



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. EGI's strategy is to establish an open ICT ecosystem that can attract research communities from across the whole digital European Research Area. This report focuses on the motivations, approaches and paths to EGI's sustainability through consideration of critical organisational, technological, financial and legal aspects, including an outline of the EGI business model framework and a risk assessment regarding the described sustainability plans. This document serves as an update to D2.7 Sustainability Plan and will continue to evolve during the project.



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II. DELIVERY SLIP

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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/>.



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

Sustainability is an essential consideration for e-Infrastructures and the Research Infrastructures and research communities that they support and as they frequently have research agendas that are measured in decades, researchers need to be assured of the continued operational presence of the e-Infrastructures that they adopt to support their work. This includes the appropriate governance to evolve this operational presence in response to their changing needs.

EGI's strategy and long-term sustainability will be through establishing an open ICT ecosystem that can attract research communities from across the whole digital European Research Area, while evolving a set of services that will increase flexibility in how the infrastructure is used.

The motivation, approaches and paths to EGI's sustainability are established within the context of the EGI2020 Strategy [R2] and by analysing the critical organisational, technological, financial and legal aspects within the EGI ecosystem. This report updates D2.7 Sustainability Plan [R1], which was produced in early 2011 and provided the first structured break down of the EGI ecosystem and services and introduced the concept of business models within EGI. Business models within the EGI ecosystem was the subject of a recent dedicated report 'Evolving the EGI Business Model [R3].

This document therefore bridges the EGI Strategy and the business models within the EGI ecosystem by focusing on the important sustainability aspects of EGI as a whole. It offers the motivation and rationale for the sustainability path being taken by EGI through the EGI business model framework and includes an assessment of potential risks. An outline of the next steps for the short- to medium-term is also provided.

The final goal for the community is that by the end of EGI-InSPIRE, the implementation of the initial phases of the EGI2020 strategy will have established an open ecosystem where individual actors supported through public and/or private funding will have been able to define their own added value and business models to support their activities. This foundation will enable EGI to continue to play a key role in sustainably bringing the digital European Research Area online.



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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 activities that need to be sustained, and how they can be sustained, by considering their organisational, technological, financial and legal aspects within the EGI ecosystem, including an EGI business model framework and a risk assessment regarding the described sustainability plans.

Overall, this document serves as an update to D2.7 Sustainability Plan [R1], which was produced in early 2011. The report provided the first structured break down of the EGI ecosystem and services and introduced the concept of business models within the context of EGI. This triggered a number of activities over the last year such as a value creation analysis of the EGI ecosystem [R4], sustainability workshops at the EGI events [R5, 6], a 3-day user sustainability workshop [R7], which compounded into two recently published reports that define the EGI2020 Strategy [R2] and EGI Evolving Business Model [R3].

This report therefore focuses specifically on the various sustainability activities that have taken place over the last year and is structured as follows:

- Defines the motivation and rationale for sustainability through the value delivered by EGI to scientific researchers and the wider contribution to both EU and national policy aims.
- Presents the approach taken towards ensuring long-term sustainability in terms of organisational structuring, technical services and financial mechanisms required to cover operations, maintenance and development costs.
- Describes the sustainability strategy through an EGI business model framework and future funding mechanisms, which includes an assessment of potential risks to the defined sustainability plans.
- Concludes with a brief summary and outline of the next steps for the short- to medium-term.



2 REASONS FOR SUSTAINABILITY

Today, science is no longer exclusively produced in a single research lab or within national boundaries. Modern scientific grand challenges in science and society will in the coming years call for integrated solutions, cross-country and multi-disciplinary collaborations and above all, computing power to analyse vast amounts of digital data being generated from instruments and simulations that needs to be delivered for decades to come. This trend for data-intensive science and collaborative discovery will continue to develop and will form the basis in Europe of future innovations in science, society and business.

In this context, EGI has played a pivotal role by integrating physical computing and storage resources with networking providers and other hardware to provide electronic services that support the intensive analysis of data that can be deployed on demand to meet the needs of researchers today and in the future.

2.1 *European Research Innovation*

EGI provides uniform access to large scale computing, storage and data resources across Europe through a federation of national resource providers that allows scientists from all fields of research to make the most out of the latest computing technologies for the benefit of their activities. Through EGI, scientists and researchers can share information securely, collaborate with colleagues worldwide and manipulate and analyse complex data faster and more efficiently in ways otherwise not possible. The research supported by EGI covers areas such as the Large Hadron Collider particle accelerator in CERN attempting to find the Higgs boson, medical researchers finding innovative cures for diseases such as Alzheimer's, malaria and avian flu as well as the creation of complex simulations to model climate change, among many others. Each of these examples has a direct impact on society at large while employing thousands of scientists and researchers across Europe and beyond.

Benefits of EGI in contributing to research innovation within Europe include:

- Ensuring the uniform and reliable availability of resources to researchers at a local, national and European scale, by having consistent monitored access to services wherever they are located.
- Enabling faster scientific results to be produced through collaboration across organisational and national boundaries due to the federation of national resource provider for the seamless uniform access to services for researchers in Europe and internationally.
- Promoting open science through the availability, accessibility and reuse of scientific data & results, use of web-based tools that facilitate scientific collaboration and ensuring public access to research.
- Allowing researchers to focus on their research rather than managing their e-Infrastructure needs.
- Providing effective utilisation of resources in different administrative domains to ensure the most effective return on infrastructure investments.
- Facilitating the innovation and sharing of solutions by building a thriving ecosystem through community events and other collaborative services.



