

Preparatory Phase for the Einstein Telescope Gravitational Wave
Observatory

Deliverable 4.2

*Update of Socio-economic Impact Study
(revised)*

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Executive summary

The document, D4.2, is a deliverable of the ET-PP Project, which is funded by the European Commission Framework Program Horizon Europe Coordination and Support action under grant agreement 101079696.

Socio-economic impact studies are to be considered when building the ET infrastructure. Here we briefly summarize the official reports by the two candidate sites to host the Einstein Telescope, the EMR site (at the borders of The Netherlands, Belgium and Germany) and the Sardinia site. This executive summary is not intended to evaluate the two updates of the socio-economic impact studies which in their final forms will be part of the official “site-bidding” process in 2026.

The Einstein Telescope (ET) is a large-scale research infrastructure for gravitational wave detection, recognized by the European Strategic Forum for Research Infrastructures (ESFRI) in 2021. ET will significantly contribute to scientific knowledge, producing numerous publications and fostering expertise in physics and related fields. The two studies independently conclude that if ET would be built at the corresponding locations the key socio-economic impacts would be:

- the project will stimulate local industries, especially those involved in construction and high-tech manufacturing;
- during construction, approximately 34,000 man-years of employment are anticipated across Europe, with a significant portion in the region;
- during operation, around 1,200-1,500 jobs are expected directly and indirectly, supporting regional employment and skills development;
- the project’s total output effects are substantial, with an overall multiplier of about 3.6-3.7, indicating that investments in ET generate widespread economic activity and income within the region;
- the influx of research funds and related investments will likely lead to upgrades in local infrastructure, benefiting broader regional development;
- the presence of ET could help combat demographic decline by attracting talent, professionals, and students, thereby supporting regional socio-economic resilience.

Both socio-economic impact studies emphasize specific aspects of which two each are listed below. Please refer to the individual reports for details For the EMR site:

- the availability of a dense network of research and industrial actors, offering economic and technological synergies;
- a vibrant research/technical landscape as evidenced by various ongoing national, regional and international projects like ETpathfinder, ET-CRISTAL, E-TEST, ET2SME’s, a.o..

For Sardinia:

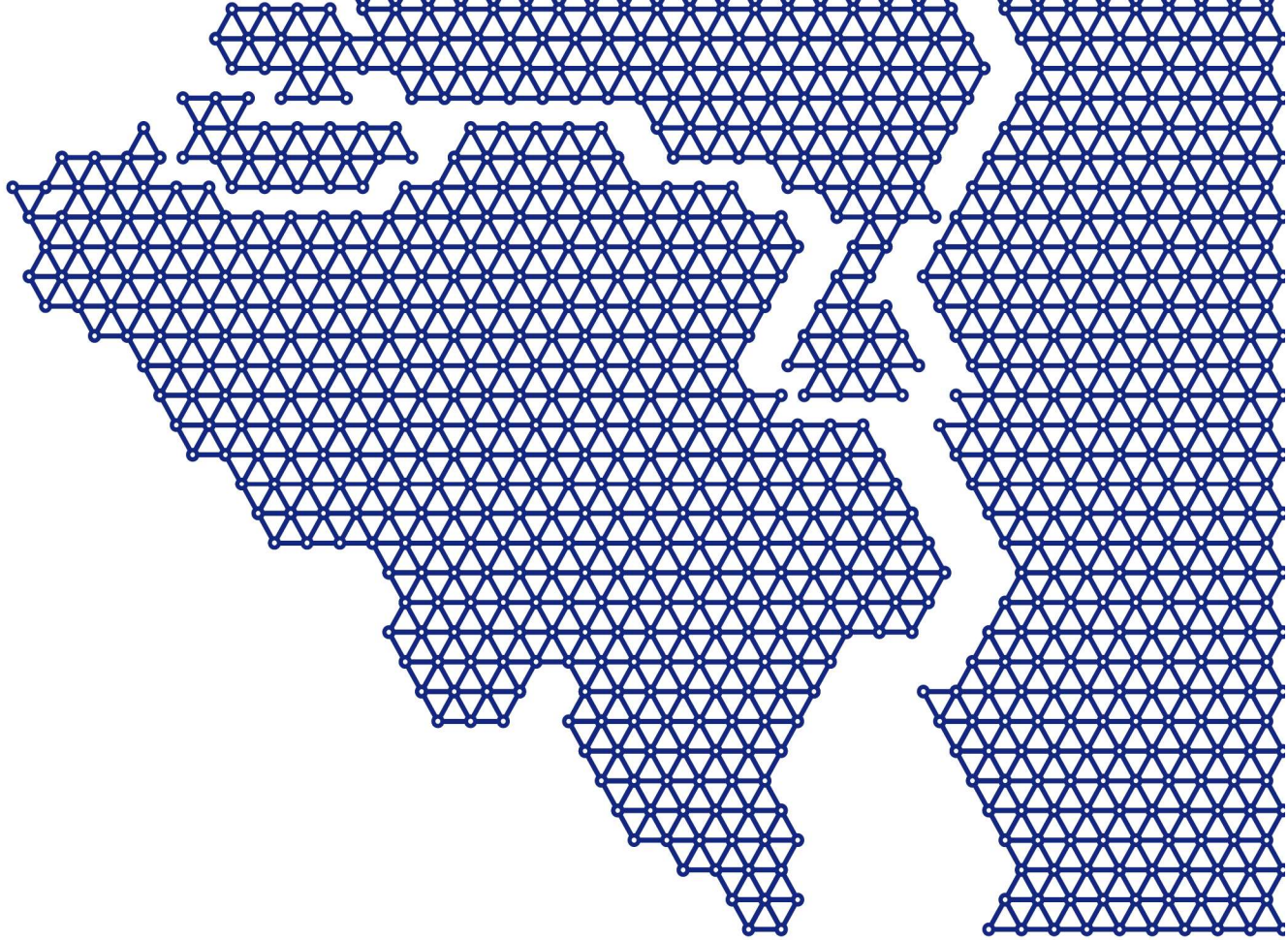
D4.2: Update of Socio-economic Impact Study

- the existence of operational research facilities (e.g., SAR-GRAV lab in the Sos Enattos mine), with experience in underground activities necessary for ET, along with skills and human capital suited for underground scientific work;
- the sufficiently differentiated productive structure with about 45,000 active companies working in ET related sectors, with special emphasis on mining and excavation related firms.

Overall, the two socio-economic impact studies highlight for both sites the significant opportunity for socio-economic transformation, including employment growth, technological advancement, enhanced regional profile, sustainable development pathways and demographic stabilization for each site.

The complete reports obtained by the EMR and Sardinia host teams are attached as Annex 1 and Annex 2, respectively.

Annex 1: EMR Update on Socio-Economic Impact



Einstein Telescope

ETPP-WP4 Socio-economic impact update report
of the EMR Project Office



Einstein
Telescope

ET-EMR Project Office
Version 1.0

17 February 2025

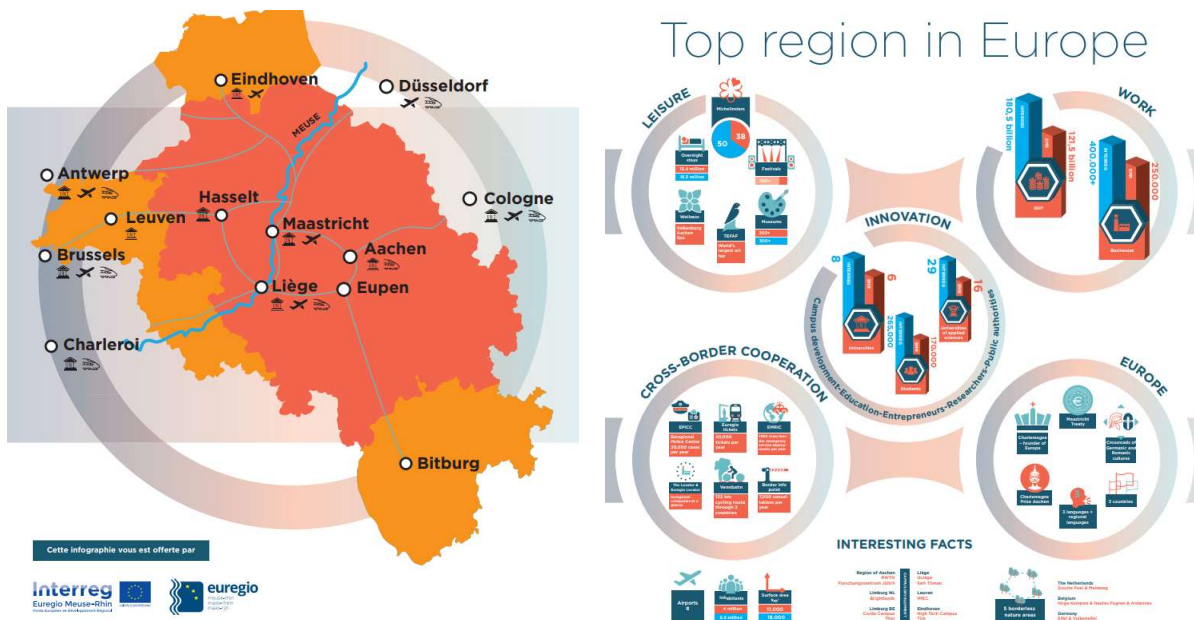


Introduction

The Einstein Telescope opportunity

The objective of the Einstein Telescope is to build a large-scale research infrastructure that will be the next generation gravitational wave detector for further scientific research of the cosmos. The Einstein Telescope is adopted in the 2021 European roadmap for research Infrastructures (ESFRI). This confirms the excellent science case and the plans to construct the Einstein Telescope in Europe including the following steps towards a site selection.

The starting conditions of the Euregio Meuse-Rhine to host the Einstein Telescope are favourable. The unique soil allows for dampening vibrations and building the research infrastructure in a relatively quiet landscape. This region offers strong research institutes and high-tech industry. And the infrastructure and international living and business climate are attractive. There is already a high-level gravitational waves infrastructure with the ETpathfinder and E-TEST research centres and the Einstein Telescope Education Centre. Governments of the three EMR countries are cooperating and are open to other countries joining their ambition to host the Einstein Telescope.



Infographics: Euregio Meuse-Rhine, a quiet landscape environment for the Einstein Telescope in the heart of a cross-border cityregion with strong research institutes, high tech industry and multimodal infrastructures

The Einstein Telescope offers the Euregio Meuse-Rhine an unique opportunity to take a global leadership position in a new pioneering area of science: gravitational wave research. Housing the Einstein Telescope in this region will boost a positive impact on science, economy and society.



Commitment of the Euregio Meuse-Rhine to host the Einstein Telescope

Since 2018 research institutes from Belgium, Germany and the Netherlands have cooperated towards a case for a bid to host the Einstein Telescope in the Meuse-Rhine Euregio. This started with the signing of the Cooperation Agreement (MoU) and research and innovation projects like ETpathfinder, E-TEST and ET2SME's. The overall investment in research and development projects for the Einstein Telescope is over €100 million.

