ROADMAP 2016

European Strategy Forum
on Research Infrastructures

ESFRI

Professor John Womersley
ESFRI Chair

STRATEGY REPORT ON RESEARCH INFRASTRUCTURES

ESFRI

- The European Strategy Forum on Research Infrastructures (ESFRI) was established in 2002 with a mandate from the EU Council to:
  - support a **coherent and strategy-led approach** to policy-making on research infrastructures in Europe
  - facilitate multilateral initiatives leading to the better use and development of research infrastructures
- Bring together representatives of Ministers of the 28 Member States, 13 Associated Countries, and of the European Commission
- Act as an incubator for pan-European and global RI
- Facilitate decisions on implementation and ensures follow-up after assessment
- Monitor state of Innovation Union and provide input as appropriate to the development of ERA Framework (Council of EU in 2010)
- Produce roadmaps (Council 2004) and prioritise projects (Council 2012)

ESFRI Roadmap

- Roadmap identifies new pan-European Research Infrastructures or major up-grades to existing ones, corresponding to the needs of European research communities in the next 10 to 20 years, in all fields of Research, regardless of possible location
- ESFRI to provide help and best practice, but **MS and AC must be the major source of funding**
- First Roadmap published in 2006, updated in 2008 and 2010, and contained 48 projects intended to foster European leadership across a broad range of scientific fields.
- Requires major financial investment (~20 b€) and long term commitment for operation (~2 b€/year)
- Council of EU in 2014 mandated ESFRI to complete a 2016 ESFRI Roadmap with fewer and more mature projects

Implementation

- ESFRI has fulfilled the commitment made by Member States and the European Commission for 60% of these projects to be implemented by the end of 2015.
- The 29 ESFRI Landmarks that have reached the implementation phase are pan-European hubs of scientific excellence, **and will require continuous support to fulfil their mission and ensure their long-term sustainability**.
- Today we present the updated 2016 ESFRI Roadmap. In addition to the 15 still ongoing projects identified in earlier years, **six* new research infrastructures** have been included that fill in important gaps in the European science landscape together with **two new initiatives that we have classified as landmarks**
- These 8 were selected from 20 eligible proposals

* one refocused and resubmitted proposal

What's new?

"A more focused, strategic approach toward identifying a number of Research Infrastructures which add value to the European Research Area"

The document contains

The ESFRI Roadmap 2016 List – 21 Projects and 29 Landmarks

An analysis of the role of research infrastructures for European competitiveness:

- Helping to structure the European Research Area
- Big Data and Big Data Analysis
- Advanced education and attractiveness for investment
- Fostering innovation and the socio-economic impact of RIs
- Global dimension

What's new?

- **Description of the Life Cycle** of a Research Infrastructure
- **Time-limited window of opportunity**: Projects on the Roadmap now have a 10-year time window for completing their incubation and reaching implementation
  - After that time implemented projects may become Landmarks
  - Non-implemented projects leave the Roadmap
  - Can be re-submitted with a revised programme and will compete with other new projects.
- **Methodology and Evaluation Process** for new projects
- **Lessons Learned** - the successful development of the 2016 Roadmap contains some useful lessons for future road-mapping activities

ESFRI's 2016 Strategy Report on Research Infrastructures is composed of three parts

ESFRI

P Projects L Landmarks

ROADMAP 2016

The **Strategy Report on Research Infrastructures** is composed of three parts:

1

Part 1 identifies the new features and conclusions of the **ESFRI Roadmap 2016** in terms of the methods and procedures that led to the call, the evaluation and selection of the new ESFRI Projects and the definition and assessment of the ESFRI Landmarks. It contains the **lists of 21 Projects** and **29 Landmarks** as identified by their acronym, full name, lifecycle stage, legal status, reference financial data and date of entry in the ESFRI Roadmap. An analysis of the impact of research infrastructures on structuring the European Research Area as well as the global research scene, and of the overall contribution to European competitiveness follows. The ongoing coaching and monitoring action of ESFRI is explained at the relevant stages of lifecycle of the research infrastructures.
A methodological section is followed by considerations on the lessons learnt in realizing the ESFRI Roadmap 2016.

2

Part 2 contains the description of each of the ESFRI Projects and ESFRI Landmarks. Each project is represented by a dedicated card reporting the outline of the research infrastructure, the background and the steps for implementation. Each landmark card reports the general description, the current activity and the impact of the research infrastructure. Reference information about the coordinator, the member and participating countries, the timeline and the updated estimate of construction and operation costs are reported in each card, along with the indication of the headquarters and website.

