funding models where researchers are allocated funds directly to purchase a set amount of resources and/or services for their specific research.

Risks/Mitigations: National legal and policy issues vary greatly with what is allowed to be done with publicly funded procurement of resources. This model is therefore open to only those resource centres that are able to participate. The technical related issues are around accounting, pricing, invoicing, payments and service level managements. In order to further explore these models, a proof of concept style experiment will first be run with willing NGIs, resource centres and user communities through a pilot group to further define areas [R6].

7.2.3.7 Coordination Services

Impact: Community and coordination is what binds EGI at a European level while also helping to expand EGI. The activities taking place to coordinate and develop the EGI community are valuable in bringing together individual national activities taking place across Europe into a coherent European activity to support EU2020 objectives of an integrated European Research Area.

Risks/Mitigations: The key issue for the provision of coordination services is to ensure the demonstration of the value-add delivered. For EGI, this is two-fold: ensuring the European agencies are aware of the innovation and world-class research that is taking place thanks to the availability of resources through EGI; and communicating to national governments and agencies how European-wide objectives and priorities benefit researchers on a local level. This is done through strategic communications with the European Commission and through national representatives within the EGI Council who are involved with local governments and research councils.

7.3 Financial

Funding the infrastructure, services and people who run them is one the major concerns of long-term sustainability across the EGI community. In a complex environment such as EGI, this issue needs to be covered from a variety of different perspectives. The following sections look at the efforts made in better understanding the costs of the current services provided, new services needed and the revenue streams that could sustain them, which have each led to the strategic long-term decisions that are being taken within the EGI Council.

7.3.1 Costs

Analysing costs have taken two forms. One has been done through the e-FISCAL project looking at costing the underlying physical infrastructure and the effort required to operate it. The other was the

result of the EGI.eu service portfolio activities, comprising EGI Global Tasks, where a cost analysis and impact assessment was conducted. Both areas are described in the following sub-sections.

7.3.1.1 Infrastructure Costs

e-FISCAL was an EC-funded project that conducted a financial study for sustainable computing e-Infrastructures. The overall goal of the project is to contribute to a more accurate understanding of the costs of HTC and HPC services, both at a national and European level. This was done by analysing the costs of the current European dedicated HTC and HPC computing e-Infrastructures for research, comparing them with equivalent commercial leased or on-demand offerings, and providing an evaluation report. As a project partner, EGI.eu provided the essential link to a large group of resource centres that were the targets of the study.

The end result was 16 NGIs completing the financial questionnaire regarding cost information such as annual budget, depreciation, personnel, electricity, space, connectivity, hardware expenditures and technical information regarding total CPUs, wall clock hours, utilisation rates, available storage, and useful life. A summary of the cost breakdown by percentage is provided in **Figure 5**.

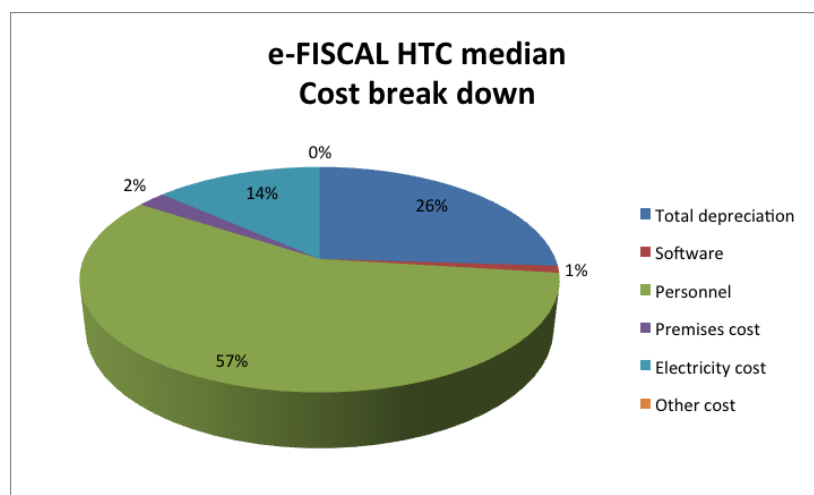


Figure 5: e-FISCAL HTC cost breakdown (median)

Data collection required to complete the questionnaire was not trivial. However, the majority of NGIs who participated were already collecting or had data available as part of normal business practices. Others used the questionnaire as an opportunity to initiate efforts in cost analysis, while others who did not or could not complete the questionnaire have started internal discussions for how to collect relevant financial data in the future.

As part of sustainability efforts regarding cost analysis, an online tool was developed which will remain available for any resource provider [R13] and the financial questions have been included in the EGI Compendium annual survey and report [R14].