The ambition to host the Einstein Telescope is also addressed to the governments in Belgium, Germany and the Netherlands. At the ET Ministerial Conference 26 September 2023 in Brussels, delegates from Belgium, the Netherlands and North Rhine-Westphalia agreed to prepare a bidbook and joint host consortium to establish the Einstein Telescope in the Meuse-Rhine Euregio. The ET-EMR Project Office is assigned by the Ministers to deliver all the necessary feasibility studies and prepare the EMR Bidbook by 2026. Governments in the Netherlands, Belgium and Germany have committed €49 million for the feasibility studies and preparations of the bidbook. Governments in the Netherlands and Belgium also have committed over €1 billion in funds to construct the Einstein Telescope in the Euregio Meuse-Rhine. The government of North Rhine-Westphalia did announce in January 2023 its intention to co-finance the candidacy, provided federal Germany will do the same.



Photo: Ministers of the Netherlands, Belgium and North Rhine-Westphalia at the conference (Eupen, 2024)



The ET preparatory phase project

The ET preparatory phase (ET-PP) will address a number of fundamental prerequisites for the approval, construction and operation of ET: the enlargement of the ET consortium, the legal framework, governance schemes, and financial regulations under which ET will be constructed and operated; the detailed technical design and costing of the ET observatory; the preparation of the ET site selection; detailing and cost-estimation of the required site infrastructure, and its socioeconomic and environmental impacts; the schemes for technology transfer, procurement and industry involvement in the technical design and construction of ET; the required linking with relevant science communities regarding the detailed definition of the science program, and the user services and data access model.

For ET-PP, support is sought for work on the legal, governance and financial issues, for the installation of a project office coordinating and supporting management of ET-PP as well as the design of ET and the planning of the implementation, for site-related work, for studies regarding the optimization and production of ET components by industry, for linking with science communities and for increasing social awareness. Hence, ET-PP will deliver a detailed implementation plan for the ET infrastructure.

ET-PP WP4 - Site Preparation - is responsible for collecting and processing, from each potential site, all the required information necessary for site qualification. This includes site specific characteristics that might impact the ET scientific performance, socio-economic impacts, legal implications, and civil engineering costs. One of the deliverables (D 4.2) is an update of socio-economic impact studies.

ET-EMR Project Office report with regard to the socio-economic impact

This report answers to the request of Nikhef als leading partner for WP 4 to the ET-EMR Project Office to coordinate creating a document that updates the existing socio-economic impact study for EMR. This report provides an overview on available information with regard to the current and anticipated impact of the Einstein Telescope and the Euregion Meuse-Rhine as site-candidate. This information is based on studies and sources available and reviewed by the ET-EMR Project Office.



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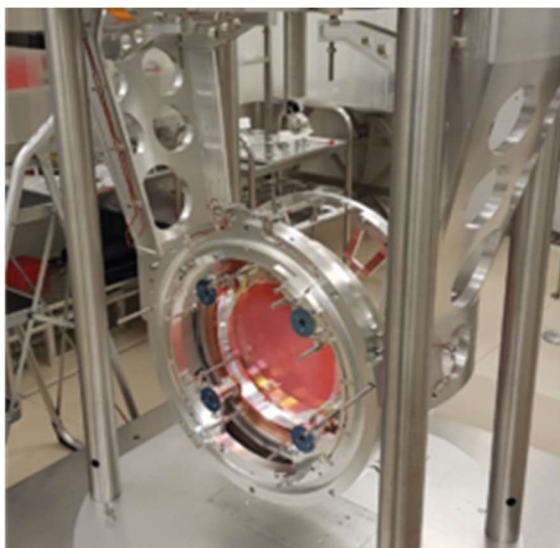


Detector research driving key enabling technologies

Strategic importance of Key Enabling Technologies for Europe

To achieve the required extreme sensitivity, the Einstein Telescope pushes boundaries of many technologies. New technologies and the development of technologies for the Einstein Telescope have the potential to create spinoffs and new products/services and increase human capital in the hosting region. This will lead to the creation of higher added value and economic growth.

Technological sovereignty has been at the heart of recent political debate in the EU. The areas of technological development for the Einstein Telescope detector overlap with five of six Key Enabling Technologies as identified in the European Union; micro and nanoelectronics, nanotechnology, advanced materials, photonics, and advanced manufacturing technologies.



Figures: Key Enabling Technologies at the heart of EU technology and innovation policies

Key Enabling Technologies are crucial for an interconnected, digitalised, resilient and healthier European society, as well as being important for the EU's competitiveness and position in the global economy. These technologies are therefore also top priority in European and national innovation policies. The technology development will continue – also during construction and operation of the Einstein Telescope - to prepare a continuous series of detector upgrades. This provides an impact perspective that goes beyond individual technology-developments and its applications in science and society; it refers to fundamental development of knowledge as a strategic European asset.



Detector research and development in the Euregion Meuse-Rhine

Using advanced laser-interferometry methods, the Einstein Telescope will be able to achieve a design sensitivity of 22 decimal places. This means that it can detect differences in distance ten thousand times smaller than the size of the protons in an atomic nucleus. To achieve that incredible accuracy, the observatory requires unique technologies, some of which are not even fully developed yet.

Since 2018 research institutes from Belgium, Germany and the Netherlands have cooperated towards a case for a bid to host the Einstein Telescope in the Meuse-Rhine Euregion. This started with the signing of the Cooperation Agreement (MoU) and research and innovation projects like ETpathfinder, E-TEST and ET2SME's. The overall investment in research and development projects for the Einstein Telescope is over €100 million. The research institutes in the Netherlands, Belgium and Germany already established additional research groups and research projects, generating additional scientific activities and economic effects in the EMR. EMR institutes lead multiple joint cross-border research projects, based on strong pan-European partnerships, as the basis for building and operating the Einstein Telescope. New high-quality testbed facilities such as ETpathfinder (Maastricht) and ET-CRISTAL (Liège) contribute to the development of a strong fabric in which the Einstein Telescope can be embedded.



Photo: research institutes for the EMR candidature, meeting 15 February 2023 in Aachen

EMR research institutes work together with industry and on the valorisation of the technologies, with projects like ET2SMEs, ET-Technologies and ET4business. The knowledge coalition for Einstein Telescope started in 2018 with the aim of strengthening cooperation in preparation for the observatory. This involves R&D for the Einstein Telescope and joint work on a strong proposal to establish the Einstein Telescope in the border region.



EMR R&D Centers; ETpathfinder

Construction of ETpathfinder started in 2020 and over the past 5 years has developed into an internationally recognized flagship Scientific Research and Development (R&D) facility. While the key focus is to support the European Einstein Telescope ambitions, positive side-effects have led also to benefits for the current Virgo detector.

The R&D Field Lab ETpathfinder is an unique low frequency laser interferometer R&D center, integrating and validating exp. technologies and measurement techniques for the Einstein Telescope. Over 100 scientists, engineers and technicians from 20 partner-institutes from NL, B, G, FR, SP, UK, PL are now involved. The ETpathfinder integrates and validates research into high-precision measurement techniques, seismic isolation, measurement and control software, cryogenics and (quantum) optics. This made the ETpathfinder a focus point for many new research projects and projects for technology valorisation and skills development (with industry and educational partners).



Photo: Impression of the ETpathfinder research facility (Maastricht)

The ETpathfinder is located at the Maastricht Campus with over 100 companies, 11.000 employees and 11.000 students. It is positioned in the Maastricht University Faculty of Science and Engineering and the national Nikhef-institute.



EMR R&D Centers; ET-CRISTAL

The ET-CRISTAL prototype suspension system was one of the two pillars of the interreg Europe project “E-TEST” that started in 2019. The project included 10 partners from the EMR region and was coordinated by the University of Liège. The other pillar of the E-TEST project focused on underground exploration of the EMR site. In the context of the E-TEST project, the ET-CRISTAL prototype suspension system was designed, constructed and eventually tested at the Liège Space Centre (CSL) at the end of 2023, when the E-TEST project ended. The CSL, with its new state-of-the-art infrastructure, is set to play a crucial role in future European Space Agency missions.



The ET-CRISTAL suspension system is based on active isolation that was combined with a quasi-radiative cooling system at 10 K. The latter was based on a new patterned heat exchanger working radiatively. This cooling system was designed and implemented at the CSL benefiting from its know-how in cryogenic qualification for space instruments. Among the various results that were obtained during the measurement campaign conducted at the end of 2023, it is worth mentioning the excellent performance of the cryogenic system that went beyond expectations: a temperature below 20 K was reached in less than 20 days.

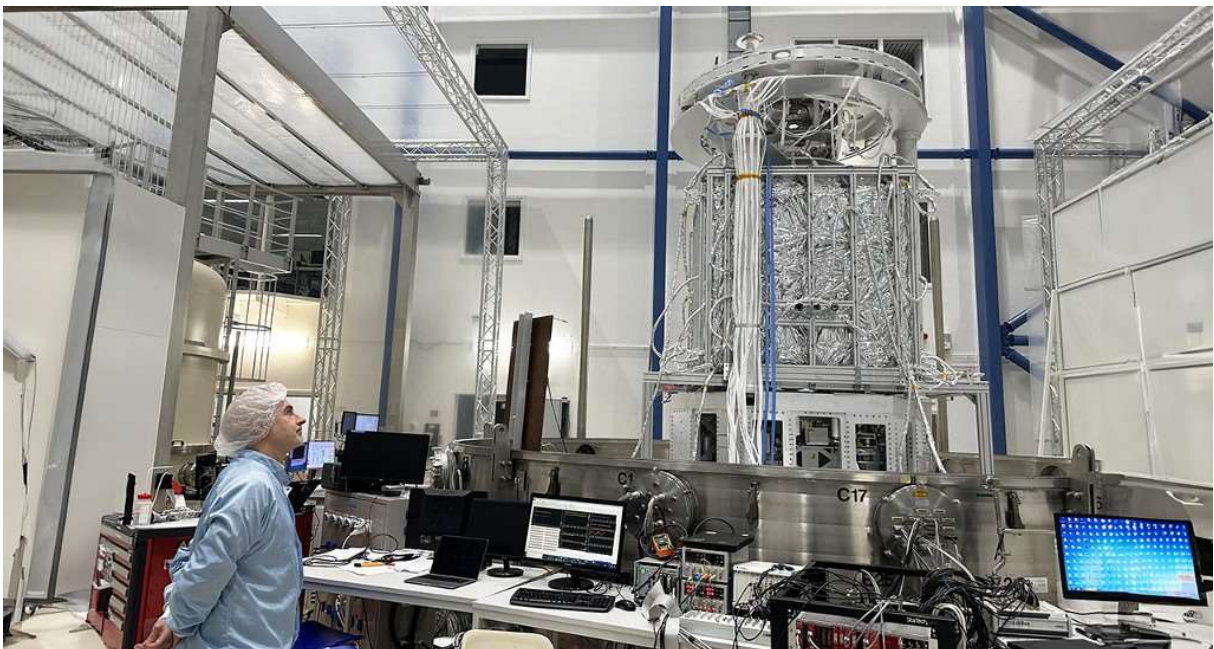


Photo: Impression of the ET-CRISTAL research facility (Liège)

EMR R&D; overall effort with partners

The R&D facilities described in the previous sections, namely ETpathfinder and ET-CRISTAL as R&D, are true EMR centers for integrating technologies for the Einstein Telescope. But additional substantial work is and will continue to be carried out at several other research facilities that act as expertise and satellite facilities. For example researchers at the Fraunhofer Institute for Laser Technology ILT in Aachen are working on the laser at the heart of the Einstein Telescope. The overall investment in research and development projects for the Einstein Telescope in Belgium, the Netherlands and North Rhine-Westphalia is over €100 million. The collaboration is an open science effort and with many strong partners inside and outside the Euregion Meuse-Rhine.