2.2 European Technology Innovation

EGI traces its origin back to the early pioneering days of distributed computing research that took place in the early 2000's as local services started to emerge for compute- and data-oriented applied researchers across Europe. Through the technology innovations developed by the EGI community in Europe over the last decade, thousands of applied researchers now have an operational production infrastructure that is integrated into and supports their daily research activities. This resource has helped European researchers develop world-leading scientific innovation [R8]. EGI is now an established European-wide federation of national computing and storage resources supporting multiple research communities as a result of over a decade of investment by national governments and the European Commission. Currently, EGI integrates more than 350 resource centres in over 35 countries, supporting 18,000 users across 15 different disciplines. The technology and the operations tools used to achieve this have been adopted around the world and established EGI as a world-leading model for federated distributed computing.

2.3 European Policy Innovation

E-Infrastructures, such as the EGI, are fundamental building blocks of the vision set out by the European Commission in the Digital Agenda for Europe (DAE) and the Innovation Union (IU) flagship initiatives, as essential parts of modern scientific research and a driver for economic growth. The strategy outlined by the flagship initiatives is ambitious, but crucial if Europe is to create a just, inclusive and modern society. Embracing the digital revolution will bring better health care, better environment solutions, better transport and, above all, better quality of life. Therefore, bringing the digital ERA online becomes a critical aspect of modernising Europe's research infrastructure.

To meet these challenges EGI provides an organisational structure for improving the capacity of the human capital that exists within Europe, the means to digitalise research workflows to radically improve the capability and capacity of Europe's researchers to meet these societal challenges and provides a cost-effective physical infrastructure through the federation of national resources to underpin this digital research future. These goals can be achieved through EGI - a unique, integrated ecosystem of research communities, resource and technology providers, technology integrators, and platform operators bound by efficient coordination.

The Digital Agenda for Europe offers opportunities for EGI to:

- Provide a single uniform market for accessing distributed computing resources and connected data in Europe through EGI's federation of national resource providers.
- Promote competitiveness and interoperability through open standards within the European Interoperability Framework (EIF).
- Reduce inefficient research spending and stimulate innovation across Europe by maximising the utilisation of federated national resources and knowledge within a common infrastructure.
- Offer large-scale ICT facilities that enable the exploration of new computing and data processing models that address scientific grand challenges facing society.

In the context of the Innovation Union, EGI can:

- Position itself as a key enabler of the digital ERA for the free circulation of researchers, knowledge and technology.



- Promote excellence in education and skills development by simplifying multi-disciplinary cooperation.
- Bridge geographical boundaries beyond Europe thanks to the many collaborations and integration with worldwide e-Infrastructures.

Overall, by contributing to the Europe 2020 strategy, primarily through the establishment of the digital ERA, EGI is capable of generating a substantial socio-economic impact for European society. Through its federated structure, the policies adopted by EGI are in turn adopted by national and regional structures. Therefore EGI, through its grass roots human network in the research community and in the delivery of research services, represents a powerful tool for the implementation of European policy initiatives nationally. The reverse is also true in that EGI has a representation role that allows input into EC policy discussions to be made that are representative of a pan-European e-Infrastructure community.

3 APPROACHES TO SUSTAINABILITY

Since it first appeared in the 1980s, the use of term 'sustainability' (the capacity of a system to endure) has grown exponentially; however, it has been difficult to pin down what it means and what people understand by it. Within the context of EGI, sustainability is seen as 'ensuring that the key critical components and capabilities of the open EGI ecosystem will endure while ensuring the evolution of other interacting but independent components and capabilities'. An ICT ecosystem is open when it is capable of incorporating and sustaining interoperability, collaborative development and transparency, while increasing capacities to create flexible, service-oriented ICT applications that can be taken apart and recombined to meet changing needs more efficiently and effectively.

3.1 EGI 2020 Strategy

With this approach to sustainability, EGI has developed a long-term strategy plan [R2] with links to the Europe 2020 priorities. The following sections build on the strategy and business development discussions that have taken place over the last year to provide a complete picture of how EGI is evolving and where and how its stakeholders can play a role in ensuring its sustainability. Specifically, EGI provides a common foundation upon which the digital ERA can be brought online by:





- Building an ecosystem that promotes competitive cooperation, collaboration and interaction at local, national and European level. Engagement with technical users and researchers can be enhanced through local 'grass-roots' support, national and European events and workshops that promote EGI and its activities within the ERA.
- Extending a European scale operational infrastructure that ensures open uniform access to locally deployed, domain specific services. While continuing to support the current services for the currently supported research communities, the operational infrastructure needs to be developed to allow other European scale research communities to monitor and manage their own services operating at their distributed facilities. In addition, the operational infrastructure needs to support the federation of resources (such as institutional private clouds) in the public sector and public clouds from the commercial sector to support uniform standards-based transnational cloud access as a new capability to attract new research communities.
- Reducing the technical barriers to accessing EGIs resources by ensuring the flexible easy deployment of the virtual research environments needed by different research communities. Research communities need virtual research environments (that span from the low-level e-Infrastructure services to the simple easy to use user interfaces on desktop and mobile devices used to access them) personalised to their particular needs and available to them across Europe. This software needs to be composed of open extensible software solutions that can be reused across the different virtual research environments needed by different research communities.

This will be accomplished through three strategic areas attracting community, EC and national funding streams:

1. **Community & Coordination:** The network of national interfaces (the NGIs) and domain specific organisations (EIROs) into a European coordination body (EGI.eu) that provides governance to the community and the continued development of that community and the ecosystem it supports through communication, outreach, support and marketing events.

2. **Operational Infrastructure:** EGI federates a European-wide operational infrastructure structured along geographical regions (normally counties) or research communities comprising over 350 resource centres that will be used to:
 - a. Support the currently deployed commonly used functional services and their evolution in demand to the use from current and new research communities.
 - b. Help pan-European research infrastructures scale out the uniform operation of their functional services across Europe.
 - c. 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.
3. **Virtual Research Environments:** A key requirement to the wider scale adoption of e-Infrastructures is the ability for individual researcher 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.