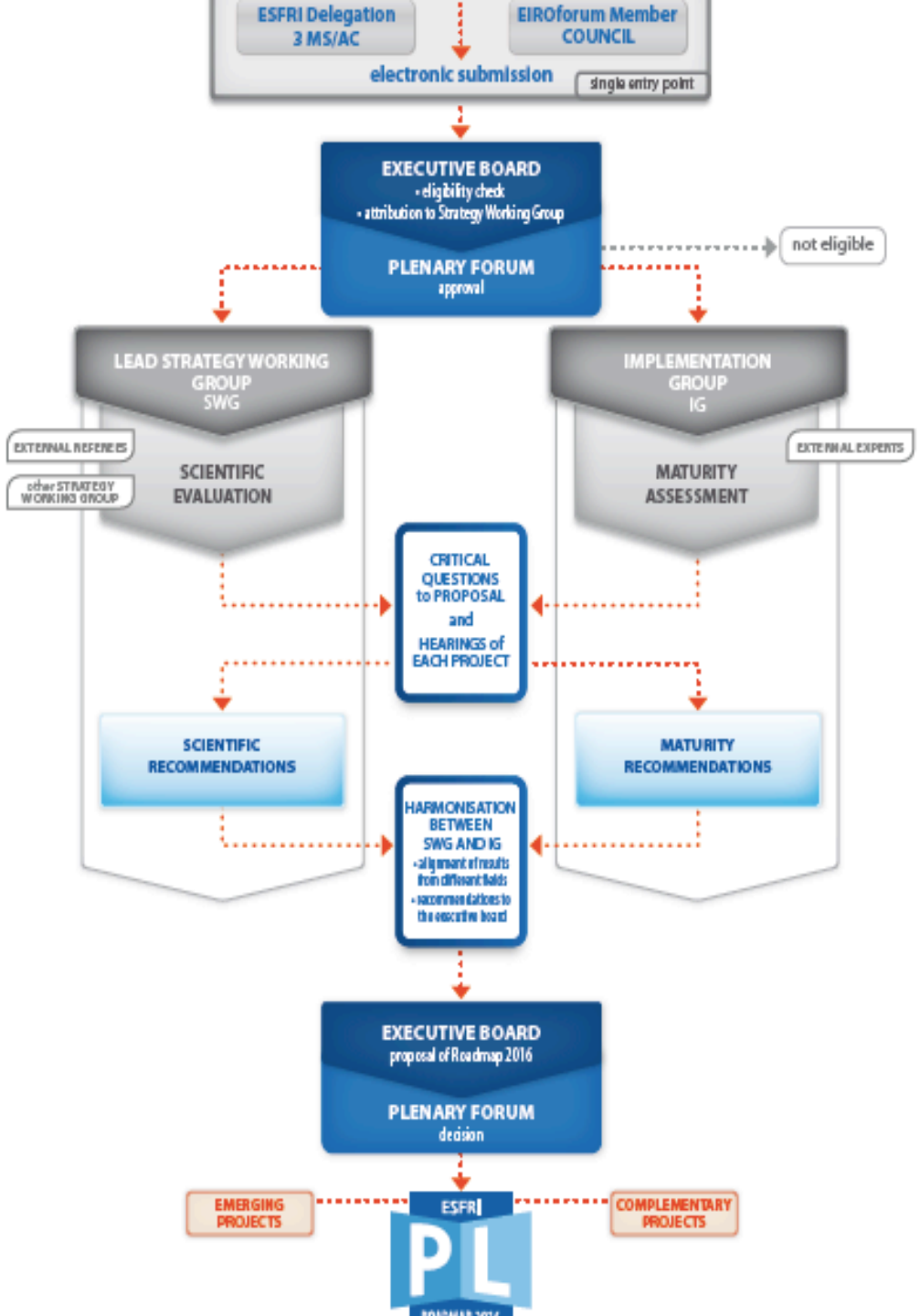
3

Part 3 contains the Landscape Analysis that provides the current context, in each domain, of the operational national and international research infrastructures open to European scientists and technology developers through peer-review of competitive science proposals. The Landscape Analysis identifies the existing resources, the gaps and the potential evolution of each field in the foreseeable future. It represents an impression of the European RI ecosystem. This responds to the invitation by the Competitiveness Council to broaden the view of ESFRI beyond the Roadmap list of projects and to prepare a general overview and survey of the whole Research Infrastructure system in Europe.
It has been produced by the five ESFRI Strategy Working Groups (SWGs) that are composed of well-recognized scientists and are coordinated by a member, or a permanent expert, of the ESFRI Forum. The e-infrastructures landscape, transversal to all domains, has been elaborated by the e-Infrastructure Reflection Group (e-IRG)[1].
The Landscape Analysis is a key ingredient of the new ESFRI evaluation methodology as it supports the understanding of the impact of new projects. It does not represent in any way the view or prioritization of ESFRI or of any Member State for commitments or future investments.
ESFRI in no case acts as an advocate of specific

ESFRI

Projects Landmarks

ROADMAP 2016



A rigorous evaluation process for new proposals

Assessed both scientific merit and project maturity

External referees and hearings

Support of at least three member states or associated countries needed

ESFRI

Projects Landmarks

ROADMAP 2016

ESFRI PROJECTS

	NAME	FULL NAME	ROADMAP ENTRY (YEAR)	OPERATION (YEAR)	LEGAL STATUS (AS OF 10 MARCH 2016)	CONSTRUCTION COSTS (M€)	OPERATIONAL ANNUAL BUDGET (M€/YEAR)
ENERGY	ECCSEL	European Carbon Dioxide Capture and Storage Laboratory Infrastructure	2008	2016	ERIC under preparation	80-120	1**
	EU-SOLARIS	European SOLAR Research Infrastructure for Concentrated Solar Power	2010	2020*	ERIC under preparation	120	3-4
	MYRRHA	Multi-purpose Hybrid Reactor for High Tech Applications	2010	2024*		NA	61,2
	Windscanner	European WindScanner Facility	2010	2018*		45-60	8
ENVIRONMENT	ACTRIS	Aerosols, Clouds and Trace gases Research Infrastructure	**2016**	2025*		190	50
	DANUBIUS-RI	International Centre for Advanced Studies on River-Sea Systems	**2016**	2022*		222	28
	EISCAT_3D	Next generation European Incoherent scatter radar system	2008	2021*		74	6
	EPOS	European Plate Observing System	2008	2020*	ERIC under preparation	53	15
	SIOS	Svalbard Integrated Arctic Earth Observing System	2008	2020*		80	2-3
HEALTH & FOOD	AnaEE	Infrastructure for Analysis and Experimentation on ecosystem	2010	2018*		200	2-3**
	EMBRC	European Marine Biological Resource Centre	2008	2016	ERIC under preparation	4,5	6
	EMPHASIS	European Infrastructure for multi-scale Plant Phenomics and Simulation for food security in a changing climate	**2016**	2020*		73	3,6
	ERINHA	European research Infrastructure on highly pathogenic agents	2008	2018*		NA	NA
	EU-OPENSCREEN	European Infrastructure of Open Screening Platforms for Chemical Biology	2008	2018*	ERIC under preparation	7	1,2
	EuroBioImaging	European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences	2008	2017*	ERIC under preparation	NA	1,55
	ISBE	Infrastructure for System Biology Europe	2010	2018*		30	7,2
	MIRRI	Microbial Resource Research Infrastructure	2010	2019*		6,2	1
PHYSICAL SCIENCES & ENGINEERING	CTA	Cherenkov Telescope Array	2008	2023*		297	20
	EST	European Solar Telescope	**2016**	2026*		200	9
	KM3NeT	KM3 Neutrino Telescope 2.0: Astroparticle & Oscillations Research with Cosmics in the Abyss	**2016**	2020*		92	3
SOCIAL & CULTURAL INNOVATION	E-RIHS	European Research Infrastructure for Heritage Science	**2016**	2022*		4	5
e-RI							