For an overview of research and innovation projects; www.einsteintelelescope-emr.eu/en/projects/



Valorisation together with industry

A well-functioning ecosystem is important for generating indirect economic return of investment because a robust ecosystem helps to drive high tech and deep tech innovation and bring it to market. It is also about the valorization of the fundamental knowledge gained in the medium- and long-term exploitation phase: converting the knowledge into commercially viable products, processes or services, and marketing them. In order to maximize the economic impact, there are intensified efforts to develop and operate an enterprise ecosystem and business development. In the preparatory phase, the focus of business development will be on engaging the local business community for construction and realization. Afterwards, the focus will shift to identifying and exploring new product-market combinations (PMCs) and new applications of the technologies, products and services. Developing and valorising detector technologies offers a source of challenging orders for businesses; innovation and jobs.

With the planning, construction and operation of the Einstein Telescope, there is the prospect of a large number of demanding and lucrative tasks for numerous companies, especially in the high-tech sector of the extended Euregio Meuse-Rhine. In all phases up to the permanent operation of the facility, companies from the border region will be able to apply directly for tenders and thus for numerous contracts involving the Einstein telescope. This shows the capacities of this region to prepare, construct and operate the Einstein Telescope in the Euregio Meuse-Rhine. These include above all the ET operating Technologies 'ET Instruments' like Cryogenics, Vacuum, Precision Mechanics / Mechatronics, Sensors, Optics & Optical Metrology, Mirrors Coating, Lasers and Advanced Control Algorithms.

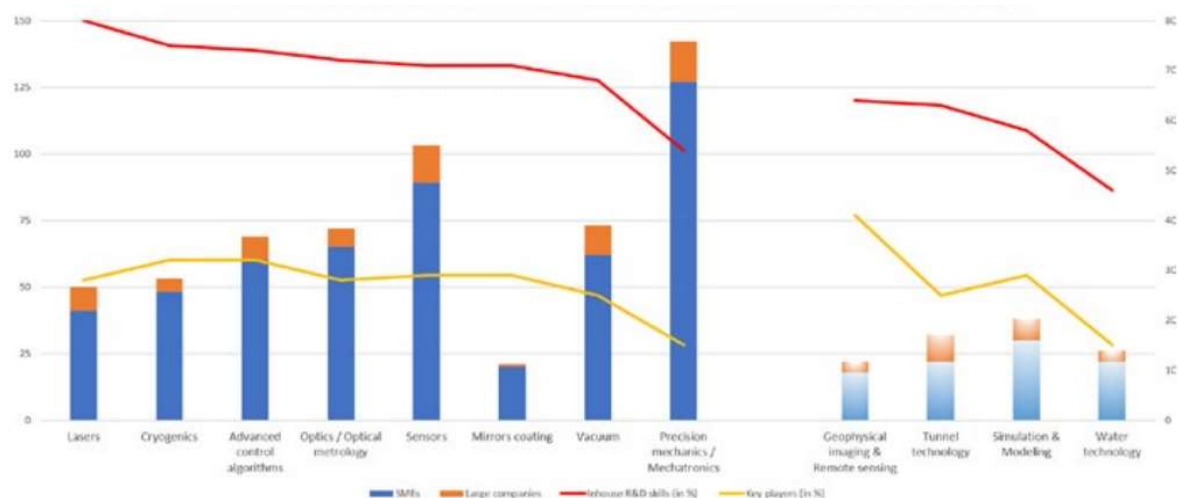


Figure: ET relevant number of companies in business clusters in the extended Euregio Meuse-Rhine



The construction and operation of ET will require many advances in research and development and new technological developments. Many of the innovations needed will build on research already conducted at LIGO (United States), VIRGO (Italy), KAGRA (Japan) and other similar facilities. For the actual construction of the Einstein Telescope (in particular the instrumentation), technology domains have been defined that will be further developed through research and innovation.

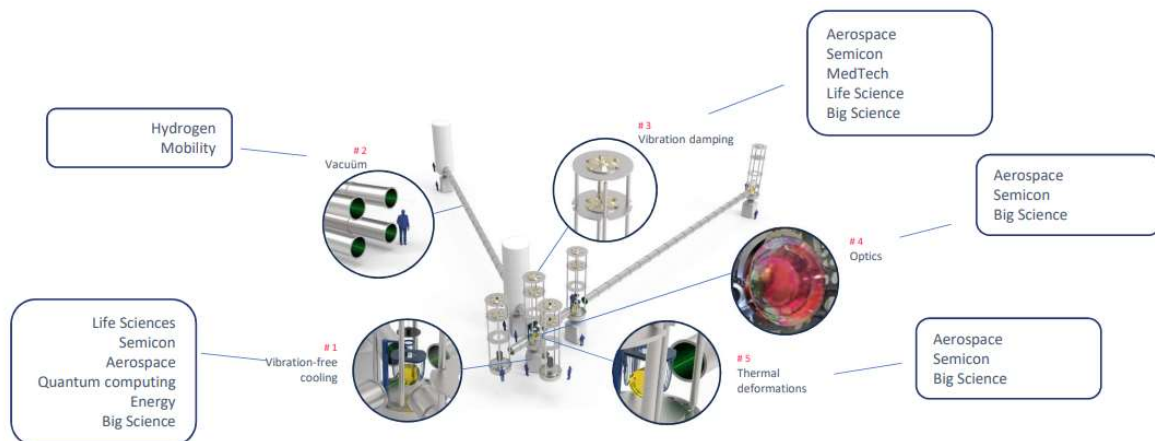


Figure: Technology domains for the Einstein Telescope and their market potential

The ET2SMEs project is carried out under the Interreg V-A Euregio Meuse-Rhine Programme. As part of the mapping of companies and research institutions carried out as part of the ET2SMEs project, around 400 relevant actors with technologies relevant to the Einstein Telescope were identified and recorded. Around 71% of the profiles can be attributed to SMEs. The project showed the interest for companies to participate. To encourage innovation and accelerated development of new technologies for the Einstein Telescope, a platform has been launched: Einstein Telescope for business. Here, companies will find information on collaboration opportunities, technology domains and the contact details of business developers in various regions.

Also see: <https://einsteintelelescopeforbusiness.nl/en>

There are already plenty of examples. The Netherlands is working on new vibration-free cooling systems that may be useful for future quantum computers. Belgian research on mirror coatings may be applicable in chip technology, or in UV filters for construction or solar cells. And German laser research is of interest to the automotive industry, in LIDAR systems to measure distances. RWTH Aachen University, Institute for Physics acts as 'hot spot' for UHV-pipe development; Here two currently running projects (BeamPipes4ET and UHV.NRW) represent together a volume of Euro 5.04 mln. and are furthermore excellent examples for euregional business involvement, as companies from The Netherlands, Flanders and NRW are essential part of both R&D consortia.

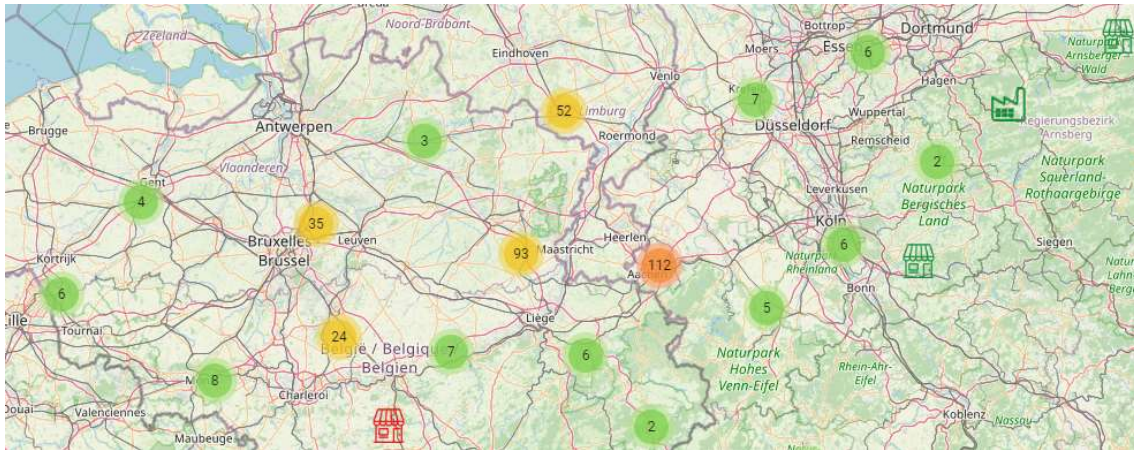


Figure: 400 actors (84% companies; 70% SME's) in the Euregion Meuse-Rhine are involved in development

Government partners work together in the Euregion Meuse-Rhine in optimizing the valorisation of technology development. Partners come from Development Agencies, Governmental Innovation and Industrial Liaison Agencies. The partnership evolved from the ET2SME's cross-border project. Recently the Euregion Meuse-Rhine was selected to host the Big Science Business Forum in 2026; also driven by the ambition to host the Einstein Telescope and stimulate European partnership in business that is founded on big science.

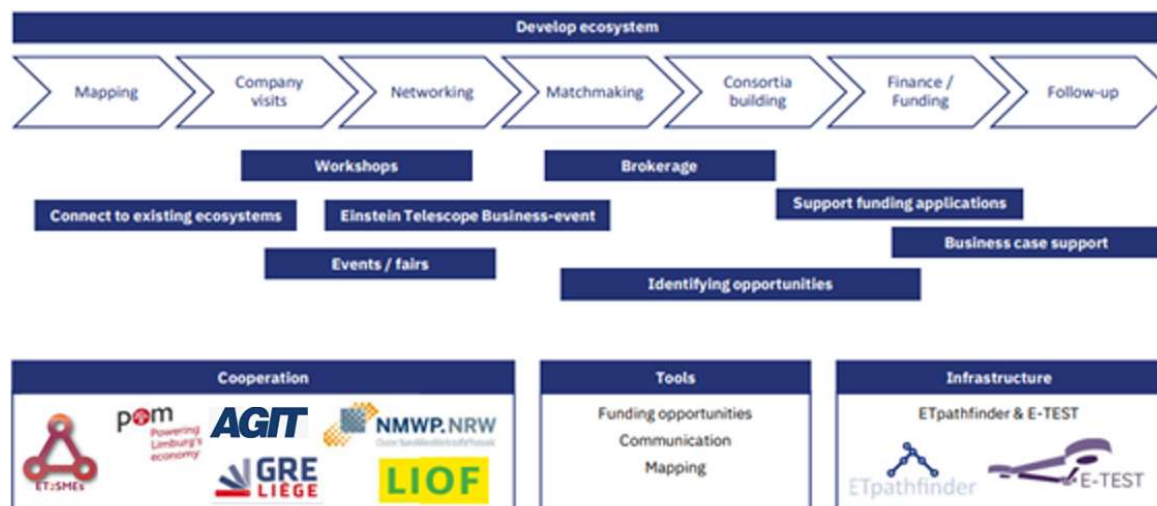


Figure: Government assigned partners involved in valorisation in the Euregion Meuse-Rhine and activities.