This strategy is summarised in *Figure 1* and expanded on later in this section. It uses community funding (through the EGI.eu participation fee) to ensure the continued operation and coordination of the operational infrastructure, the majority of which is already funded through national sources, but EC and national project funds are used to develop new innovation and bring these new capabilities to a state where they are ready for large-scale deployment and operation. European level community building and coordination are funded on a project basis through the EC. This supports the integration and delivery of VRE technology and the VREs to researchers and research collaborations which are funded independently through their individual mechanisms.

-  Operational Infrastructure coordination funded by the EGI.eu participation fee with other European community & coordination activity funded through EC projects.
-  Research community specific funding mechanisms
-  Innovation funded by EC projects
-  Funded by national sources

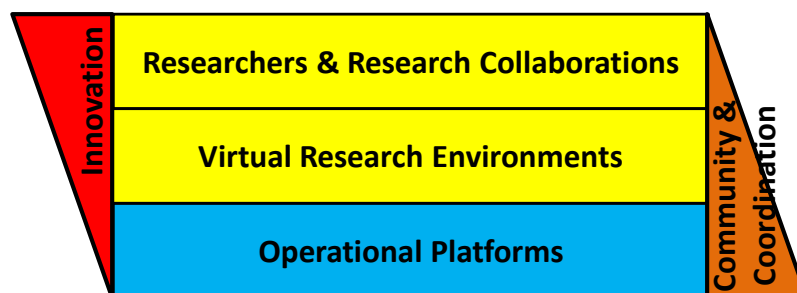


Figure 1 The funding of EGI's strategic areas



Against this strategic direction and investment areas, EGI's approach to sustainability through an open ecosystem is now considered from an organisational, technology, financial and legal aspects as identified within the 'Roadmap for Open ICT Ecosystems' paper [R22].

3.2 Organisational Sustainability

For EGI to become an open ICT ecosystem, it needs to continue its evolution from a monolithic project based entity established in EDG (European Data Grid) and EGEE (Enabling Grids for E-science) a decade ago, to a collection of cooperating independent technology providers, resource infrastructure providers, research communities and the national (NGIs) and European (EGI.eu) coordination bodies that have established themselves over the last few years (see Figure 1). Other roles (e.g. platform integration and platform operation) are beginning to emerge from within the community's current activities.

The first stage of the organisational sustainability was completed in 2010 with the establishment of EGI.eu, an independent legal entity to provide European coordination and representation for the EGI community. Alongside EGI.eu's European level coordination, each country established national coordination bodies – National Grid Initiatives (NGIs) – for their local needs. Some of these NGIs have been established as independent legal entities or are hosted inside existing legal entities. Meanwhile, the establishment of the European Middleware Initiative (EMI) [R9] and Initiative for Globus in Europe (IGE) [R10] technology projects alongside the main infrastructure project represented the first step in their evolution towards organisational sustainability. Alongside the activity in the e-Infrastructure, the European Research Infrastructures within ESFRI [R11] are pursuing their own sustainability strategies through legal entities such as the European Research Infrastructure Consortia (ERICs) [R12].

Although, EGI.eu has a pivotal role within the EGI ecosystem to facilitate sustainability across the community it is not EGI.eu's responsibility to ensure sustainability for the whole community. Individual activities need to establish their own business models, identify the unique value they can bring to the consumers of their services, and to establish their own funding streams to sustain their activities. The legal organisation, the services and the funding mechanism will vary from country to country and research community to research community.

3.2.1 EGI Ecosystem roles and functions

The ecosystem that preceded EGI provided minimal distinction between the roles of the different actors and the values they provide. As a result, the EGEE series of projects was frequently seen as a monolithic and closed ecosystem with which it is difficult to interact and collaborate unless you were able to use the single deployed technology solution.

In defining the EGI Strategy, an analysis of the various actors in the ecosystem was performed to examine the current state of the actors that are in place or emerging within the EGI community, the values that are being exchanged between these actors while mapping these actors to the strategic activities, roles and services that are being defined and developed. This analysis led to a new decomposition of the EGI ecosystem, which has evolved to provide a clearer separation between the national roles and Technology Providers as well as the creation of specific roles called Platform Integrators and Platform Operators to assemble and operate virtual research environments customised to specific research communities [R14].

It was important to decouple the platform integrator and operator roles that for the most part sit within the national infrastructures and technology providers so that they can be delivered by additional organisations in order to scale out EGI's ability to interact with different research communities. Platform Operators have the technical expertise to deploy and operate products and services to meet the needs of particular researchers, while Platform Integrators are able to respond to specific needs by integrating independent software components into a coherent software stack to enable fully functional services based on a researcher's individual needs. The following sections provide more detail to these roles. Even if done as part of a national structure, the roles of platform integrator and operator are targeted at specific research communities or infrastructures.

Figure 2 provides a high-level view of the refined ecosystem as a result of this analysis. This moves the current monolithic ecosystem towards one that has increased openness that would provide a structure where others can replace existing actors without damaging the ecosystem as a whole, thus ensuring a persistent and sustainable e-Infrastructure for years to come.