*expected **for centralised services

ESFRI LANDMARKS

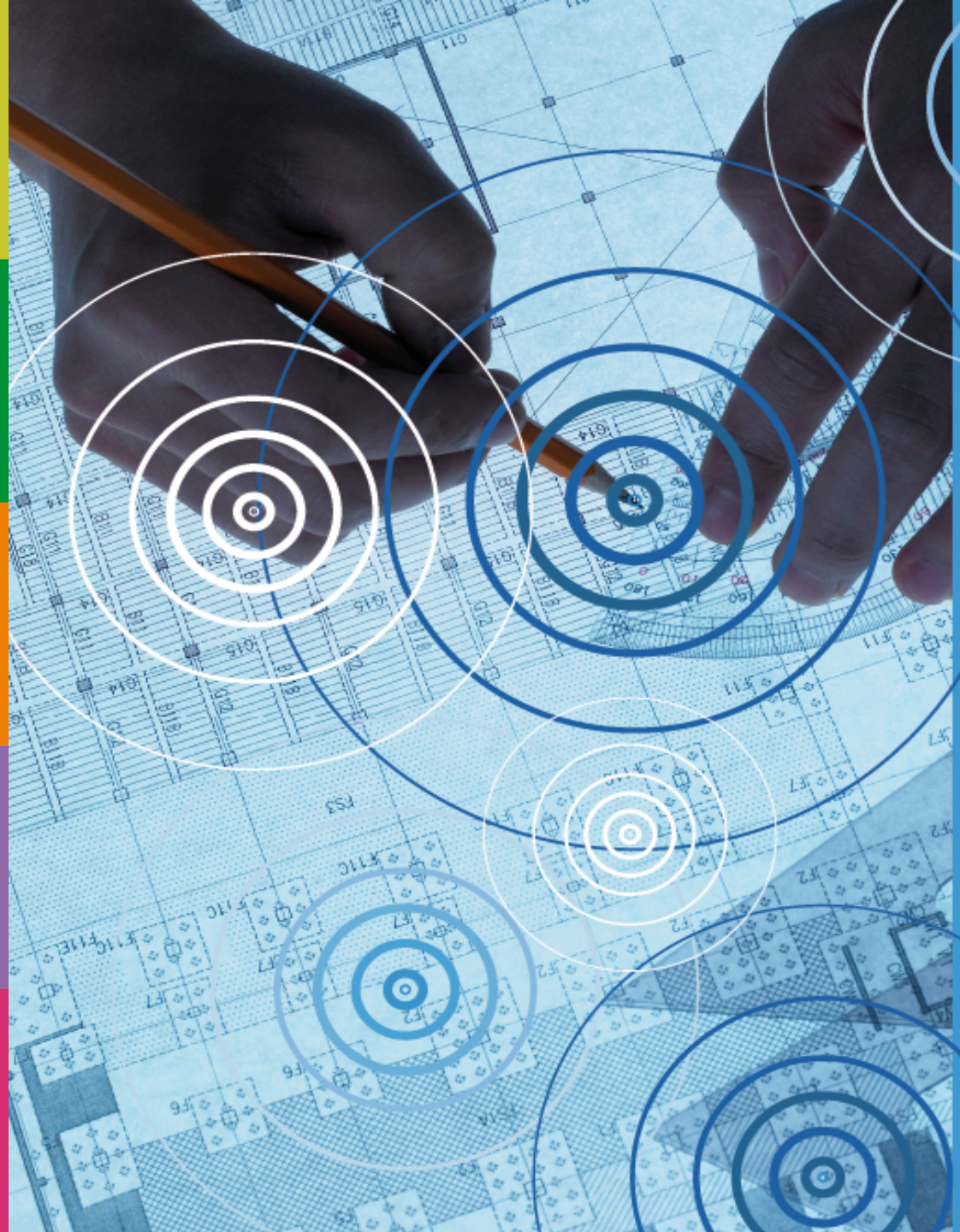
	NAME	FULL NAME	ROADMAP ENTRY (YEAR)	OPERATION (YEAR)	LEGAL STATUS (AS OF 10 MARCH 2016)	CAPITAL VALUE (M€)	OPERATIONAL ANNUAL BUDGET (M€/YEAR)
ENERGY	JHR	Jules Horowitz Reactor	2006	2020*		1.000	NA
ENVIRONMENT	EMSO	European Multidisciplinary Seafloor and water-column Observatory	2006	2016	ERIC under preparation	108	4 (per site)
	EURO-ARGO ERIC	European contribution to the International Argo Programme	2006	2014	ERIC, 2014	10	8
	IAGOS	In-service Aircraft for a Global Observing System	2006	2014	AISBL, 2014	25	6
	ICOS ERIC	Integrated Carbon Observation System	2006	2016	ERIC, 2015	48	24-35
	LifeWatch	e-Infrastructure for Biodiversity and Ecosystem Research	2006	2016	ERIC under preparation	66	10
HEALTH & FOOD	BBMRI ERIC	Biobanking and Biomolecular Research Infrastructure	2006	2014	ERIC, 2013	170-220	3,5
	EATRIS ERIC	European Advanced Translational Research Infrastructure in Medicine	2006	2013	ERIC, 2013	500	2,5
	ECRIN ERIC	European Clinical Research Infrastructure Network	2006	2014	ERIC, 2013	1,5	2
	ELIXIR	A distributed infrastructure for life-science information	2006	2014	ELIXIR Consortium Agreement, 2013	125	95
	INFRAFRONTIER	European Research Infrastructure for the generation, phenotyping, archiving and distribution of mouse disease models	2006	2014	GmbH, 2013 ERIC under preparation	180	80
	INSTRUCT	Integrated Structural Biology Infrastructure	2006	2012	International Consortium Agreement, 2012 ERIC under preparation	285	25
PHYSICAL SCIENCES & ENGINEERING	E-ELT	European Extremely Large Telescope	2006	2024*	Programme of ESO	1.000	40
	ELI	Extreme Light Infrastructure	2006	2018*	AISBL, 2013 ERIC under preparation	850	90
	EMFL	European Magnetic Field Laboratory	2008	2014	AISBL, 2015	170	20
	ESRF UP	Phase I Phase II: Extremely Brilliant Source	2006 **2016**	2015 2022*	Programme of ESRF	180 150	82
	European Spallation Source ERIC	European Research Infrastructure Consortium	2006	2022*	ERIC, 2015	1.843	140
	European XFEL	European X-Ray Free-Electron Laser Facility	2006	2017*	GmbH, 2009	1.490	115
	FAIR	Facility for Antiproton and Ion Research	2006	2022*	GmbH, 2010	1.262	234
	HL-LHC	High-Luminosity Large Hadron Collider	**2016**	2026*	Programme of CERN	1.370	100
	ILL 20/20	Institut Max von Laue-Paul Langevin	2006	2020	Programme of ILL	62	92
	SKA	Square Kilometre Array	2006	2020*	SKAO, 2011	650	75
	SPIRAL2	Système de Production d'Ions Radioactifs en Ligne de 2e génération	2006	2016	Programme of GANIL	110	5-6
SOCIAL & CULTURAL INNOVATION	CESSDA	Consortium of European Social Science Data Archives	2006	2013	Norwegian limited company, 2013 ERIC under preparation	NA	1,9
	CLARIN ERIC	Common Language Resources and Technology Infrastructure	2006	2012	ERIC, 2012	NA	12
	DARIAH ERIC	Digital Research Infrastructure for the Arts and Humanities	2006	2019*	ERIC, 2014	4,3	0,6
	ESS ERIC	European Social Survey	2006	2013	ERIC, 2013	NA	6
	SHARE ERIC	Survey of Health, Ageing and Retirement in Europe	2006	2011	ERIC, 2011	110	12
e-RI	PRACE	Partnership for Advanced Computing in Europe	2006	2010	AISBL, 2010	500	120

*expected NA= Not Available

ESFRI

Projects Landmarks

ROADMAP 2016



part 2

ESFRI PROJECTS

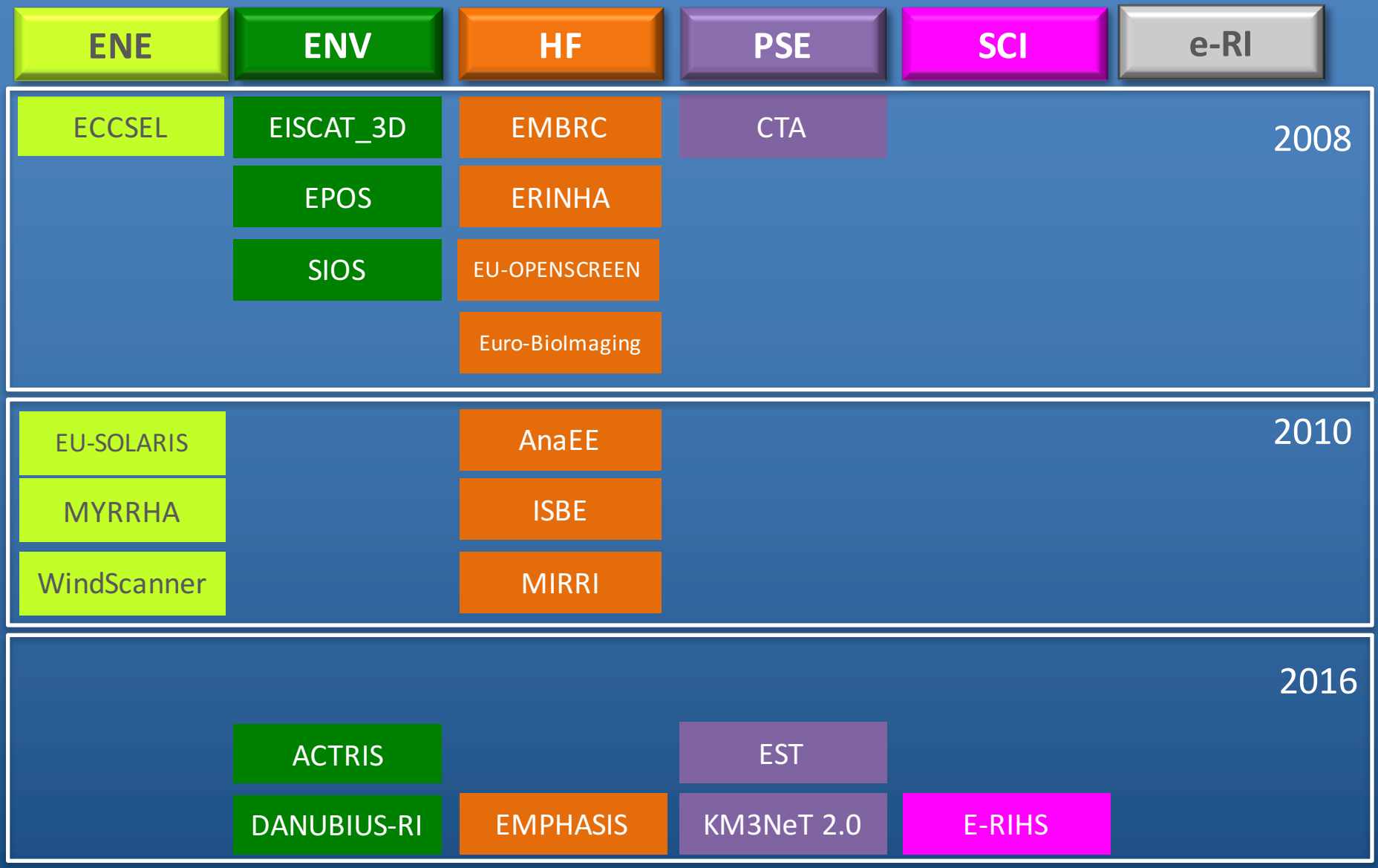
The ESFRI Projects listed in **Part 1** are individually described in the following pages. They were selected for scientific excellence and maturity and represent strategic objectives for strengthening the European Research Infrastructure system.