Two new projects offer opportunities for industry and technological innovation. Also see: www.einsteintelelescope-emr.eu/en/2024/09/30/the-einstein-telescope-as-a-driver-of-innovation-in-wallonia/



Building an ecosystem for talent development

With the arrival of Einstein Telescope to the region, the same region will be able to attract and retain knowledge workers. This includes not only scientists, engineers, doctoral students and postdoctoral fellows, but also technical personnel at college and secondary school level. The involvement of three different countries also makes it possible to promote further cooperation and exchange in education and research. The interaction with knowledge institutions will encourage students to pursue a STEM education. Linking leading scientific research with talent development will enhance the reputation and visibility of the Euregion Meuse-Rhine. This will also have a major impact internationally. Einstein Telescope then acts as a magnet for talent and science and can thus contribute greatly to raising the attractiveness of the profile of the Meuse-Rhine Euroregion.

Among today's workers, the demand for new technical skills is growing. Einstein Telescope can be an attractive catalyst to boost attention to engineering in general, but the project also needs new technologists and skills. Einstein Telescope foresees a growth in employment: the potential of this project is enormous. Construction already provides 34,000 man-years of employment directly. We are talking about structurally 500 jobs directly and an additional 1,150 jobs indirectly. This also requires a lot of additional education and training in the region. Retaining, attracting and developing STEM talent is a breeding ground for the high-tech ecosystem in on a multi-year basis. New activities do not only attract existing talent and knowledge, but also speak to the imagination of young people to choose for a study in the fields of Science, Technology, Engineering and Mathematics (STEM).



Figure: In the ETpathfinder Smart Skills Lab a partnership of research institutes, vocational educational institutes and companies will work together in developing talent for the Einstein Telescope with wider impact

The availability of various education and training programmes in the region is a precondition; there is for example a possibility to increase the number of international bachelor and master programmes. Projects in the EMR region to drive skills development include ETpathfinder SMART Skills Lab and Einstein Academy (with vocational education partners and industry) and the Einstein Telescope Educational Center (with high school classes).



High school students work at the Einstein Telescope Education Center in a day-long teaching programme entirely devoted to the science behind the Einstein Telescope. With the help of a film, an interactive demonstration lecture and workshops, pupils will discover that physics as they learn it in secondary school is actually applied in the ET project. Partners also reach out to teachers and wider public more directly. A recent example: POM Limburg, FWO and the Leuven Gravity Institute organised a teachers' day especially for STEM and science teachers at the ThorPark in Genk, where the ET-expo, the interactive exhibition about the Einstein Telescope, can also be found.



Photo's: Up to 1000 high school students each year visit the Einstein Telescope Education Center (ETEC).

The launch of the science faculty in Maastricht and the realization of the ETpathfinder is an example of a major boost. Exemplary of the high potential of the Einstein Telescope is the increase of STEM-students at Maastricht University from 800 (2011) to 3700 students (2024); also related to the Einstein Telescope related investments in science and engineering capacities. Also other universities, vocational educational institutes and industries are expanding their training capacities. Another example: KU Leuven university launched the Leuven Gravity Institute in October 2024. This institute aims to support and expand the multidisciplinary research fabric that underlies gravitational wave observations. The institute is also shaping a broad education in this field for students, young researchers and engineers, ranging from gravity (astro)physics, data analysis and computing, to engineering for the detectors.

The Einstein Academy is an initiative of Zuyd University of Applied Sciences and the Limburg institutions for vocational education VISTA college and Gilde Opleidingen, with other educational institutions from the Meuse-Rhine Euregion possibly joining in. The aim is for the Einstein Academy to train hundreds of professionals over the next few years, who will soon be able to build and maintain the Einstein Telescope.



Returns of constructing and operating the infrastructure

A study in 2018 by research firm Technopolis on the socio-economic impact of Einstein Telescope already comprehensively identified the potential indirect economic and social effects of the possible realization of Einstein Telescope in the Meuse-Rhine Euregio. Additional research into the potential socioeconomic impact of Einstein Telescope was then conducted as part of the ESFRI application. In this report, we take these research results as a starting point and summarize them in this chapter, as these are still valid and up-to-date outcomes.

The ESFRI application and roadmap give the following cost indications:

- Preparation; 171.0 M€ (2018 t/m 2027)
- Construction; 1,736.0 M€ (2026 t/m 2035)
- Operation; 37.0 M€/year (2035-)

It is anticipated that a majority of these costs will lead to spending and direct economic effects in the hosting region, considering the locationspecific character and additional costs that would come from goods and services outside the hosting region (location boundness). This also induces additional economic effects along the supply chain, and also due to workers' induced expenditure. Technopolis estimates that the anticipated employment effects for the Einstein Telescope and the hosting region and per invested M€ are 8FTE (direct) and 18 FTE (total).

These range from scientists and engineers to maintenance workers and support staff; a broad range of professionals is needed during construction and operation of the Einstein Telescope. Their spending power will have wide impact in the hosting region economy.

The total costs and following direct economic effects will first of all depend on the European design and costs and the additional (specific) site-related costs. The total numbers with regard to direct economic effects can be updated when there is a European cost update available (based on the European technical design report, by the ETO) and the following site specific cost-updates (based on the site feasibility studies, by the ET-EMR Project Office). These cost updates (European design and site related) are not yet available; these are expected not before 2026.

To what extent the costs will generate direct economic effects ('direct returns') during preparation, construction and operation will also depend on a.o.; (1) the location-boundness of products and services; (2) the competitive advantages of local suppliers; and (3) the outcome of European negotiations and procurement regulations.



Economic impacts in the preparation phase

Costs in the preparatory phase largely concern site-specific research that will be carried out mainly on a regional (or national) scale. On cost grounds, it is estimated that a substantial part of this work (even in the event of a possible European tender) will be carried out by regional and national (sub)contractors. The preparation phase will therefore have a primarily regional impact. Multiplier effects of these preparatory efforts to other sectors are plausible because it concerns innovative activities that may have new economic spin-offs. The companies involved can apply the new technologies beyond the construction of Einstein Telescope.

Contacts with companies are still in an inventory and construction phase. The preparatory work, such as the design and construction of the prototype ETpathfinder, does already attract a lot of attention and research and education activities to the region, which otherwise would not have taken place in the region. Additional funding is also being attracted, for example for research, albeit mostly regional funding that would otherwise have been spent in the region in other ways. Technopolis notes that research centers almost always produce a positive multiplier. This involves effects in sectors of the economy other than the sector in question: think of housing and living expenses by (additional) employees, additional hotel turnover for visitors, etc.

Economic effects in the construction phase

Construction includes the largest expenditure from the Einstein Telescope budget. Most of the investments for on-site preparation and construction (under-tunneling) involve site-specific activities. The intended construction volume is € 1.7 billion. About € 930 million of this is for civil engineering, of which € 840 million is for excavation, tunneling and underground works, and € 98 million for above-ground facilities. An amount of €804 million is estimated for instrumentation, of which € 566 million is for the ultra-high vacuum system and € 238 million for the other systems. The economic effects of these are strongly tied up in time and contract: they are mainly one-time impulses, which will fade out fairly quickly once construction is complete.

Technopolis has frayed the economic effects of construction. The ESFRI application looked at multiplier effects in Europe, in terms of Total Output (TO) and Value Added (VA). Assuming a 50/50 split of total costs in this phase between construction work and technology R&D, that European analysis showed that TO could be € 6.1 billion and VA between € 2.4 and 2.6 billion. In terms of employment, the same analysis assumed 34,000 man-years, the lion's share of which (32,500 man-years) would be realized in the supply chain.



In terms of total output, the realization of Einstein Telescope would bring a multiplier of 3.6. This multiplier applies to both the construction phase and the operational phase. These are multipliers for the European economy. At the same time, most of these effects are expected to occur particularly in the region. Contracts to design, develop or build a facility or, for example, to provide specific products and services are more often awarded to local and national companies than to foreign parties. Studies give a number of reasons for this. First, nearby companies are able to offer the requested products and services at a lower price because transportation costs are correspondingly lower, especially when large or heavy components are involved. Second, it is obvious to use local companies for maintenance or other issues that require constant attention. Third, physical proximity to the network is important. The presence of a social network, within which there is formal and informal exchange of information and trust, is an important catalyst for close contacts between companies, science, governments (triple helix).

The investments are for around 70% in fairly low tech (i.e. site development) and for around 30% in high-tech. The low-tech component will, because it is location-bound, have its main impacts in the region and on a fairly short term. There will be a direct economic effect on the building industry and its suppliers of some M€ 900, and an indirect effect as a consequence of the increased economic building activity (on local shopkeepers, etc.) of approximately M€ 500. These total numbers are related to the costing in the ESFRI application and roadmap. Cost updates (European design and site related) are not yet available; these are expected not before 2026.

Economic effects in the operating phase

In operation the Technopolis study anticipates 500 jobs (direct) and an additional effect of 1150 jobs (indirect). The (direct) involved researchers and technicians have a direct economic spillover to the regional economy because they will be housed in the region, mostly with their families. Per year, this could lead to an additional income in the region. It is realistic to expect that during the lifetime of Einstein Telescope (50 years) the equipment will be constantly improved technically. In doing so, the limits of what is possible will be repeatedly pushed. During the operating phase, the observatory's high-tech instrumentation will be *upgraded* every 5 to 7 years. The economic effects will partly rain down on the hosting region.



Economic value of research activities

Scientific research directly attributable to Einstein Telescope is expected to cost about € 400 mln per year. That involves the deployment of some 4,000 researchers per year worldwide, calculated at a cost factor of €100,000 per person-year. So the scientific organizations that provide the funding for this are placing a high value on the research. That is a readily measurable indication of the value of the scientific research directly linked to Einstein Telescope. Viewed in this way, the total, combined investment of €2 billion in the physical setup has been "recouped" in valuable scientific research in five years. Cumulatively, the worldwide 'turnover' of scientific research (WO) in the 50 years that Einstein Telescope is in operation thus comes out to about € 20 billion, a factor of 10 on the initial joint investment of € 2 billion. Second order effects of the flow of research could still be calculated. This monetization effect can be further extended by also making (the increase of) study programs around Einstein Telescope measurable.



Sources available

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<https://einsteintelelescopeforbusiness.nl/en> (January 2025)

Want to know more?