7.3.1.2 EGI Global Services Costs

A cost analysis was also conducted based on the service portfolio, which allowed EGI management to analyse the costs breakdown by Service Category, Service Name and Supporting Activity/Component. Each area was then further separated between Maintenance, Operations, Development, Coordination and Support (staff). The understanding of where the costs are coming was a key component in determining which services needed to be sustained and define from which revenue stream they could be supported. To do this, the impact was also assessed by evaluating the impact by not doing the activity. The impact was assessed by labelling each supporting activity by:

- Critical: EGI will end in the short-term if this activity stops
- Degradation: EGI will degrade over time if this activity stops
- No Growth: EGI will not grow or expand in the future if this activity stops
- None: There will be no impact on EGI (e.g. activity performed by a partner external to EGI, activity not needed, or can be performed inside another project/activity/organisation)

An open discussion was held and impact refined at the Evolving EGI Workshop in January 2013 [R7]. The work is currently supporting strategic decisions within the EGI Council and evaluated as part of the overall sustainability plan.

7.3.2 Revenue Streams

7.3.2.1 Community Funds

Community funds relate primarily to non-project based income. At present this is primarily the EGI.eu participation fees totalling around €1.6M a year. Future EGI.eu and NGI income could be derived from the implementation of Brokerage Models (See XXX), Pay-Per-Use models (See XXX) and the delivery of Professional Services (See XXX) to research communities through other organisations or projects.

7.3.2.2 National Public Funding

Public funding is the main source of support for not only the infrastructure, but also for the researchers that use it. Within EGI, national funding agencies and research councils provide the necessary funds to purchase and operate the hardware and set the policy and priorities around its use.

The “Fee In, Free Out” model where the infrastructure or resource provider receives funds to develop a service to meet specific needs, while offering that service free of charge to subsequent clients who are able to use it with no further modification has been the standard model used over the last decade and is expected to continue at least in the short-term.

An alternative model where the service consumer are given the funds directly then chooses the most appropriate service provider is a small fraction of the total public funding, but is growing slowly due to its use in purchasing commercial cloud computing resources. The ability of service consumers to pay for service use within EGI is being explored by developing a service portfolio with identified service consumers and beneficiaries, and exploring pay-for-use mechanisms (See section 7.3.2.4).

7.3.2.3 European Commission Funding

The European Commission, like national public funders, is able to use its funds to drive the implementation of European policy and introduce prioritisations into key areas. Its key role within the context of e-Infrastructures is to provide the funds for the coordination of the national infrastructures at a European level and the means to deliver new innovations and policy actions that enable this coordination. With respect to the ERA it is essential that Europe establishes an open compute and data infrastructure that is able to support research infrastructures and individual researchers, and the most effective approach is to ensure that there are generic e-Infrastructures available that meet the needs of these stakeholders.

It is expected that the European Commission will hold competitive calls from which the EGI Community could obtain project funding that would focus on new service innovation, the development of e-Infrastructure policy, international cooperation, the development of EGI’s human capital and the promotion of EGIs activities and opportunities to researchers in the ERA.



7.3.2.4 Pay-for-Use

EGI currently operates within a traditional publicly-funded environment where services are provided free to the researcher following peer review. However, the EGI community is assessing how it can increase its flexibility and agility to researchers who have exhausted their peer reviewed resources by adopting a marketplace of resources where users can ‘pay-for-use’.

EGI has been investigating how to develop a more market driven approach to resource provision to prepare for a shift towards different funding models where users receive funds to purchase services rather provided freely following peer review.

Therefore, EGI.eu prepared an exploratory report [R8] endorsed by the EGI Council, which led to the forming of a dedicated Pilot Group [R6]. The objectives of the group are to gather both resource providers and user communities as active participants to define how resources will be metered, accounted and billed for through the Accounting Portal (already part of EGI-InSPIRE JRA1’s work programme); perform a gap analysis of customer, consumer, broker and resource provider supporting services (either new or extensions to the current tools) that would enable the increased automation of the process once it has been manually established and subsequent development required for missing functionality; evaluate legal, policy, and organisational issues around the full implementation of the pay-for-use model; and submit a final report for EGI Management.

7.3.2.5 Partnerships

There are a wide range of organisations throughout the EGI ecosystem and beyond that provides services to both research communities and the infrastructures. These efforts take shape in a number of different forms, whether through funded research projects, national structures or legal entities. Collaboration agreements have been used as a way to engage different organisations for mutual benefit. This typically provides in-kind effort for joint activities that facilitate added-value services while reducing replicated work.

However, in-kind effort is difficult to quantify in terms of costs and value as well as predict within strategic planning. Therefore, partnerships will continue to be established when areas of mutual benefit have been identified, but are not considered as reliable sources “revenue” within the overall strategic planning. A list of ongoing partnerships can be here [R9].