Fifteen projects were listed in previous editions of the ESFRI Roadmap – nine in the 2008 update, and six in the 2010 update. Five new entries and one reoriented project integrate the Roadmap 2016. They were selected among the 20 eligible proposals through the evaluation procedure outlined in **Part 1**.

The ESFRI Projects have a maximum term of "residency" on the Roadmap of 10 years. After that term the fully implemented projects may become Landmarks. Non-implemented projects leave the Roadmap: if desired they can be re-submitted with a revised programme and will compete with other new projects.

21 ESFRI Projects

15 + 6 new



A lesson learned

Need to clearly define the roles of the participants

COORDINATING COUNTRY/ENTITY:
Member States, Associated Countries or entities like EIROforum or other organisations which coordinate the Research Infrastructure

PROSPECTIVE MEMBER COUNTRIES/ENTITY:
Countries engaged in the definition of a legal entity or a formal agreement. They could be Member States, Associate Countries, other Countries or international organisations

PARTICIPANTS:
Scientific Partners from indicated Countries, Countries with Observer and Candidate status, and international organisations

Examples

Part 2 contains a full description of each project

Can be downloaded from www.esfri.eu/roadmap-2016

Carbon Dioxide Capture and Storage technologies to enable low to zero CO_2 emissions to combat global climate change

ECCSEL

European Carbon Dioxide Capture and Storage Laboratory Infrastructure

TYPE: distributed
COORDINATING COUNTRY: NO
PROSPECTIVE MEMBER COUNTRIES: CH, EL, ES, FR, IT, NL, NO, PL, UK

TIMELINE
- ESFRI Roadmap entry: 2008
- Preparation phase: 2011-2014
- Construction phase: 2014-2030
- Operation start: 2016

ESTIMATED COSTS
- Capital value: 1.000 ME
- Preparation: 5 ME
- Construction: 80-120 ME
- Operation: 1 ME/year (Central HUB)

HEADQUARTERS
Norwegian University of Science and Technology-NTNU
Trondheim
Norway

WEBSITE
http://www.eccsel.org/

NORWAY

Description

The European Carbon Dioxide Capture and Storage Laboratory Infrastructure (ECCSEL) aims at opening access to top quality research devoted to next generation Carbon Capture and Storage (CCS) technologies with an efficient and structured approach to help enabling low to zero CO_2 emissions from industry and power generation to combat global climate change. ECCSEL implements and operates a distributed, integrated European Research Infrastructure based on a selection of the best research facilities in Europe for CO_2 capture, storage and transport research. ECCSEL provides a scientific foundation to respond systematically to the R&D needs in CCS in a short and long-term perspective. It maintains Europe at the forefront of the international CCS scientific community making the European Research Area more attractive for European and international scientists and reinforces cooperation between research institutions.

Background

Carbon Abatement Technologies (CAT) enable fossil fuels to be used with substantially reduced CO_2 emissions. CCS is the most innovative of these technologies by reducing up to 85% of CO_2 emissions from fossil fuels used for power generation as well as from industrial processes. Global demand is large, in particular from emerging economies. Further research and technological development is urgently needed if CCS is to become a viable and cost-effective technology. It involves the deployment of a chain of technologies for CO_2 capture, transportation and storage, rather than developments focused on the combustion plant alone. Most of the technologies needed to implement CCS are currently available through other applications but there is an urgent need to validate the operation of the whole CCS technology chain and to reduce its cost. CCS has the potential to be an essential technology to significantly reduce greenhouse gas emissions and allow the continued use of fossil fuels for energy security, without damaging climate security. Additionally CCS combined with biomass, known as Bio-CCS offers the only large scale means of going carbon negative.

Development of new CCS research facilities and upgrades to existing ones have been proposed by ECCSEL, and will require large investments by the parties involved. The facilities being developed will enable more advanced levels of research in CCS. Examples of existing facilities that are initially part of the ECCSEL RI are: High pressure oxy-fuel combustion test rig & Tiller CO_2 capture pilot plant & Transport test facility (SINTEF/NTNU, NO); Sotacarbo Research Center - Coal to Hydrogen pilot plant with CO_2 capture (Sotacarbo, IT); High pressure absorber and desorber pilot plant (TNO, NL); Hontomín CO_2 Storage Technology Development Plant & Centre for CO_2 Capture, Leon (CIUDEN, ES); Chemical Looping Combustion facility (CERTH, GR); Rock Mechanical & Geophysical Property Testing System & Near surface gas monitoring facility (BGS, UK); High pressure hydrostatic flow cell to measure permeability (ETH-Z, CH); High pressure facility to perform percolation and transfer experiments on fluid-rock interactions (BRGM, FR); PANAREA off-shore & LATERA on-shore CO_2 leaking natural laboratories (OGS, IT); Fixed bed reactor for clean coal technologies studies & Pilot-scale moving bed reactor (IFG, PL).

Steps for implementation

ECCSEL was conceived and included in Roadmap 2008. Coordinated by the Norwegian University of Science and Technology (NTNU), ECCSEL has been planned by a consortium comprising leading European CCS research institutions over two Preparatory Phases (2011-2014). ECCSEL, currently in the implementation phase, is expected to be in operation and to prepare for establishing the European Research Infrastructure Consortium (ERIC) in 2016. Ambition is to become a key instrument that the European Commission can utilise and support to meet the objectives of the European Strategic Energy Technology Plan (SET-Plan), and to interact with relevant bodies such as European Energy Research Alliance (EERA), the ZEP-TP, Lighthouse projects, EII and others.

ESFRI

PL Projects Landmarks

ROADMAP 2016

Ground-based stations to understand past, current and predict future evolution of the atmosphere

ACTRIS

Aerosols, Clouds and Trace gases Research Infrastructure

TYPE: distributed
COORDINATING COUNTRY: FI
PROSPECTIVE MEMBER COUNTRIES: CH, CZ, EL, ES, FI, FR, IT, NL, PL, RO, UK

PARTICIPANTS: BE, BG, CY, DE, DK, EE, HU, IE, NO, SE

TIMELINE
- ESFRI Roadmap entry: 2016
- Preparation phase: 2016-2019
- Construction phase: 2019-2021
- Pre-operation start: 2021
- Operation start: 2025

ESTIMATED COSTS
- Capital value: 450 M€
- Preparation: 6 M€/year
- Construction: 190 M€
- Operation: 50 M€/year

HEADQUARTERS
University of Helsinki and Finnish Meteorological Institute
Helsinki, Finland
&
Consiglio Nazionale delle Ricerche-CNR
Rome, Italy

WEBSITE
http://www.actris.eu

FINLAND

Description

The Aerosols, Clouds and Trace gases Research Infrastructure (ACTRIS) is a distributed infrastructure dedicated to high-quality observation of aerosols, clouds, trace gases and exploration of their interactions. It will deliver precision data, services and procedures regarding the 4D variability of clouds, short-lived atmospheric species and the physical, optical and chemical properties of aerosols to improve the current capacity to analyse, understand and predict past, current and future evolution of the atmospheric environment. ACTRIS serves a vast community of users working on observations, experiments, models, satellite data, analysis and predicting systems and offers access to advanced technological platforms for exploration of the relevant atmospheric processes in the fields of climate change and air quality.

Background

Short-lived atmospheric components – aerosols, clouds, trace gases – have a residence time in the atmosphere from hours to few weeks, which differentiates them from long-lived greenhouse gases. The short lifetimes make their concentrations highly variable in time and space and involve fast processes. They are recognized to be among the most significant anthropogenic pollutants affecting Earth's radiation balance and the largest source of uncertainty in terms of radiative forcing impact. In parallel, short-lived atmospheric compounds have recognized adverse health effects at concentrations typically found across Europe and potentially lead to more than 400.000 premature deaths annually in the EU28. Information on concentrations and distributions of aerosols and trace gases is therefore required to reduce air pollution and related adverse effects on health and ecosystems.