Visit our website for more information about the Einstein Telescope and to keep up to date with developments.

www.einsteintelelescope-emr.eu

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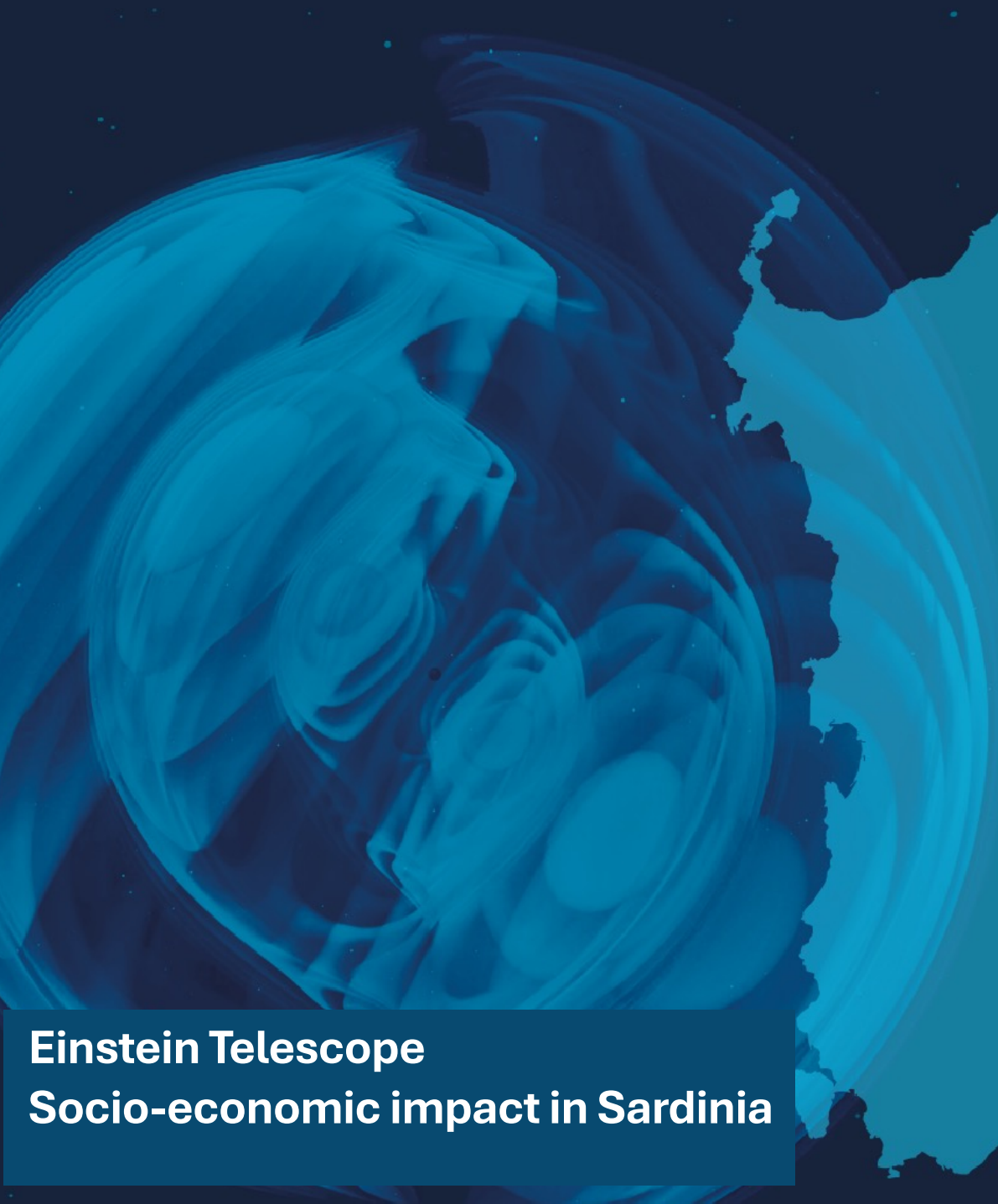
 [@ET_Euregio](https://twitter.com/ET_Euregio)



Einstein
Telescope

Annex 2: Sardinia Update on Socio-Economic Impact

—



Einstein Telescope Socio-economic impact in Sardinia

Report update
Prepared by the INFN

EXECUTIVE SUMMARY

Einstein Telescope: Economic and Social Impact Assessment

This report summarizes the report "Einstein Telescope - An evaluation of the Economic and Social Effects of a New Research Infrastructure" realized by Guiso L. et al. which will be published in 2025. It also draws on a previous version of the report titled "Einstein Telescope: An assessment of its economic, social and environmental impact in Sardinia" (Atzeni G. E. et al., 2020).

Project Overview

The Einstein Telescope (ET) is a large-scale research infrastructure project aimed at developing a next-generation gravitational wave detector to observe and study gravitational waves. The project's scientific excellence was officially recognized in 2021 when the European Strategic Forum for Research Infrastructures (ESFRI) included ET in its 2021 Roadmap, listing it among the research infrastructures of pan-European significance.

Ideal Location

The Italian candidate site of Sos Enattos, located in Sardinia, stands out as the ideal location in Europe to host ET. It fully meets the scientific requirement of an environment free from background noise thanks to the complete absence of earthquakes and seismic risks in the region, as well as the low population density, limited economic activity, and minimal road infrastructure in the surrounding area.

Economic Impact

The construction phase (€1,562.0 million) is expected to generate €5,817.5 million in total output with a multiplier effect of 3.72 per euro spent, contributing €2,196.5 million to GDP and creating approximately 33,221 full-time equivalent jobs. The operational phase (€57.8 million per year) is projected to generate €204.21 million in annual output with 1,202 sustained jobs.

1

Geographical Advantages

Sos Enattos offers a former mine where INFN has been conducting underground measurements since 2010. The region's near-total absence of earthquakes and seismic risk is critical for gravitational wave detectors. The area is among the least densely populated in Europe (5-12 people per square kilometer), with minimal human activity, economic activity, and traffic—all factors that could disturb the telescope's operations.

2

Strategic Features

Sardinia has 145,061 active firms, with approximately one-third (45,102) operating in sectors relevant to ET. The region offers extensive accommodation capacity (302,183 bed places), strong connectivity through 161 direct worldwide air connections via three major airports, and well-equipped ports. The GARR-T network provides robust internet infrastructure with a resilient terrestrial optical ring and dual submarine cables connecting to mainland Italy.

3

Scientific & Social Impact

ET will significantly advance scientific knowledge across multiple fields, with an expected 5,000+ scientific publications over its 30-year operational period. Young scholars working at ET can expect an annual salary premium of €2,428.73. The facility will attract approximately 7,000 visitors per year and generate additional benefits through patents, research spin-offs, improved local services, and foreign direct investment attraction.

4

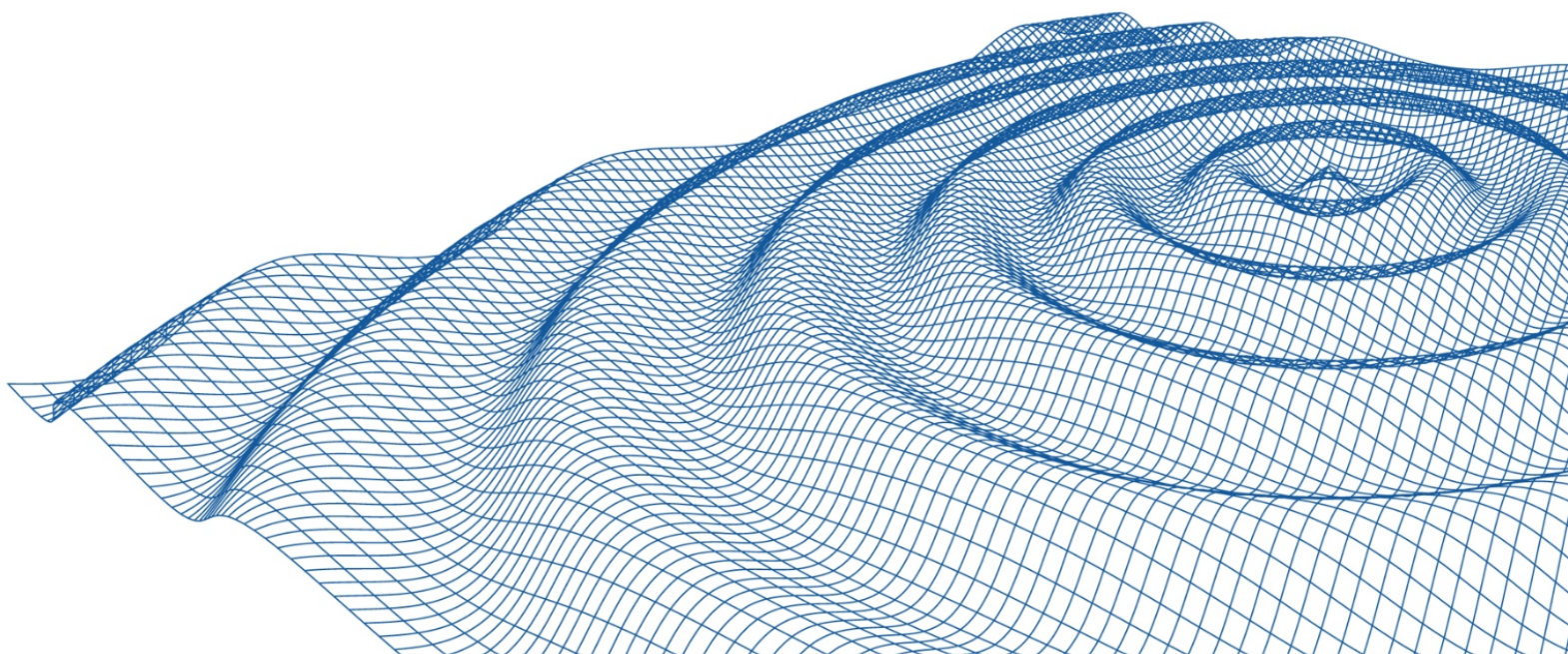
Local Community Benefits

The peripheral Sos Enattos area, currently experiencing population decline and high unemployment, could see a reversal of these trends through increased demand for public services, growth in the housing market, and greater demand for commercial services. The project has already encouraged municipalities to collaborate on long-term development strategies and has served as a mediator among local stakeholders.

Several initiatives have already been planned and funded for a total of 1042,70M€ by the Italian Government, and 405,90 M€ by the Sardinia Regional Government.

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1 INTRODUCTION

The Einstein Telescope (ET) is a large-scale research infrastructure project aimed at developing a next-generation gravitational wave detector to observe and study gravitational waves. The scientific excellence of the project was officially recognized in 2021 when the European Strategic Forum for Research Infrastructures (ESFRI) included ET in its 2021 Roadmap, listing it among the research infrastructures of pan-European significance.

The Italian candidate site of Sos Enattos (Sardinia) emerges as the ideal place in Europe to host ET. First, it fully satisfies the scientific requirement of absence of background noise thanks to the complete absence of earthquakes and seismic risk in the region, as well as to the low density of population, economic activity, and roads in the site surrounding area. Secondly, the infrastructure and socio-economic conditions of Sardinia are strategic for guaranteeing the project realization as well as a significant scientific and socio-economic return.

Sardinia is an Italian island in the middle of the Mediterranean. With a surface of 24,090 square Km and a population of 1.57 million people, it has an average population density as low as 65 people per square kilometre, about $\frac{1}{2}$ the average European density and $\frac{1}{3}$ of Italy's population density. Sos Enattos is in the inner centre/east side of the Island belonging to the municipality of Lula with land extending to the municipalities of Bitti and Onanì, where populations density is even lower than the region average. In Figure 1 is reported a map of Sardinia and singles out Sos Enattos, highlighting, in the bigger map, also the surrounding municipalities.