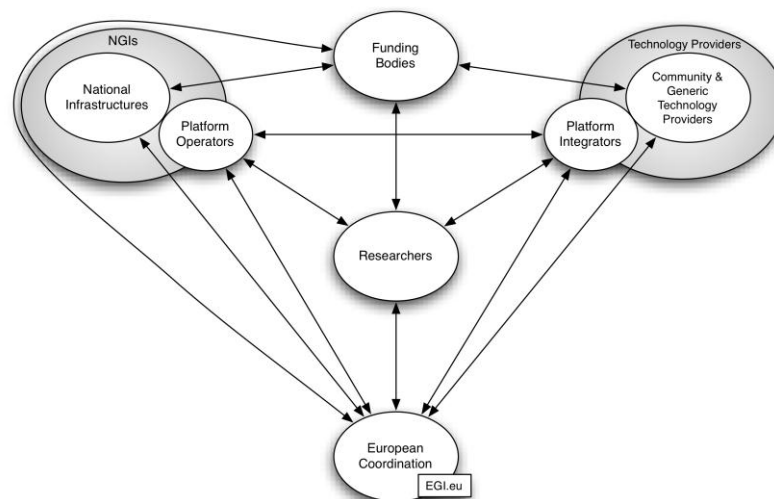


Figure 2 - EGI Ecosystem Overview

- **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) [R15].
- **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:** EC, national research councils or other organisations that define policies and funding schemes to support the digital research.

3.2.2 Community & Coordination

The first of three key strategic investment areas start with Community and Coordination. This is the network of national interfaces (the NGIs) into a European coordination body (EGI.eu) that provides governance to the community and the continued development of that community and the ecosystem it supports through communication, outreach, support and marketing events.

The activities taking place to coordinate and develop the EGI community are valuable but it is challenging to define who the specific beneficiaries of the services are. Much of the work in this area is to bring together individual national activities taking place across Europe into a coherent European activity to support EU2020 objectives of an integrated ERA with open trans-national services. Therefore a mixed mode of support is foreseen:

- **Governance:** By adopting a federal model much of the governance is devolved to a national level. Bringing these national representatives together to provide European governance and coordination within and for their own community will continue to be supported through EGI.eu and the participation fee paid for by its consuming community.
- **Events:** While individual events are expected to operate on a non-profit basis, experience over the last decade has shown that a persistent event secretariat that can provide professional coordination, management, marketing and communication around an event significantly increases the quality and therefore the effectiveness of the event. As many of these events are explicitly to structure the pan-European development of the infrastructure or its engagement across research communities, the continued support of the EC will be sought.
- **Marketing & Communications:** As has been noted, the main success of the large EGI events can be attributed to a professional marketing and communications team at the heart of the event secretariat. In addition, such a team provides a resource to the whole EGI community and its ecosystem to provide professional services. While direct funding from an EC project to provide such European level activity is seen as the main source of funding, the provision of professional services to organisations within the ecosystem (paid for by either private or public funds) and providing a service to its direct stakeholders within EGI are business options that need to be developed.
- **Policy:** The provision of accurate, understandable policy material for internal and external decision makers is essential and needs to be supported by those who derive the most value from the information. Internally, the EGI community should support the generation of material that is of benefit to its internal processes and stakeholders. Externally, collecting material that supports external policy making activities or accelerates the integration of national infrastructures into the ERA (e.g. EGI Compendium) should be supported by the EC.
- **NILs:** Establishing a grassroots network throughout all NGIs, which is integrated across EGI provides, an excellent framework within which to connect geographically to researchers



across Europe and across different disciplines. The network itself represents a significant investment in human capital that needs to be developed, but a framework from within which human capital of the research community could be developed. The growth of such a human network would underpin the digitalisation of the European Research Area and its integration at a European level. The establishment of such a network would need to be supported heavily by the EC.

3.3 Technology Sustainability

EGI does not develop the technology deployed to access the resources located at its federated resources centres in the production infrastructure – all upgrades and new programmes are produced elsewhere, by independent technology providers. The prioritisation and rationalisation of the requirements and the outsourcing of technology developments to independent technology providers is managed by EGI.eu’s Technical Collaboration Board (TCB).

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 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 [R16]).

3.3.1 Technology Providers

The technology area within the EGI ecosystem is built upon open-source or commercial software coming from community and generic technology providers that is put together by platform integrators to meet the needs of particular research communities. For instance, the EMI project integrates a platform for high-throughput computing from software that is developed within the project primarily for the EGI community (i.e. community technology providers such as the product teams within EMI) with software developed outside the EGI community (i.e. generic technology providers such as Apache [R17]) to meet particular use cases coming from their target research community (e.g. WLCG [R18]).

The current technology providers deliver two important capabilities across two classes of services defined as:

- **Infrastructure Services:** Part of the Core Infrastructure Platform used to manage, monitor and account for the use of the functional services that are deployed in EGI’s resource centres.
- **Functional Services:** Provided by the different Community Platforms that provide service-oriented access to the resources within EGI needed by the different research communities as part of their virtual research environment.
- **Support:** Refers to the routine maintenance of the software services within EGI needed to keep them operating.
- **Innovation:** Refers to the software engineering work needed to prototype and develop new capabilities in response to requirements coming from the community that consumes the service, and to integrate these new innovations into the production environment.

The sustainability of these activities is described below:

Infrastructure Services

Functional Services



Support	Infrastructure Community Funding or Effort	Research Community Funding or Effort
Innovation	Project Funding	Project Funding

Table 1 – Funding and Services Types

3.3.2 Operational Infrastructure

The Operational Infrastructure provides coordination services (either to internal or external consumers) that are used to ensure the provisioning and delivery of high-quality services to researchers across different disciplines. These services are grouped into platforms to provide distinct products to different consumers.