ACTRIS addresses these challenges by operating at National Facilities via a combination of near-surface and remote-sensing systems and include: near-surface measurements of aerosols and short-lived trace gases, vertically resolved measurements of aerosols, vertically resolved measurements of clouds and precipitation, profile and column observations of short-lived trace gases and ancillary measurements of meteorological and radiation quantities. ACTRIS also includes exploratory platforms at the national level. The observation platforms are often components of European or International networks. ACTRIS relies on appropriate Central Facilities – Calibration Centres, Data Centre, Head Office – that ensure compliance with standard operating procedures and/or quality protocols to provide harmonized, reliable, and documented observational data. The data curation and storage services are handled by a dedicated Central Facility, the ACTRIS Data Centre. Central Facilities are fundamental to provide the access to the ACTRIS services, organising the right level of training and education, both within and outside the RI, and delivering tailored services for various users, scientific community, space agencies, COPERNICUS and the private sector.

Steps for implementation

ACTRIS is a new ESFRI project but it results from long-term collaborative work of the atmospheric science community through a series of INFRA projects that started in 2000. ACTRIS complements the environmental research infrastructure as it contributes data and services with its National Facilities and Central Facilities on atmospheric composition changes.

Aims of the full implementation plan is to set up a research infrastructure service system for the complex data-stream that starts at the National Facilities and goes through quality screening and higher level data products made available through the data centre, and finally to the repositories that will secure long-term access by a very large community of users, globally.

ACTRIS enters now in the preparation phase. The gradual shift towards the construction phase is foreseen in 2019-2021 planning the commissioning phase in 2021-2022. ACTRIS will be fully operational in 2025.

An infrastructure for heritage interpretation, preservation, documentation and management

E-RIHS

European Research Infrastructure for Heritage Science

TYPE: distributed
COORDINATING COUNTRY: IT
PROSPECTIVE MEMBER COUNTRIES: BE, CZ, DE, EL, ES, FR, HU, IT, NL, PT, UK

PARTICIPANTS: BG, BR, CY, DK, IE, IL, PL, SE, SI

TIMELINE
- ESFRI Roadmap entry: 2016
- Preparation phase: 2016-2019
- Construction phase: 2020-2021
- Operation start: 2022

ESTIMATED COSTS
- Capital value: Not Available
- Preparation: 2 M€/year
- Construction: 4 M€ (Central Hub)
- Operation: 5 M€/year

HEADQUARTERS
Proposed in Florence, Italy. To be finalized in the Preparatory Phase with possibly the involvement of ICCROM-International Centre for the Study of the Preservation and Restoration of Cultural Property

WEBSITE
www.e-rihs.eu

ITALY

Description

The European Research Infrastructure for Heritage Science (E-RIHS) will support research on heritage interpretation, preservation, documentation and management. It will comprise: E-RIHS Headquarters and National Hubs, fixed and mobile national infrastructures of recognized excellence, physically accessible collections/archives and virtually accessible heritage data. Both cultural and natural heritage are addressed: collections, buildings, archaeological sites, digital and intangible heritage. E-RIHS will provide state-of-the-art tools and services to cross-disciplinary research communities advancing understanding and preservation of global heritage. It will provide access to a wide range of cutting-edge scientific infrastructures, methodologies, data and tools, training in the use of these tools, public engagement, access to repositories for standardized data storage, analysis and interpretation. E-RIHS will enable the community to advance heritage science and global access to the distributed infrastructures in a coordinated and streamlined way.

Background

Heritage Science has brought about the need of structuring the net of infrastructures operating throughout Europe. Fragmentation, duplication of efforts, isolation of small research groups put at risks the competitive advantage of European heritage science research, promoted so well by the unique cultural heritage. The long-term tradition of this field of research, the ability to combine with innovation, and the integration promoted by EU-funded projects such as EU-ARTECH, CHARISMA and IPERION CH in conservation science, and ARIADNE in archaeology represent the background of E-RIHS.

E-RIHS exploits the synergy of the cooperation among the academy, research centers and cultural institutions. The global lead that the EU holds in this research field, so precariously supported by a combination of national and EU measures, requires a joint and resolved effort. This has been fully recognized by the European Union with the continuous and reiterated support of initiatives aimed at integrating existing Heritage Science infrastructures, as well as, with a focus on Member States' national research programs, the JPI on Cultural Heritage, coordinating efforts of 17 EU national funding bodies supporting heritage science. The enthusiastic reviews of these initiatives testify the success of their action to advance knowledge and to establish a research community, acknowledged as "advanced" in official EU documents concerning conservation, or quickly growing in the field of archaeology as shown by the performance indicators of the relevant project ARIADNE.

This demonstrates beyond any doubt both the scientific and the socio-economic importance connected with Heritage Science: it is a sector and a research community that has achieved the maturity necessary to make the leap towards a permanent European Research Infrastructure that will impact broadly on society and economy.

Steps for implementation

E-RIHS is expected to lead a Preparatory Phase in the years 2016-2019 which will be used to address legal status and governance/management organization. This will lead to application to ERIC (or to other suitable legal form). The establishment of a legal structure and governance and the refinement of the business plan for long-term sustainability will be the three most important deliverables, together with demonstrators of users access as implemented by the consortium availing of the existing infrastructure projects.

Preliminary work will also be done in the framework of the H2020 IPERION-CH project started in May 2015.

E-RIHS will be launched as a stand-alone RI in 2020. Further developments are planned for connecting and including partners and facilities outside EU, and gradually reaching the status of a global distributed research infrastructure.

ESFRI

Projects Landmarks

ROADMAP 2016

part 2

ESFRI LANDMARKS

The ESFRI Landmarks listed in **Part 1** are individually described in the following pages. These are former ESFRI Projects that have reached the implementation stage and are now established as major elements of competitiveness of the European Research Area.

Most of the Landmarks were first identified as ESFRI Projects in the Roadmaps 2006 and 2008. Two Landmarks were selected among the 20 eligible proposals through the evaluation procedure outlined in **Part 1** recognizing that their implementation is underway.

The ESFRI Landmarks need continuous support for successful completion, operation and upgrade in line with the optimal management and maximum return on investment criteria. Periodic review of the Landmarks will be carried out by ESFRI in order to verify the continuous fulfilment of the reference role in their respective domains.

29 ESFRI Landmarks

27 + 2 new

ENE	ENV	H&F	PSE	SCI	e-RI	
JHR	EMSO	BBMRI ERIC	E-ELT	CESSDA	PRACE	
	EURO-ARGO ERIC	EATRIS ERIC	ELI	CLARIN ERIC		
	IAGOS	ECRIN ERIC	European Spallation Source ERIC	DARIAH ERIC		
	ICOS ERIC	INFRAFRONTIER	Eu-XFEL	ESS ERIC		
	LifeWatch	INSTRUCT	FAIR	SHARE ERIC		
		ELIXIR	ILL			
			SKA			
			SPIRAL2			2006
			EMFL			2008
			ESRF-EBS*			
			HL-LHC			2016

* ESRF upgrade was a project in the 2006 roadmap

Examples

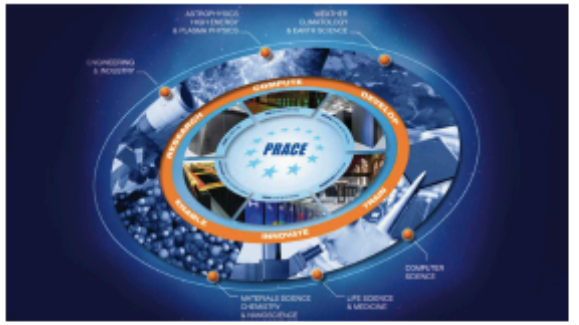
Part 2 contains a full description of each landmark

Can be downloaded from www.esfri.eu/roadmap-2016

The top level of the European High Performance Computing ecosystem

PRACE

Partnership for Advanced Computing in Europe



TYPE: distributed
COORDINATING ENTITY: PRACE-AISBL

PARTICIPANTS: AT, BE, BG, CH, CY, CZ, DE, DK, EL, ES, FI, FR, HU, IE, IL, IT, LT, NL, NO, PL, PT, RO, SE, SI, SK, TR, UK

TIMELINE
- ESFRI Roadmap entry: 2006
- Preparation phase: 2010-2013
- Construction phase: 2011-2015
- Operation start: 2010
- Legal status: AISBL, 2010

ESTIMATED COSTS
- Capital value: 500 M€
- Operation: 120 M€/year

HEADQUARTERS
PRACE-AISBL
Brussels
Belgium

WEBSITE
http://www.prace-ri.eu/

PRACE-AISBL

Description

The Partnership for Advanced Computing in Europe (PRACE) is a pan-European supercomputing RI providing access to computing and data resources and services for large-scale scientific and engineering applications at the highest performance level.
It enables high impact scientific discovery and engineering research and development across all disciplines by offering world-class computing and data management resources and services through a peer-review process. PRACE also seeks to strengthen the European users of High Performance Computing (HPC) in industry through various initiatives. PRACE has a strong interest in improving energy efficiency of computing systems and reducing their environmental impact.