ET really represents a great opportunity for this region and the Area of Sos Enattos. The socio-economic impacts ET may trigger are quite significant and can help reverse the demographic and socio-economic trends of the marginalized area of Sos Enattos as well as those of Sardinia. For this reason, the local, regional, and national institutions have shown their commitment to the ET

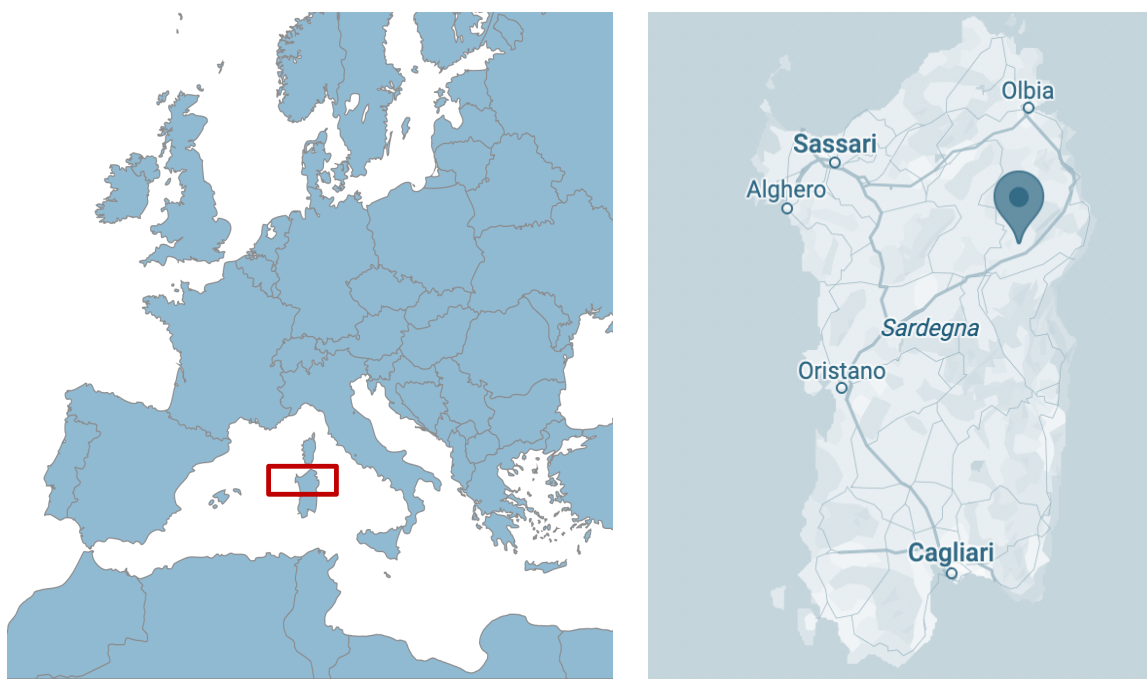


Figure 1 - Location of the ET site in Sardinia

project and have been taking significant initiatives to support it. Intervention will touch on various domains: a) Mobility and transportation: with the aim of improving and speed up the connection between Sos Enattos with the main cities in the Island and its airports; b) Social welfare: to strengthen the local supply of accommodation, international school, and local hospitals; c) training programs: set up specific initiatives and linkages between ET and research activities at local universities and exploit synergies between ET activities and other knowledge- based investments in the region; d) Environment and landscape: a program of urban and territorial regeneration including the recycling of the excavated material and the requalification of former quarries. So far many of these initiatives have been planned and funded like:

Table 1 - Italian Government: investments and plan

INVESTMENT	AMOUNT	YEAR
ETIC (NRRP)	50 M€	2023 / 2025
MEET-FABER (NRRP)	2,7 M€	2023 / 2025
TERABIT	13 M€	2023 / 2025
ET SUN LAB (CO-FINANCING)	10 M€	2025
ET ITALY	17 M€	2018 / 2021
ET CONSTRUCTION	950 €M	2022

Table 2 – Sardinia Regional Government: investments and plan

INVESTMENT	AMOUNT	YEAR
SAR GRAV 1	3,5 M€	2017 - 2024
ET SUN LAB (CO-FINANCING)	10 M€	2023
PROMOTION OF THE CANDIDACY	0,8 M€	2023 / 27
ROAD RESTORATION WORKS	2,9 M€	2023
ET SCHOLARSHIPS AND RESEARCH GRANTS	4 M€	2023
URBAN DEVELOPMENT PLANNING	0,2 M€	2024
ROAD AND RESERVOIR DAM RESTORATION	20 M€	2025
ET CONSTRUCTION	350 M€	2025
RESTORATION OF SOLOGO INDUSTRIAL AREA	8 M€	2025
PROMOTION OF THE SITE AREA	2,5 M€	2025
KETS DEVELOPMENT TARGETING LOCAL SMES	4M€	2025

The Regional government has instituted a set of bodies to provide all the organizational assistance for the realization of ET and coordinate the various relevant stakeholders (Universities, municipalities, research centers).

2 GEOGRAPHICAL AND STRATEGIC FEATURES OF SARDINIA AND SOS ENATTOS AREA

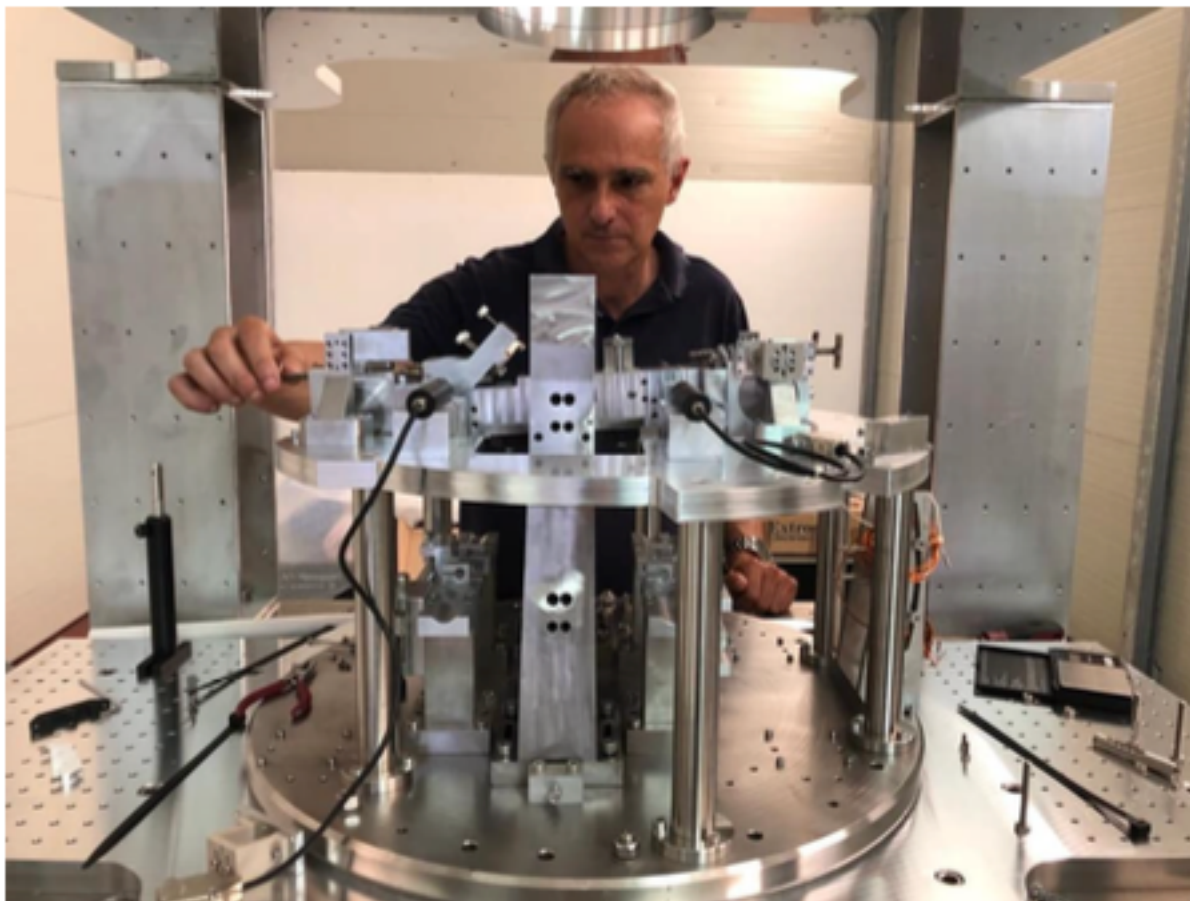


Figure 2 - A picture of the Archimedes experiment hosted at the SAR-GRAV lab in Sos Enattos (Sardinia, Italy)

2.1 Geographical features

According to the likely project configuration, the main infrastructure – the interferometer – would be in an underground tunnel, running on an equilateral triangle of 10 km side. The Italian candidate site of Sos Enattos has a first important asset that is the mine where over the period 1886-1996 local people worked to extract silver and galena. Already since 2010 the Sos Enattos mine is used by INFN to obtain underground measures relevant for ET, at different depth. Measurements done up to now confirm that the underground environment is an ideal place for testing some of the ET technologies. In 2019 the Universities of Sassari and Cagliari, the INFN, and the INGV inaugurated the SAR-GRAV lab in one of the mine's underground halls. The lab carries experiments - like the Archimedes experiment (see Figure 2)- that contribute to the assessment of the scientific quality of the site as well as to develop ET-relevant technologies.

Moreover, the mine tradition implies that locally there is availability of human capital with the skills, confidence and culture to work under-ground. This is quite relevant because the ET

interferometer will lay underground and require services provided by personnel familiar with working underground, as mine workers indeed are.

A second noteworthy strategic feature of the Sos Enattos and more generally of the whole of Sardinia, is the virtual absence of earthquakes and seismic risk. Such condition is the most relevant requirement for gravitational wave detectors best performance. While the Italian peninsula records numerous episodes of medium, large, and even extra-large earthquakes events, there is none in Sardinia. This is because geologically Sardinia does not belong to the Italian block but to the Spanish French block. Over the past 800 years there is no evidence of seismic episodes in the Sardinia site. In this regard Sos Enattos appears to be an extraordinary stable land. Besides earthquakes, the efficiency of the telescope and its ability to detect gravitational waves can be threatened by three additional sources of perturbation or noise, all proportional to the population density: a) high human activity; b) high density of economic activity; c) high density of motorways, particularly railways and trucks and train traffic. Sos Enattos area is among the geographical regions with lowest population density of Europe. The population density in the main municipalities in the area ranges between 5 to 12 people per km².¹ In this regard Sos Enattos is an ideal location. It also marks a clear advantage with respect to the density of economic activity which is among the lowest in Europe. Similarly, it has a very low traffic density according to all indicators. Truck traffic on motorways or primary roads is very low in Sardinia and virtually absent in Sos Enattos. Railway density is much lower in Sardinia and there are no railways in the Sos Enattos area.

1.1 Strategical features

The location for the ET infrastructure is affected also by other strategic features such as the presence in Sardinia of firms in sectors relevant for ET or a system of other research facilities.