- **Core Infrastructure Platform:** These are the services used by NGIs and their resource centres to integrate their local functional services targeted at consuming research communities into national infrastructures, and then to federate their national infrastructures hosting these local functional services into a uniform integrated European infrastructure.
- **Cloud Infrastructure Platform:** The adoption of a cloud model by EGI would enable research communities, or platform operators working on their behalf, to access virtualised resources at individual resource centres (where authorised) directly for the purposes of provisioning services as part of a community’s virtual research environments for individual research communities or individual researchers. This would allow platform operators to provide customised solutions for the research community they were supporting independently of any generic service the resource centre might choose to provide. This flexibility and choice is essential in order to provide an e-Infrastructure for the long tail of smaller research communities needing to undertake their multi-disciplinary collaborative research.
- **Collaborative Infrastructure Platform:** These services help distributed communities (beyond the resource centres and the production infrastructure) to work more effectively together. While the services can benefit a similar type of consumer as the Core Infrastructure Provider, they can also enable collaboration and interaction between research communities and research communities and resource providers.

The use of these Infrastructure Platforms enables the resource providers to provide services to their consuming research communities. To promote adoption by these research communities the long-lived operation of these services needs to be assured by its providers. Therefore the cost of routinely operating these Infrastructure Services needs to be assured through the EGI community with routine national operation being assured by national funds and routine European coordination to deliver the operational infrastructure to be assured through EGI.eu through the participants’ contribution. The development and introduction of new innovative capabilities and operational techniques into the infrastructure through short-term projects needs to be supported by external funding sources such as the EC.

3.3.3 Virtual Research Environments

Each research community has different needs around the physical infrastructure they require for their data analysis and the software environments needed to undertake this work. Supporting different virtual research environments (VREs) for different research communities within the production infrastructure is essential in order to increase its attractiveness and uptake. Although



there may be many different VREs, they may have many common services coming from independent technology providers that are assembled by platform integrators for operation by platform operators on behalf of particular research communities. Some of these services will be provided centrally specifically for the research community, some services may come from the Collaborative Infrastructure Platform available to all, and other services that are expected as part of the VRE will need to be deployed at each participating resource centre as part of that community's Community Platform.

One of the purposes of the Collaborative Infrastructure Platform is to provide services that help organisations undertaking a platform integration role to discover, assemble and deploy the VREs into production. Once in operation, there are services in the Collaborative Infrastructure Platform that can assist the platform operators in delivering the VRE to the consuming research community. There are two 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.

While there is a responsibility for EGI to ensure that an open ecosystem is established that allows platform integrators, platform operators and research communities to have equal access to these services provided by EGI, the quantity of resources that are allocated to a research community is allocated at a national level outside of EGI's governance, as is the funding to support a particular research community and the platform operators and integrators, and the technology providers that they may work with.

3.3.4 Open Standards

The value of EGI to its adopting researchers is the ability to integrate processes across both organisational and technical boundaries, hence the need for interoperability. Reaching interoperability amongst organisations and technologies is a long-term activity that cooperating e-Infrastructures have to achieve, which requires reaching consensus through compromises and then refactoring/rebuilding systems or procedures according to these agreements. Interoperability between e-Infrastructure providers and within their resource centres and services can be addressed at different levels and open standards and standards development organisations with open processes play a key role at the technical level.

Open standards are a key building block for an open ICT ecosystem as they drive interoperability and are the backbone of a service-based approach. They ensure that criteria and decisions are service-oriented and technology neutral. Open standards allow components to be combined, mix and matched, and replaced without the expense and expertise of custom coding connections between service components.

EGI is fully committed to the promotion and adoption of standards-based technology and this is pursued by tracking the relevant specifications, by defining a standards roadmap, and by engaging technology providers through Memorandum of Understanding (MoUs) with a dedicated activity to promote awareness and steer adoption.



More information regarding EGI standards work can be found in a dedicated report [R21].

3.4 Financial Sustainability

Funding is certainly a key element of sustainability; but the funding for innovation leading to establishing or improving the operational efficiency and technical capabilities of the ecosystem needs to be decoupled from the funding that is needed to operate the ecosystem. Many of the providers in the ecosystem can be foreseen to have a service delivery activity – sustained frequently by the community that drives the most value from that activity – but where the innovation in this service delivery is funded, when required, through short-term focused projects driven by community need and supported by European and national funding bodies.

Middleware development projects, such as EMI and IGE, are ending in Spring 2013 with no immediate plans for any follow on projects. Groups dependent on such middleware services - the infrastructure providers and individual research communities - are exploring what the support options might be.

3.4.1 Public Funding

3.4.1.1 European Driven Funding

While the EGI community has been in existence in various forms for over a decade it continues to evolve. The pioneering experimentation phase undertaken between resource providers and a few early adopting research communities is over. The challenge for the next decade is to scale out the delivery of services to meet the needs of the digital ERA through further targeted EC investment in areas such as:

- Development of policies and processes to scale an ecosystem designed for a few large transnational research communities to one that can manage many large international research communities, small communities and even support countless individual researchers.
- Continue to build the international ecosystem and the community within it through regular Forums that promote collaboration and the exchange of best practices between NGIs; by raising awareness of the different activities taking place within the ecosystem, and topical workshops to help develop a community wide approach in specific areas.
- Communications within EGI's own technical community (resource providers technology providers, platform integrators and platform operators), and communications within the research community that uses e-Infrastructures (such as publications like iSGTW) and marketing to research communities not already using e-Infrastructures such as EGI.
- Training and education of the technology providers and operations staff – EGI's human capital – to promote community wide best practice to ensure that the smaller NGIs and communities new to EGI have the required skills for the effective and secure use and operation of EGI's services.
- Integrating and operating virtual research environments that can be deployed on EGI resources to meet the needs of individual researchers and research collaborations by bringing together commercial and open-source software components and technical expertise.