PRACE is established as an International not-for-profit Association under Belgian Law (AISBL) with seat in Brussels. It has 25 member countries whose representative organizations create a pan-European supercomputing infrastructure. A total of six supercomputers and their operations accessible through PRACE are provided by four hosting members – France, Germany, Italy and Spain.

Activity

The four hosting members – BSC representing Spain, CINECA representing Italy, GCS representing Germany and GENCI representing France – committed a total funding of 400 million € for the initial PRACE systems and operations. In pace with the needs of the scientific communities and technical developments, systems deployed by PRACE are continuously updated and upgraded to be at the apex of HPC technology. Currently, the Fourth PRACE Implementation Phase is coordinated by Forschungszentrum Jülich (DE). PRACE-4IP is designed to start new innovative and collaborative activities including: assisting the transition to PRACE 2, strengthening the internationally recognized PRACE brand, preparing strategies and best practices towards Exascale computing, coordinating and enhancing the operation of the multi-tier HPC systems and services and supporting and educating users to exploit massively parallel systems and novel architectures. PRACE is evolving from the business model used in the initial period (2010-2015) that deployed the existing petaflop/s systems made possible by the strong engagement of four hosting partners towards a long-term sustainable configuration that will promote and consolidate Europe's leadership in HPC applications. The novel application codes for PRACE need to prepare for future system architecture embodied in accelerators or co-processors, by investigating new programming tools and developing suitable benchmarks. PRACE Advanced Training Centres (PATCs), target both the academic and industrial domains aiming to increase European human resources skilled in HPS applications. New services are being developed, including "urgent computing", the visualization of extreme size computational data, and the provision of repositories for open source scientific software libraries. Links will be strengthened with other international e-infrastructures and Centres of Excellence. Energy-efficiency and lower environmental impact throughout the life cycle of Exaflop/s HPC RIs and best practices for prototype planning and evaluation are being addressed.

Impact

European scientists and engineers need to exploit more broadly high-end HPC and connection with many ESFRI RIs is to be strengthened to maximize the impact on the ERA and on broad applications in industry and services. PRACE actively interfaces with XSEDE – the Extreme Science and Engineering Discovery Environment (USA), RIKEN (Japan) and Compute Canada, and also with GÉANT – the pan-European data network for the research and education community, EGI – the European Grid Infrastructure, EUDAT – the European data infrastructure and HBP – the Human Brain Project.

ESFRI

Projects Landmarks

ROADMAP 2016

The world's biggest eye on the sky to revolutionise our perception of the Universe

E-ELT

European Extremely Large Telescope

TYPE: single-sited
COORDINATING ENTITY: ESO
MEMBER COUNTRIES: AT, BE, CH, CZ, DE, DK, ES, FI, FR, IT, NL, PL, PT, SE, UK

PARTICIPANTS: BR

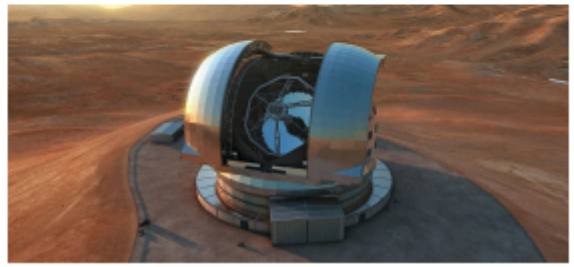
TIMELINE
- ESFRI Roadmap entry: 2006
- Preparation phase: 2006-2012
- Construction phase: 2014-2024
- Operation start: 2024

ESTIMATED COSTS
- Capital value: 1.000 M€
- Operation: 40 M€/year

HEADQUARTERS
ESO
Garching
Germany

WEBSITE
http://www.eso.org/public/teles-instr/e-elt/

ESO



Description

The European Extremely Large Telescope (E-ELT) is a revolutionary new ground-based telescope developed by ESO for the advancement of astrophysical knowledge, allowing detailed studies of objects including planets around other stars, the first objects in the Universe, super-massive black holes, and the nature and distribution of the dark matter and dark energy which dominate the Universe. Equipped with a 39-metre main mirror, the E-ELT will be the largest optical/near-infrared telescope in the world: the world's biggest eye on the sky.

The E-ELT is an integral part of ESO, the EIROforum organisation operating facilities at five sites. The E-ELT programme was approved in 2012 and green light for construction was given at the end of 2014. It will be located at Cerro Armazones, a 3060-metres high mountain in the central part of Chile's Atacama Desert, about 20 kilometres from Cerro Paranal, home of ESO's Very Large Telescope (VLT). The E-ELT first observation is planned for 2024.

Activity

The telescope's primary mirror will be almost half the length of a soccer pitch in diameter and will gather 15 times more light than today's largest optical telescopes. The optical design comprises a three-mirror anastigmat with two flat folding mirrors providing the adaptive optics to correct for the turbulent atmosphere, giving unprecedented image quality. One is supported by more than 6.000 actuators operating at a frequency of 1.000 Hz. The primary mirror consists of 798 hexagonal segments, each 1,4 metres wide. The secondary mirror will have a diameter of 4 metres. The telescope will have several science instruments, with switching from one instrument to another within minutes. The ability to observe over a wide range of wavelengths from the optical to mid-infrared will allow scientists to exploit the telescope's size to the fullest extent.
Science with the E-ELT covers many areas of astronomy – from the Solar System to extra-solar planets, from nearby galaxies to the furthest observable objects at the edge of the visible Universe, from fundamental physics to cosmology. They include discovering and characterising planets and proto-planetary systems around other stars, resolving stellar populations in a representative sample of the Universe, the study of the physical processes that form and transform galaxies across cosmic time, the discovery and identification of distant type Ia supernovae and constraining dark energy by directly observing the global dynamics of the Universe, as well as searching for possible variations over cosmic time of fundamental physical constants.

Impact

The E-ELT is a major technological challenge and triggers industrial interest and preparedness to deliver extraordinary performance, as it occurred to previous ESO projects (notably the VLT). ESO has since many years devolved its instrumentation programme so that science instruments are largely designed and built by national institutes, often in collaboration with industry. In this model, national facilities cover the human resources cost against compensation in guaranteed observing time. The E-ELT will employ advanced technologies and engineering solutions in a number of areas, from gigantic, lightweight high-precision structures, opto-mechanical systems, optical design and control systems. Many of these technologies will be applicable to other areas of technology development. As regards short-term benefits, these are found in spin-off technologies and the inspirational and educational aspects, strengthening the scientific and engineering recruitment base and public awareness of science.
Concerning the contribution to societal challenges, astronomy is basic science in its most fundamental form and its main purpose is to enhance our understanding of the Universe, its evolution and the role of planet Earth as our cosmic home. It does not aim to contribute towards addressing short-term societal challenges, but just as for example quantum physics, the findings in astronomy have a potentially most profound impact on society in the long run, both in technological and cultural terms.