ET requires a variety of services both during the construction phase and during the operations phase that must be supplied by local firms to be cost effective. Sardinia, despite being a region with GDP per capita below average in the EU, has a sufficiently differentiated and rich productive structure with 145,061 active firms in 2023, about 93 per thousand people. Among them, about one third (45,102 active firms) operate in ET-related sectors and are potential suppliers of goods and services relevant for the ET at both the construction and operating phases as identified by the scientist at the INFN drawing on their past experience. 29% are in the accommodation and food services and around 23% in the construction of buildings or specialised construction (21%) including mining engineering and excavation. Firms in these sectors are important particularly during the construction phase of ET. 330 of them are among the top 1,000 firms in terms of size (measured by sales volume). Several of these firms operate in transport and storage (83), construction of buildings, civil engineering, and specialized construction activities (81), and accommodation and food service activities (60), whose goods or services are typically required by ET. Overall, this suggests that the industrial structure of Sardinia guarantees a favourable environment for some of the construction and operating activities related to a large research infrastructure project such as the ET.

¹ See municipalities statistics at <http://www.comuni-italiani.it/091/statistiche/>

Importantly, Sardinia has a significant accommodation capacity due to its tourist vocation. Such capacity will be relevant to host the workers and scientists that will visit ET. The overall number of official accommodation establishments in Sardinia was 21,491, for a total of 302,183 bed places of which 70% provided by hotels and 30% by other types of accommodations. Importantly, the area of Sos Enattos hosts 16.5% of Sardinian establishments, for a total capacity of 45,553 bed-places mainly supplied by hotels.

Sos Enattos is relatively well connected to urban areas, ports and airports. It is within half an hour to two hours' drive from the main regional cities of Nuoro, Sassari, Alghero, Olbia, and Cagliari. Since Sardinia is a region of significant commercial and touristic activity it is well connected to the rest of the country by ship and air. Direct flights from its three airports (Olbia, Cagliari and Alghero-Fertilia) also connect the island to some of the main European capitals. There are 161 direct connections worldwide, 40 domestic and 121 European and international. The other two major ports - Porto Torres (north-west) and Cagliari (South) are within two hours' drive. Sardinian ports are all suitable for receiving heavy equipment and machinery required for the construction and operating activities of the ET, besides offering a good network of direct daily connections mainly between the island and mainland Italy, as well as some direct connections to other EU countries such as France and Spain.

The site is also well endowed with Internet connectivity and data transfer infrastructures that the ET activity will require to produce a constant flow of data to external computing centers and to communicate at high capacity. The connectivity for Research and Education in Sardinia is provided by GARR-T(erabit), the Italian National Research and Education Network [1]. Consortium GARR is going to complete, in the next months, a substantial upgrade of its infrastructure in capacity and services in the southern regions. Part of the funds for the upgrade are the result of its participation to two projects, ICSC and TeRABIT funded by NextGeneration EU through the National Recovery and Resilience Plan.² In Figure 3, the upgraded network in mid-2025 is provided. The GARR-T network is based on optical fibers capable of thousands of Gigabits per second in each fibre. The network continues to be seamlessly connected to other countries, the European backbone GÉANT and general Internet. A specific objective of the TeRABIT project is the upgrade of the network in the island of Sardinia, this specific upgrade corresponds to an investment of about 16ME. The upgrade consists of

- A resilient terrestrial optical ring connecting all research and education sites in Sardinia.
- Connectivity to the Italian peninsula through two different submarine cables, in which a part of the spectrum has been rented with a long lease contract, to permit easy and cost-effective capacity upgrades. The two cables provide full resiliency to island connectivity.
- lightning the direct fiber connectivity to the ET site of Sos Enattos, providing full access

² See for more details about these projects: Consortium GARR <http://www.GARR.it>; TeRABIT project <http://www.terabit-project.it>; ICSC National Centre for HPC, Big Data and Quantum Computing, <https://www.supercomputing-icsc.it/>; GÉANT, The research and education European backbone, <http://www.geant.org>

- to optical service of the GARR-T network. The dark fiber has been laid with an additional specific regional grant of 1 ME.

The TeRABIT project has also the objective to facilitate and innovate access to High Performance Computing and hybrid Cloud-HPC environment through the collaboration of all its partners: INFN, OGS, GARR and CINECA, the results will be available to the ET collaboration and exploitable through the worldwide National Research and Education Networks system and the Internet connectivity.

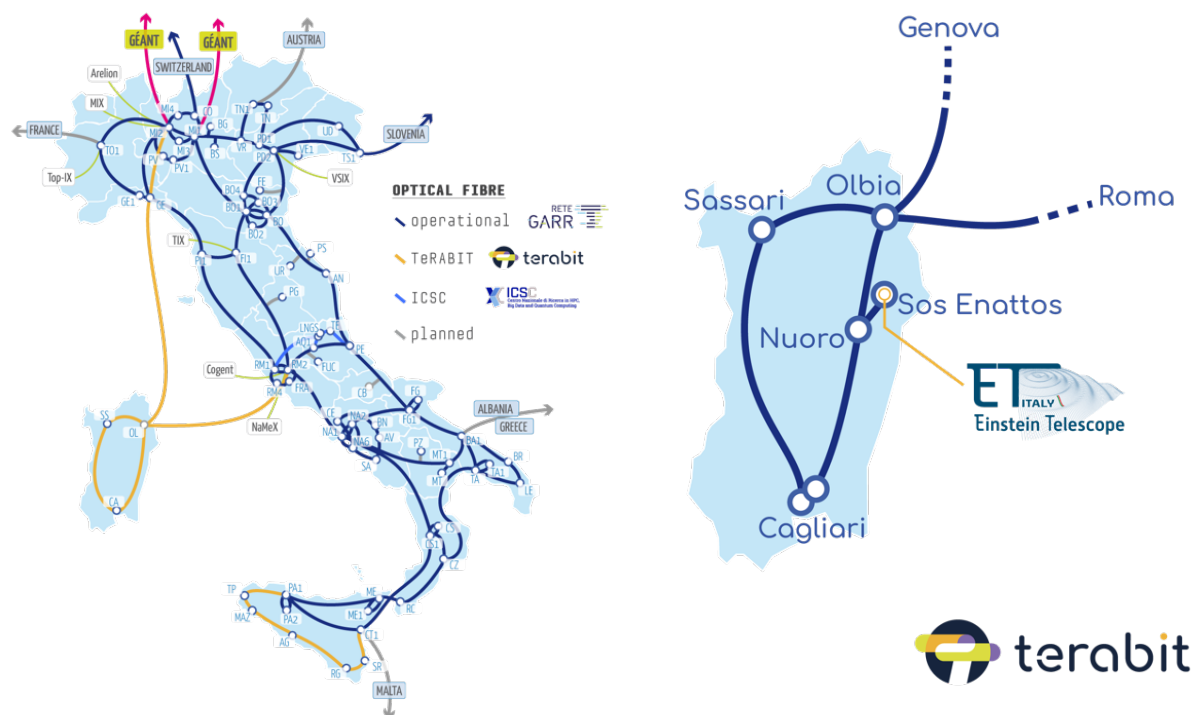


Figure 3 - GARR-T network and the upgraded GARR-T network in mid 2025 in Sardinia

Another strategic feature of the region is its scientific and innovative environment constituted by two universities and other research institutes. This system is clearly highly complementary with ET. It includes the University of Sassari, the University of Cagliari, the SAR-GRAV research centre in Sos Enattos, the ARIA project carried in a decommissioned mine, the Sardinia Radio Telescope, the Space Propulsion Test Facility, the Sardinia AeroSpace District, the sic centres of the National Research Council, the agency Sardegna Ricerche, the Porto Conte Ricerche, and CRS4.

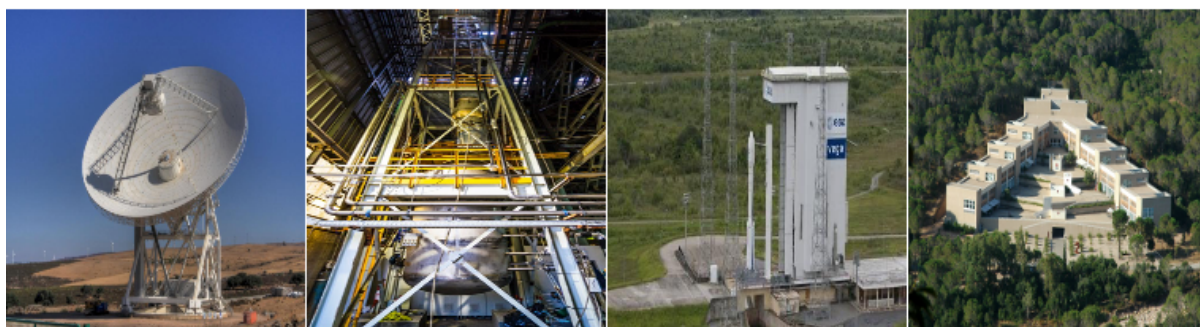


Figure 4 - Photo: The Sardinia Radio Telescope, the ARIA project, the Space Propulsion Test Facility, and the CRS4

3 Economic impacts

The ex-ante assessment of the economic impact of ET located at Sos Enattos was firstly conducted by the University of Sassari in 2020 and recently updated in a study conducted by a group of economists from several Italian universities and coordinated by the economist Luigi Guiso. These studies quantify the economic returns deriving from the initial investment of the construction phase as well as those generated by the annual budget for the operating phase.

The construction and operation phases of the ET project will generate a demand for goods and services over time, stimulating production and affecting total output, value-added, and employment across many industrial sectors in different geographic areas. This demand effect propagates through a multiplier mechanism. For instance, the construction phase. The initial effect is given by the demand for goods and services demanded by the organisation responsible for the construction of ET. The magnitude of this initial demand shock will be determined by the value of bids/tenders for procuring the necessary goods and services. In turn, the suppliers contracted by the agency will demand intermediate goods and services, including labour. These intermediate goods and services will be supplied by other suppliers, including households that offer labour, which may demand additional goods and services from other producers as their collective income increases. In this way, the initial demand shock propagates along the supply chains and through different sectors of the economy according to a multiplier mechanism, generating an indirect impact. Accordingly, the overall demand effect will exceed the initial stimulus by some multiplier factor. Similar logic applies to the operational phase. The organisation managing ET will demand goods and services to operate ET. The suppliers of these services will demand intermediate goods and services provided by other producers and labour supplied by households, giving rise to a multiplicative process.

The demand shocks of both phases equal to the costs that have been estimate by the ET scientific community as follows:

- Construction phase: 1,562.0 M€
- Operating phase: 57.8 M€

These costs are used to quantify the overall economic impact of ET which includes:

- i. The direct impact, which is measured by the value of goods and services, including labour, produced by the firms contracted by the organisations responsible for the construction or functioning of ET.
- ii. The indirect impact that corresponds to the value of intermediate goods and services, including labour, demanded by subcontractors and other suppliers along the supply chain.
- iii. The induced impact due to the additional induced effects of household income generation through payments for labour services and the associated consumer expenditures on goods and services produced by the various sectors.