7.3.2.6 Professional Services

Additional income could be generated from staff at EGI.eu and the NGIs providing professional services to the academic and business community outside of project collaborations, e.g. delivering specific services from the portfolio to research infrastructures, or expert technical consultancy to an external independent project. This is one area to be further explored and for the long-term strategy of EGI.eu to understand if it can, should, wants to move beyond being an “internal” service provider to the NGIs and resource centres.

7.4 Legal

The final stage of sustainability relates to the legal aspects of an open ICT ecosystem. Last year, a number of different legal structures were analysed comprising foundations, associations, limited company, the ERIC legal framework and European economic interest group. The overall benefits for the structure such as EGI indicated that the current form of EGI.eu was the most appropriate (**Table 11**). However, the ERIC legal framework needed to be further investigated, which was document in an EGI-InSPIRE deliverable [R15]. Therefore, the following sections looks at the current state of both EGI.eu and more depth research into the suitability of the ERIC legal framework for EGI.



Coordination	FDN, Assn., Ltd., etc.	ERIC	EEIG
European	√	√	√
National	√	X	X
Research Community	√	√	√
Technology	√	X	√

Table 11: Legal Entities to Coordination Services

7.4.1 EGI.eu

EGI.eu was set up in 2010 as not-for-profit foundation to provide a stable structure for managing the European Grid Infrastructure (EGI) federation on behalf of its participants: National Grid Initiatives (NGIs) and European International Research Organisations (EIROs). The issues experienced have been documented over the first couple years, as with any new organisation, in addition to coordinating a large-scale project such as EGI-InSPIRE at the same time, but this last year, the third year, has started to show the importance of the role that EGI.eu plays, the value-add that it brings, and has both stabilised and matured.

Therefore, EGI.eu as an organisation and the coordinating entity of EGI is planned to remain in place in the short- to medium-term future, which should increase user confidence in the services being provided. Having a stable foundation for which to build will only continue to improve the service delivery as well as long-term sustainability.

7.4.2 European Research Infrastructure Consortium

The European Research Infrastructure Consortium is a legal framework established by the European Commission designed to facilitate the joint establishment and operation of research infrastructures of European interest.

The suitability of the ERIC framework for EGI was investigated by a dedicated ERIC Working Group and was documented in an EGI-InSPIRE deliverable [R15]. The end result of the investigation and potential transition plan was to create a common Digital Research Infrastructure (DRI) ERIC with the vision to deliver sustainable single integrated uniform market of ICT services that would match increasing demand for a single, uniform and integrated digital European Research Area.

A common e-Infrastructure ERIC would require participation from each of the coordinating bodies from PRACE, EUDAT and GEANT. The complexity and work required was documented with more concrete steps being looked at within Horizon 2020.

8 ANNEX 2: RISK ASSESSMENTS AND MITIGATION

Risk and Description	Probability ⁹	Effect	Impact ¹⁰	Mitigation and Contingency
Political – Inability to bridge national political priorities	Medium	Governments and national funding agencies move funds to other areas of strategic importance	Major	Strategic guidance provided by national representatives within the EGI Council. High-level engagement with national government bodies and national infrastructures to align both national and European priorities.
Economic – Funding reductions	High	Restriction of number of services and personnel reducing potential of overall value-add and quality of service delivered	Major	Cost-benefit analysis and market studies leading to revised service portfolio and focus of required innovation.
Social – Value-add not communicated and loss of customer base to commercial market	Medium	Loss of customer base, reduces need of e-Infrastructure	Moderate	Service descriptions better articulated. Build and utilise local human networks. Increase ease of use for increased adoption.
Technological - Key technologies or components are not available at the expected time; development takes longer than expected	High	Substantial increase in effort required by community (both technical development and coordination)	Major	Formal transition plan of potential missing services and components done in advance with together with stakeholders.
Organisational – Required roles and functions unable to be fulfilled (e.g. lack of interest or expertise)	Low	Inability to deliver required service.	Minor	Majority of services supported are based on a high level of requests therefore more easily attract the required personnel.
Legal – Changes to legal entity negatively impacts infrastructure	Low	Loss of a stable coordination body would lead to fragmentation of service delivery across Europe.	Insignificant	EGI.eu has reached a stable and mature level that is supported by the NGIs. The ERIC framework has been evaluated and will remain a point of discussion for the medium- to long-term.

Table 12: Risk Assessment and Management

⁹ Probability: Low (1%-20%), Medium (21%-60%), High (61%-99%)

¹⁰ Impact grades: 1=Insignificant, 2=Minor, 3=Moderate, 4=Major