A gateway for access to biobanks and biomolecular resources for health research

BBMRI ERIC

Biobanking and BioMolecular resources Research Infrastructure

TYPE: distributed
COORDINATING COUNTRY: AT
MEMBER COUNTRIES: AT, BE, CZ, DE, EE, EL, FI, FR, IT, MT, NL, NO, SE, UK

PARTICIPANTS: CH, PL, TR, (IARC/WHO)

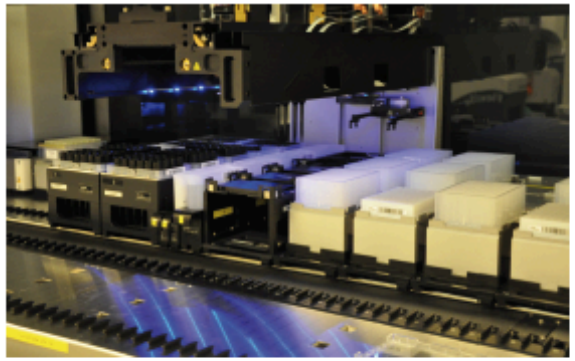
TIMELINE
- ESFRI Roadmap entry: 2006
- Preparation phase: 2008-2011
- Interim phase: 2011-2013
- Operation start: 2014
- Legal status: ERIC, 2013

ESTIMATED COSTS
- Capital value: 170-220 M€
- Operation: 3,5 M€/year

HEADQUARTERS
BBMRI ERIC
Graz
Austria

WEBSITE
http://www.bbmri-eric.eu

AUSTRIA



Description

The Biobanking and BioMolecular resources Research Infrastructure (BBMRI) is one of the largest Research Infrastructures for health research in Europe by providing a gateway for access to biobanks and biomolecular resources coordinated by national nodes. BBMRI aims at improving the accessibility and interoperability of the existing comprehensive collections, either population-based or clinical-oriented, of biological samples from different (sub-) populations of Europe or rare diseases. These collections include the associated data on factors such as health status, nutrition, lifestyle, and environmental exposure of the study subjects.

On December 2013 BBMRI became a European Research Infrastructure Consortium (ERIC). The agreement of ultimately 17 countries (14 members and 3 observers) and one International Organisation enabled to set up a pan-European distributed research infrastructure that shall develop into one of the most important tools in biomedical and clinical discovery.

Activity

BBMRI strives to facilitate access to quality-defined human disease relevant biological resources in an efficient as well as ethically and legally compliant manner by reducing the fragmentation of the biomedical research landscape through harmonisation of procedures and by implementing common standards and fostering high level collaboration. This is achieved by defining criteria for high quality assured samples and their data to be provided by members for selected disease entities and by defining the quality of samples and data.
In a first step, enriched data pools will facilitate the trans-national cross-biobank search for suitable biospecimens. Thus, the IT-Gateway to European biobanks will provide a single access point to the European biobank network and lays the basis for national as well as trans-national research consortia based on the entire samples and data from various sites. It also allows for highly targeted research, where small teams achieve statistical significance of their results by combining their resources throughout Europe. This approach extends previous catalogue-based solutions by enabling the processing of requests on a sample-based level explicitly challenging privacy aspect and solving it at least on the first level by delivering highly aggregated data.
Ultimately, BBMRI will provide a one-stop access to the collections of the European biobanking community, expertise and services to foster access to other parties, including the private sector. Collections will include documents, SOPs and best practices developed by BBMRI, published results and data in coordination with partners of BBMRI, samples and related clinical data primarily based on merit review of the proposal by the relevant biobank scientific and ethical committee.

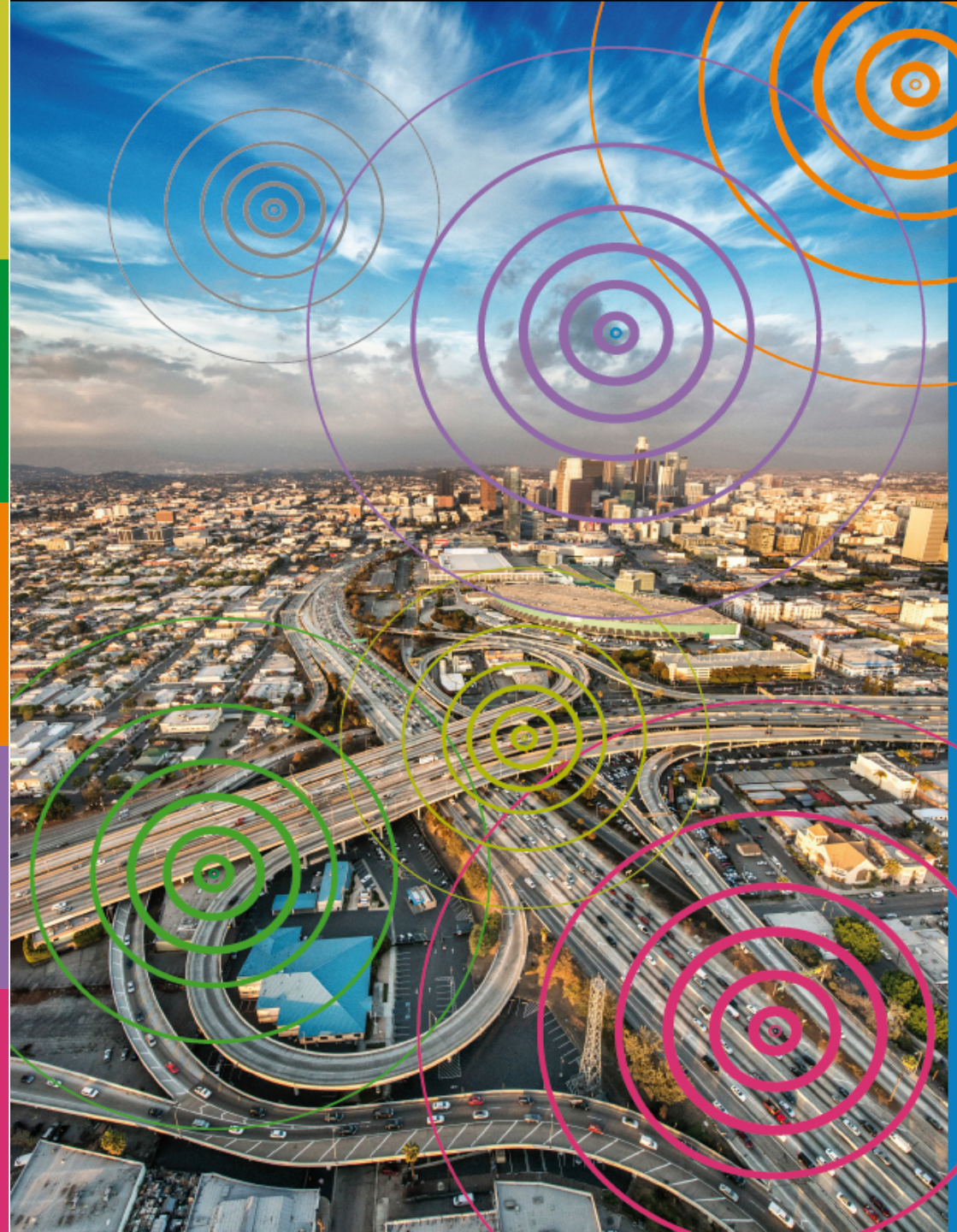
Impact

New medical applications, new therapies, new preventives, new diagnostics, personalised or stratified medicine and new biomedical industries shall evolve to improve socio-economic competitiveness and increasing possibilities for equitable healthcare in Europe. Expectantly, BBMRI-ERIC will impact on partnerships with patients/donors, who will be informed that their own tissues, samples and personal data can yield discoveries and advances in medicine, diagnostics, and therapies. In return, BBMRI-ERIC is taking up the responsibility to use the samples and data made available to the research in the best way for the advancement of knowledge, ultimately contributing to improve EU's healthcare systems.