3.4.1.2 National Driven Funding

NGIs and their resource centres benefit directly from centralised technical services and support that help coordinate and integrate EGI's operational infrastructures thus should be the primary contributors to these services. As European priorities evolve focusing on innovation and development, national funding will need to ensure general operations and maintenance of the infrastructure to meet national priorities. As domain specific interests vary between countries, clearly separating out the funding responsibilities across different areas will allow for more targeted funding for sustaining specific activities. However, as members of the European community, national based interests have traditionally followed in support of European objectives, therefore it is expected that European funding will continue in partnership with national funding. Financial tools set up by the European Commission, such as Structural funds, are one mechanism that can provide an adequate framework for financing a wide range of projects and investments to deal with disparities across various countries while encouraging economic growth. NGIs have been encouraged through the EGI Council to take advantage of these opportunities.

3.4.2 Community Contributions

A community based funding model is currently used to support EGI.eu (a Dutch foundation) through participation fees set by the EGI Council and levied annually. Community based funding models, either through the participation fees or direct service charges, provides a mechanism to drive consolidation and efficiency in the routine baseline operation of the infrastructure. Community funding can assure the continued European coordination of the core infrastructure to meet the needs of the research communities that directly benefit from it. The majority of the infrastructure's operating costs (i.e. hardware, staff, support, buildings, electricity) are already funded directly from national funding sources. Moving the long-term steady state support of the infrastructure completely to national funding schemes and their contribution to European coordination through the EGI.eu participation fee would send a strong message as to its sustainability to the research communities that they are depending upon it.

EGI has analysed the costs of the EGI Global Tasks [R19] that are partially supported through community contributions. The costs of delivering technical and non-technical services, as well as the individual service operation, maintenance and development costs, are identified across different capabilities. This was an important exercise as different business models (project based funding or community contributions) are being considered for the different service categories based on the main beneficiaries of the different services.

Work will continue in PY3 to refine the costing around these services and to formally define an EGI Service Portfolio.

3.4.3 Private Investment

Commercial organisations remain a largely untapped source of funding due to legal and logistical concerns and are more likely to be delivering services to the EGI ecosystem in the future rather than purchasing services from the EGI ecosystem. However, the operational infrastructure needs to support the federation of resources (such as institutional private clouds) in the public sector and public clouds from the commercial sector to support uniform standards-based transnational cloud access as a new capability to attract new research communities.



Understanding the opportunities through Public-Private Partnerships, especially in the area of cloud computing, is another area to be further investigated.

3.5 Legal Sustainability

The final stage of sustainability relates to the legal aspects of an open ICT ecosystem. EGI needs to be able to provide a framework that addresses procurement, licensing, privacy, intellectual property, competition and other issues that go beyond the basic rules of adopting open standards. The infrastructure currently operates within a well-structured system, built not only on open standards and interoperability, but also using structured organisations and mechanisms to conduct its business. As EGI develops its strategy and solidifies its model of an open ecosystem, the individual actors within the ecosystem are able to establish and refine their own business models and any legal entities needed to support them.

From a European perspective, EGI.eu, a legal Dutch non-profit organisation based in Amsterdam, was established to coordinate and manage the infrastructure (EGI) on behalf of its participants: National Grid Initiatives (NGIs) and European Intergovernmental Research Organisations (EIROs). EGI.eu, coordinator of the EGI-InSPIRE project, 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.

However, within an open ICT ecosystem, there are a number of organisational forms that can be used to carry out the coordination roles and functions at a European level and national level, and around providing research community or technology specific coordination and services. The table below provides an overview of some legal entity types that can be used to provide the required function. Again, EGI can only provide a framework and identify mechanisms through coordination services, but which role, function, service and mechanism that is chosen is specifically up to the individual organisations and country that best suit them.

Some of these legal structures include:

- **Foundations, Associations, Limited, etc.** - There are a variety of legal forms or organisation types available in all countries that offer different tax benefits as well as comprise differing legal obligations, formalities and paperwork - especially between a public organisation and a private company. There are also a number of factors that go into deciding which organisational type will be the best vehicle for a particular activity, but each type provides a legal foundation for formalising relationships and entering legal contracts and agreements with defined legal and financial liabilities.
- **European Research Infrastructure Consortium (ERIC)** - A new legal instrument has recently been adopted by the EC to facilitate the establishment of pan-European organisations dedicated to supporting research communities [R12]. Two models have been explored by the EGI community around the adoption of the ERIC model - both of these models remain under discussion at this time:
 - A 'lightweight' EGI ERIC would absorb the work currently undertaken by EGI.eu, but as a result of the ratification process required of an ERIC could bring additional national recognition and funding commitment from the member states.
 - A 'heavyweight' EGI ERIC would build on a 'lightweight' ERIC and provide an additional service to the EGI community through the purchasing and management by



NGIs of ICT facilities (potentially funded by the EC and by member states taking advantage of preferential ERIC taxation options) to meet the needs of the research communities it supports.

The ERIC is being considered by many of the ESFRI projects and several have already been established.

- **European Economic Interest Group (EEIG)** - A type of legal entity created under European Community (EC) Council designed to make it easier for companies in different countries to do business together, or to form consortia to take part in EU programmes. Its activities must be ancillary to those of its members, and, as with a partnership, any profit or loss it makes is attributed to its members. Thus, although it is liable for VAT and employees' social insurance, it is not liable to corporation tax. It has unlimited liability. It was based on the pre-existing French groupement d'intérêt économique (G.i.e.) [R13].

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

Table 2 – Legal Entities to Coordination Services

Each national grid community has different requirements and legal environments that they must operate in leading to the adoption of different governance models. For instance, one country may decide to have a dedicated legal entity to coordinate e-Infrastructures of any kind (e.g., Grid, high-end computing, network) while delegating the central operations to another entity. Another country may decide to have an existing legal entity provide national grid coordination, central operations and physical resource alongside a broader research oriented remit. Yet another example can envision the lack of a legal entity for the national coordination with functions distributed among the partners aggregated as a kind of association.