The economic impact of both ET phases are assessed according to the following dimensions:

- i. Total output, which captures the overall potential increase in the level of economic activity.
- ii. Value-added, which measures the effect on the production of final goods and services and serves as an estimate of the contribution to GDP.
- iii. Employment, which measures the potential increase in employed workers.

The impacts discussed occur across various geographic scales, including local, regional, national, and international levels. This is largely due to the unique characteristics of large-scale projects like ET, which require extensive facilities and advanced high-tech equipment that only a few companies worldwide can supply. Consequently, while local and regional firms are well-positioned to provide some of the necessary goods and services during both phases, national and international companies also play a significant role in ET's procurement process.

3.1 Economic impact in the construction phase

The direct impact over the 10-year construction period, given by the yearly flows of initial demand for goods and services demanded by the organisation responsible for the construction of ET, equals to the construction cost. The indirect and induced impact derives from the further demand for intermediate goods and services along the supply chain that the suppliers contracted trigger. Overall, the total impact on output, which measures the potential increase in production during the construction of ET, equals 5,817.5 M€, associated with a multiplier of 3.72 per euro spent. The contribution to GDP, captured by the impact on value-added, amounts to 2,196.5 M€. The potential increase in employed workers is estimated at 33,221 FTE units due to increased economic activity. Finally, the construction will also have a significant impact on imports of about 582.8 M€. About 30%-40% of the estimated impacts is expected to take place at the regional, while the remaining 60%-70% is expected to spread at the national and international level.

3.2 Economic impact in the operating phase

Similarly, the yearly direct impact, given by the yearly flows of initial demand for goods and services demanded by the ET operating activities, equals to the ET annual running cost. The indirect and induced impact derives from the further demand for intermediate goods and services along the supply chain that the suppliers contracted trigger.

The overall yearly impact on total output 204.21 M€, implying an output multiplier of 3.53. Furthermore, the investment is expected to contribute 79.58 M€ in GDP- or value added- each year. In addition to its impact on the national territory, ET's operation will also imply about 17.63 €M per year of imports, stimulating economic activity outside the country. The employment prospects are equally encouraging, with the project anticipated to sustain almost 1,202 FTE positions annually translates to a ratio of nearly ≈ 21 FTE jobs per M€ expenditure, showcasing the project's strong employment stimulus effect. The expected share of these impacts to remain within the hosting region of Sardinia is between 50% and 60%, while the remaining 40% to 50% of the impact should spread across Italy and abroad.

4 Spillover and social impact

The operating phase of large research infrastructures such as ET generates also social impacts whose ex-ante estimation is challenging. Such type of impact mainly refers to the impacts that ET will have on the scientific community, young scholars, firms (especially suppliers), and the society overall.

4.1 Scientific Impact

In the case of the scientific community, the most obvious effect will be the scientific production of the researchers involved in the ET collaboration, taking into account the growth of the community in the future, the number of publications and citations generated and the cost of producing them. The ET will significantly foster the advancement of scientific knowledge in physics, but also in many related fields. By accessing and analyzing unique data, scientists and researchers working at the interferometer and their teams will produce reports, working papers and peer-reviewed publications contributing to the progress of scientific knowledge. However, the social value of a piece of knowledge produced is not confined to the social value of a publication per se; it also includes a “ripple effect” corresponding to the influence of that piece of knowledge within the scientific community. The ET scientific community is expected to, initially composed by 1,730 members³ (November 2023), suggests an increase of about 162 members⁴ per year. The overall number of publications produced over the 30-year operating period is estimated to be about 5212.

4.2 Human capital and skill development

The involvement of young scholars is also key in evaluating the impact of ET, as it represents the most important source of production of human capital and skills. PhD students and/or postdocs using the ET facility will have a unique opportunity for advanced training, which, in turn, should affect their employment opportunities. Better employment can be proxied by salary premia. The estimates annual salary premium for young scholars that gain work experience at ET is 2.428 €.

4.3 Knowledge and technology transfer

Firms cooperating with the ET facility will also benefit, especially suppliers in the construction phase. As science projects require very sophisticated (and sometimes unique) components, it is reasonable to expect the suppliers to have to innovate. Innovation is often measured by patents, but patents are a very imperfect measure of innovation and, in the case of large RI, not very informative (low numbers of patented inventions, but important learning processes). Indeed, RIs procurement has a positive impact for the supplying companies, ranging from the acquisition of new knowledge and technical competencies, development of new products, entry in new markets and reputational impact.

³ Data source: ET Members Database (ETMD). Data updated at October, 10, 2024.

⁴ Considering that the constant and linear growth rate for LIGO&VIRGO is equal to 0.0936, for the ET scientific community we have $1,730 \times 0.0936 = 162$.

4.4 Scientific attractiveness

Finally, a large facility such as ET, will not go unnoticed by the community both local and international. Unique facilities such as this become very often also a tourist attraction as they promote different types of outreach activities. ET is expected to attract 7000 visitors per year.

4.5 Other social impacts

The social impacts discussed so far do not exhaust all the effects that the literature associates with facilities such as ET and may thus underestimate their overall contribution. Important additional effects concern the benefits of patenting by scientists, research spin-offs, local services, and foreign direct investment. Knowledge creation by the research activities at ET can lead to patenting, which may have far-reaching implications. Once codified and protected through the registration of the corresponding patent, a piece of knowledge can generate a private return to the inventor but also broader knowledge spillovers to society as others can build on that codified piece to produce more knowledge.

Research facilities like ET have also been shown to foster the creation of spinoff companies. These spinoffs add social and economic value, in particular to the areas hosting the facility. The added value derives from a “pull effect” originating from the market opportunities created by the facilities and a “push effects” driven by the highly innovative activities taking place at the facilities.

Moreover, the operation of a facility like ET requires the local availability of all sort of specific services, such as high-speed internet connections and high-quality electricity supply. Once made available to the facility through the deployment of the corresponding infrastructures, those services become also available to all stakeholders in the local community without any further investment.

Finally, the last effect worth stressing concerns the role that the construction and operation of ET can play in attracting FDI to the area where it will be located. The foreign companies involved tend to be leaders in high-tech sectors and set up branches close to the research facilities with the aim of exploiting the market opportunities offered by their construction and operation. The products and services offered by those companies meet the research facility’ specific needs and standards that are not satisfied by domestic suppliers, such as communication systems, machinery, materials, and so on.

5 The local social impact

Besides the social impacts mentioned above, there are further social impacts which mostly affect the local community that live in the surrounding area of the ET site of Sos Enattos. To understand and assess such impacts a survey was administered to the local inhabitants of this area to identify above all the positive impacts on the territory and in the local community.

Sos Enattos surrounding area is mostly a peripheral and marginalized area which is experiencing population decline, high unemployment level, and a progressive decrease in services to the population like social and health services, and infrastructure connections. The creation of ET in an area that is in the spiral of marginalization can represent an important trigger to reverse the trend of the territory. The arrival of new, highly qualified inhabitants, accompanied by families, can increase:

- the demand for citizenship services, which can be organised in an integrated manner with respect to services for the local population;
- the demand for housing, which can move the local real estate market, both for sales and rentals, bringing opportunities for the valorization of the local real estate assets and income for the inhabitants;
- demand for commercial services, relating to the consumption needs of the new population, primarily digital services, for which it will be necessary to better infrastructure the territory. This too is an important opportunity to provide families and businesses in the area with fast connections and to reorganise some services thanks to digitalization.

ET, therefore, can intervene on at least two inversion points of the spiral of marginalization: it introduces a new population into the area, increasing the number of people requesting services and the average per capita income, bringing dynamism to the local economy; furthermore, for ET to attract researchers from all over the world, it is necessary to provide the territory with services, which can be designed in an integrated way with respect to the needs of the local community.

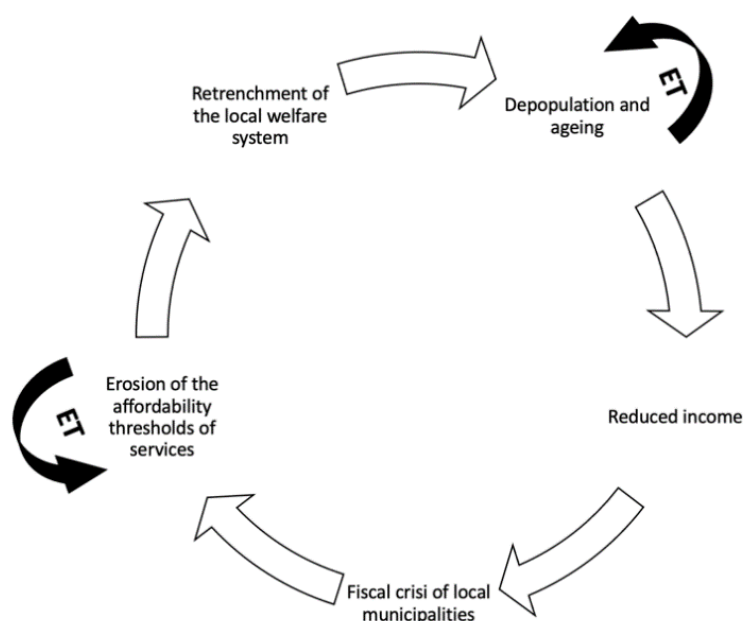


Figure 5 - ET reversal points

Some material and immaterial impacts of ET are already seen in the local community. The preparatory activities that local authorities are implementing to strengthen the territory in the face of the possible arrival of ET are already having effects on the local community. ET is bringing together local municipalities to outline development strategies for the coming years. Having such

an important objective pushed the mayors to work together and define large-area policies together. For instance, the MediAree – Next Generation City project aims to build multilevel governance tools for strategic planning at a large area level and to equip the territory with common policy tools and technical skills for development planning. Moreover, after years of conflicts and tensions around the issue of wind power and more generally around the prospects for territorial development, ET acted as a mediator between local actors and organisations, bringing together businesses, environmentalists, trade unions and agricultural organisations on a idea of the future of the territory that puts the ET project at the centre. ET would be able to promote local development, protect the landscape from large wind farms, force different stakeholders to converge around a sustainable development strategy, and provide temporary and long-term employment.

Overall, ET enjoys an important reputation in the area. Both citizens and local administrators are convinced that ET represents an opportunity for improving living conditions in the area. Expectations are very high and the population appears to be aware of the type of project, its aims and possible impacts. The good level of information of the population, however, must not be a point of arrival, but rather a starting point. The institutions now have the task of strengthening ET's reputation by implementing institutional initiatives to inform and involve the population.

SOURCES

Einstein Telescope - An evaluation of the Economic and Social Effects of a New Research Infrastructure (Guiso L. et al., 2025, to be published)

Einstein Telescope: An assessment of its economic, social and environmental impact in Sardinia (Atzeni G. E. et al., 2020) <https://zenodo.org/records/3895752>

ESFRI proposal and roadmap, Italian Government, (2020)

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LIST OF ACRONYMS

Einstein Telescope - ET
 Istituto Nazionale di Fisica Nucleare – INFN
 Istituto Nazionale di Geofisica e Vulcanologia – INGV
 Istituto Nazionale di Astrofisica – INAF
 European Strategic Forum on Research Infrastructures – ESFRI
 Research and Development - R&D
 High Performance Computer – HPC
 European Organization for Nuclear Research – CERN