ESFRI

P L
Projects Landmarks

ROADMAP 2016



Part 3

P L

LANDSCAPE ANALYSIS

The Landscape Analysis provides the current context, in each domain, of the operational national and international research infrastructures open to European scientists and technology developers through peer-review of competitive science proposals. It represents an impression of the European RI ecosystem. This responds to the invitation by the Competitiveness Council to broaden the view of ESFRI beyond the Roadmap list of projects. It has been produced by the five Strategy Working Groups (SWGs) of ESFRI that are composed of well-recognized scientists and are coordinated by a member, or a permanent expert, of the ESFRI Forum. The e-infrastructures landscape, transversal to all domains, has been elaborated by the e-Infrastructure Reflection Group (e-IRG). The Landscape Analysis is a key ingredient of the new ESFRI evaluation methodology as it supports the understanding of the impact of new projects. It does not represent in any way the view or prioritization of ESFRI or of any Member State for commitments or future investments. ESFRI in no case acts as an advocate of specific potential future projects. ESFRI and its Member States have taken note of it.

P and **L** highlighted marks in the text are toggles for direct access to the relevant cards of **Part 2**.

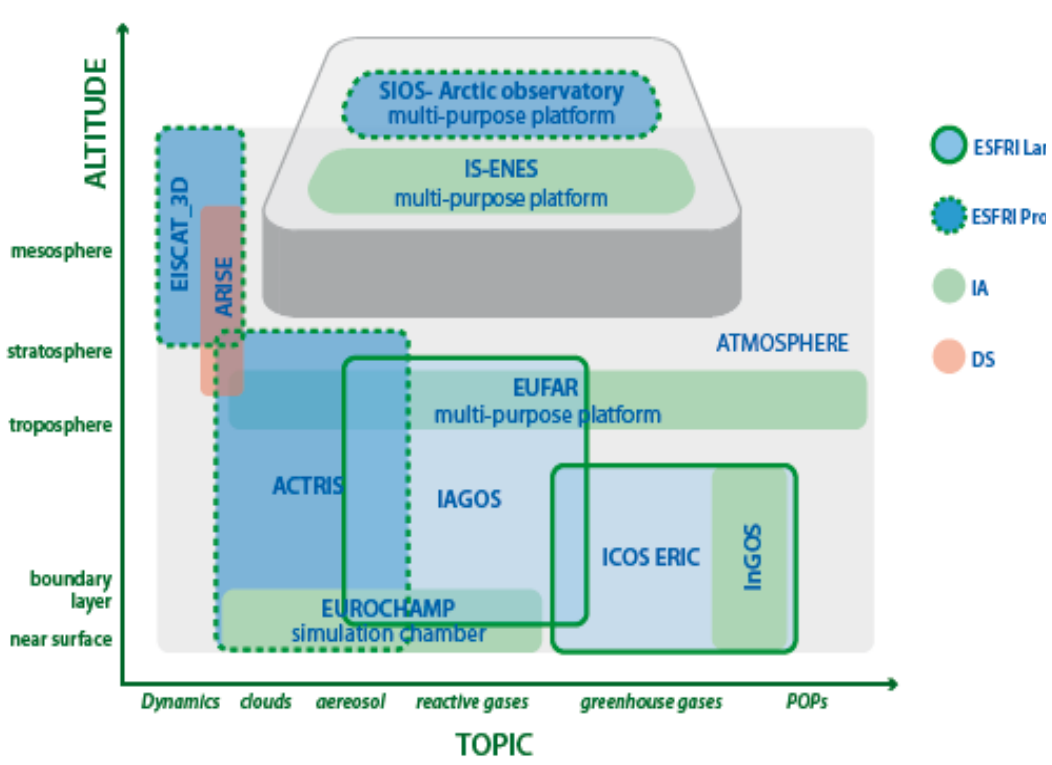
Part 3 – Landscape Analysis

- Gives the context, in each domain, of the operational national or international research infrastructures open to European scientists and technology developers through peer-review of competitive science proposals.
- Identifies the existing resources, the gaps and the potential evolution of each field in the foreseeable future, Emerging projects and Complementary Projects
- Responds to the invitation for ESFRI to broaden its view and to consider the whole Research Infrastructure system in Europe
- Produced by the five ESFRI Strategy Working Groups (SWGs) composed of well-recognized scientists in each domain
- The e-infrastructures landscape, transversal to all domains, has been elaborated by members of the e-Infrastructure Reflection Group (e-IRG).

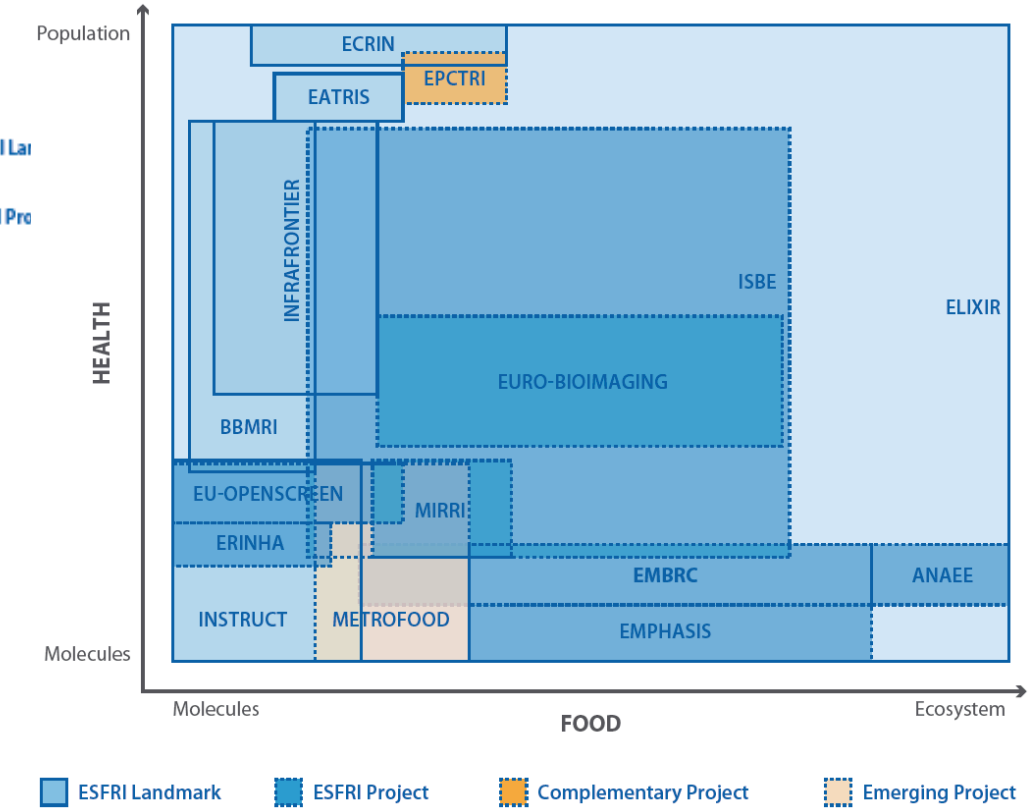
- *Note that the Landscape Analysis does not imply any level of decision or engagement by ESFRI in prioritizing future solutions, nor does the content necessarily reflect the view of ESFRI Members.* ***ESFRI in no case acts as an advocate of specific potential future projects.***

Examples

Environment



Health and Food



What next?

- ESFRI has presented its 2016 Strategy report on Research Infrastructures
- Identifies 29 Research Infrastructures under implementation as Landmarks, together with 21 pan-European Research Infrastructure projects
- Result of a rigorous evaluation process that considered both scientific merit and project preparedness
- ESFRI will closely monitor the implementation of ESFRI projects and will periodically assess the status of ESFRI Landmarks
- We encourage the Member States and Associated Countries to continue their efforts in developing and updating national roadmaps for Research Infrastructures in line with the ESFRI roadmapping process and to secure appropriate funding in order to achieve the timely implementation and long-term sustainability of these Research Infrastructures
- We will prepare for the next ESFRI Roadmap update in 2018

ROADMAP 2016

European Strategy Forum
on Research Infrastructures

ESFRI

Thank you!

STRATEGY REPORT ON RESEARCH INFRASTRUCTURES