Each form of legal organisation brings with it advantages and disadvantages optimised around the local environment. For instance a large established organisation may be restricted by its operating mandate to only work in public funded research and is restricted in undertaking commercial activities. A small, dedicated organisation may be more flexible in its financial activities, but lack the critical mass provided by a larger organisation.

As EGI evolves into an open ecosystem and its service design and management continues to adopt a more service oriented approach, the formal agreements made between the various actors will need to evolve and eventually become legally defensible. For collaborations between projects, EGI will continue to use various mechanisms such as mutually agreed Operational Level Agreements (OLAs) and Memorandum of Understanding (MoUs) to identify responsibilities within the collaboration. However, as the open ICT ecosystem develops, formalising the framework in which the various components interact whether between organisations or with third parties will become necessary.



This would mean replacing the collaborative OLA or MoU model with commercially or legally defensible Service Level Agreements (SLAs) and service contracts. These can only effectively be made between legal entities instead of projects represented by legal entities. The establishment of legal entities within the ecosystem is therefore a pre-requisite for the establishment of legally defensible SLAs and contracts. Therefore, the establishment of legal entities potentially driven by the need to consume or deliver services with legal guarantees, will only happen when the community is ready to accept the benefits and responsibilities of such a change.



4 PATHS TO SUSTAINABILITY

The previous sections have identified in the context of the EGI ecosystem what needs to be sustained within EGI and how it can be sustained across organisational, technology, financial and legal aspects identified within the ‘Roadmap for Open ICT Ecosystems’ paper [R22]. The following sections identify how EGI can be sustained through a brief overview of the EGI business model framework and opportunities within the ecosystem.

4.1 Strategy

EGI’s Strategy [R2] for the next decade revolves around investments in and evolution of the community and coordination, the operational infrastructure and virtual research environments customised for individual research communities. The sustainable operation of these structures and activities falls to either the resource infrastructure providers (i.e. EGI and its federation of national resource infrastructure providers) or the research communities (i.e. support or operation of the virtual research environments that they use). However, the innovation and development needed to meet any new challenges coming from the applied research community or operating a distributed federated infrastructure at such an unprecedented scale is expected to come from short-term project based funding using public, private or community sources.

EGI’s strategy across the four identified aspects of sustainability is:

- **Organisational Sustainability:** By recognising and moving towards an open ecosystem the centralisation and number of critical activities is reduced, but the number of entities able to build on top of this open platform is increased enabling multiple actors to compete to deliver services to a particular consumer providing redundancy and choice within the system. An open standards based ecosystem also makes it easier for commercial entities to offer or consume services.
- **Technical Sustainability:** The technology needed to operate the infrastructure is distinct from the technology needed by research communities to access the resources in the infrastructure and different sustainability strategies need to be adopted for each. A small set of Infrastructure Platforms with key enabling services will be maintained by resources from within the infrastructure community. This will enable research communities to deploy and operate virtual research environments that they sustain using the mechanisms and resources that are most appropriate within their research community.
- **Financial Sustainability:** The physical operational infrastructure has been sustained outside of EC based public funds since it was established. During the last decade, the technical innovation needed in the operation of and access to federated resources has been funded by national and EC based projects. Through this innovation, these environments have matured where they can be operated through community funding models. However, the innovation and the integration of this innovation into the operational infrastructure need to be funded through short-term projects.
- **Legal Sustainability:** The EGI community has established EGI.eu as a legal entity to provide centralised European governance, coordination and services related to infrastructure operation as part of an open ecosystem. This legal sustainability exists in some of the larger and more mature research communities (e.g. the EIROForum labs)



and has yet to coalesce within many of the community's technology providers where discussions on sustainability and governance models are ongoing.

Given EGI's sustainability strategy across these four aspects, the business models that can be adopted by the entities within the EGI ecosystem can be considered.

4.2 Business Models

D2.18 EGI Evolving Business Model [R3] report provided a framework for business model generation for the various actors that can play a role in contributing to the delivery of services within EGI. The approach started with a SWOT analysis to identify Strengths, Weaknesses, Opportunities and Threats for the individual roles in the ecosystem. This analysis helped to find a competitive advantage by matching the strengths to opportunities, while suggesting conversion strategies to convert weaknesses or threats into strengths or opportunities. After the SWOT analysis, an exemplar business model was defined through the lean business model canvas for each of the EGI ecosystem components.

The framework provides a pragmatic way to start defining a business strategy by building upon a common framework. The canvas proposes nine specific distinct subparts that enable to deconstruct a business model. They are a tested decomposition proved to work in many different real-world use cases. They can be individually completed for/by the various entities of the EGI ecosystem and the simple format helps a conversation among the interested parties by keeping it focused on the core elements who lead the success of a business instead of getting lost in complex business plan documents. It is not for EGI to define or govern the individual business models adopted by the different entities and services that they provide, but to provide an open ecosystem in which these entities can thrive.

4.3 Funding Opportunities

The move away from a project-based structure to a sustainable coordinating organisation (EGI.eu) has provided a clearer managerial and operational focus, but it is clear through the development of the business model framework that the engagement of research communities with e-Infrastructure providers and the individual technology providers needs to further develop within the context of an open ecosystem. An integral part of EGI's sustainability plan and that of the community within the ecosystem is to identify the business models and funding streams that can be used to support its different activities. As each organisation starts to define what roles and functions they can fulfil and which services they can provide based on their level of expertise and operational costs, a gap analysis can then be conducted to ensure that each area that is crucial to the infrastructure and the services to the researchers are ensured leading to increased sustainability.

The next decade presents a variety of opportunities that build on EGI's existing strengths through:

- Assuring the continued integrated federated operation through community and national funding of a key transnational European e-Infrastructure through the uniform deployment of services to access compute and storage resources.
- Developing further technology innovation and integrated European operation of the Core, Cloud and Collaborative Infrastructure Platforms through EC funding that will be the foundation of the digital ERA and enable research communities to deploy the virtual research environments needed to undertake their work.



- Using EGI's human network across Europe to increase through EC funding the human capital and reach of the digital ERA across countries and across disciplines within Europe and worldwide.
- Working with technology providers, platform integrators and platform operators to provide through EC and national funding the innovative personalised virtual research environments needed by the different research communities.
- Ensuring through EC funding that Europe retains its global leadership and presence in e-Infrastructure by working with other established and emerging national and regional e-Infrastructure providers around the world to provide service interoperability and interoperation to meet the needs of European researchers and the global collaborations as part of the digital ERA.

4.4 Risk Assessment

For EGI to be successful, identifying the critical risks, potential impact and required mitigation strategies are essential to long-term sustainability. The following section provides an overview of the main risks to EGI and how these risks are reduced for the EGI community:

- **Funding:** Lack of funding from European and national agencies, by which sustainability is directly dependent, both in the EGI community and in the research communities that surround it.
- **Relevance:** Inability to respond promptly to the needs of new research communities and provide the services that are required for continued long-term usage.
- **Structure:** Failure in efforts to streamline activities towards better defined roles and functions and more targeted services for maximising funding support.

4.4.1 Funding

Public funding is the central focal point of sustainability as the foundation of EGI is for the purpose of scientific research for social-economic impact. Across the ecosystem, public funding supports not only the efforts to build and maintain the physical infrastructure, the software innovations needed to operate and use the distributed resources, but also funds the researchers and science as well. Therefore, the key to securing long-term funding will be to ensure that the delivered services match the needs of the consumers and the priorities of their funding agencies. It is expected that national funding will continue to cover the maintenance and operation of national infrastructures and domain specific activities according to country priorities. European funding will cover the innovation and development needed to achieve priorities in the Europe2020 Strategy. Community funding, either in cash or in kind, provides an approach to meeting the routine operational needs of the infrastructure operations or maintenance of domain specific software environments. Frequently, both European and national priorities coincide and partnership for mutual beneficial goals is expected to continue.

4.4.2 Relevance

Even if funding is provided, it does not guarantee the longevity of the infrastructure as only through continued usage can the ultimate added value of EGI be determined. Therefore, it is of utmost importance to ensure that the services provided meet the needs of the researchers who use them. This matches EGI investment areas around operational infrastructure and virtual research environments that coupled together provide increased flexibility for researchers to develop the



virtual research environments they need for their work, and then deploy the software environments they need, where and when they need them. With strong community and coordination activities, both outreach and technical support will ensure that researchers are not only just aware of the infrastructure but are guiding through the entire process, from first contact to use.

4.4.3 Structure

Finally, EGI is enabled through a set of both human and technical services that are provided on behalf of the community. As described, the rich EGI ecosystem has been analysed and decomposed into roles and responsibilities in order to improve clarity on value exchange between different actors and set out the context for opening it up to improve efficiency and flexibility. It is through this analysis and restructured ecosystem that will allow for EGI to exploit the knowledge built up throughout the community over the last decade and to provide target services around this expertise. This will ultimately allow for higher quality of services to be provided and to increase funding opportunities.



5 CONCLUSIONS AND NEXT STEPS

Sustainability discussions within EGI have evolved significantly over the last several years following on from the EGI_DS project [R23], with many key discussions having taking place during the past year. The EGI sustainability framework has been designed to ensure the long-term presence of the infrastructure for the researchers who need it and the resource infrastructures that provide it within an open and evolving ecosystem. This framework comprises a defined strategy for EGI2020, which includes three key strategic investment areas, a set of infrastructure platforms and virtual research environments that will increase user flexibility and expand the user base, and the evolution of an open ICT ecosystem that provides the roles and functions coupled with a business model framework and individual business models to deliver it.

This report has built on two key deliverables, the EGI2020 Strategy and EGI Business Models, bringing together value proposition, strategy and architecture evolution and opportunities for each component of the ecosystem moving forward. Over the next year a number of activities will take place in order to ensure the implementation of the sustainability plan by the end of EGI-InSPIRE:

- June 2012 - The EGI Council meeting to review the EGI Strategy.
- September 2012 - The EGI Technical Forum full-day session on EGI sustainability.
 - Focused sessions on the technology and resource providers' sustainability strategies and business models.
 - Results from the cost analysis carried out by the e-FISCAL project and the EGI compendium survey will also be presented.
- December 2012 - Following the start of the EC-funded FedSM project, EGI will benefit from consultancy to support the development of its service strategy.
 - A service portfolio will also be defined in line with the IT service management best practices with consultancy provided by the gSLM project and in the future the FedSM project where EGI.eu will participate as "client" of service management experts.
- January 2013 – Dedicated workshop to support organisations in refining their own concrete business models following up from the Technical Forum and in preparations for the EGI Community Forum and end of PY3.
- March 2013 – EGI Community Forum dedicated session on presenting results around sustainability plans and business model development and offer an opportunity for discussion.
- April 2013 - Revised strategy plan, platform roadmap, technical roadmap and business models will be provided.

The final goal for the community is that by the end of EGI-InSPIRE, the implementation of the initial phases of the EGI2020 strategy will have established an open ecosystem where individual actors supported through public and/or private funding will have been able to define their own added value and business models to support their activities. This foundation will enable EGI to continue to play a key role in sustainably bringing digital the European Research Area online.

6 REFERENCES

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