



**Montenegro**  
**Ministry of Science**

**MONTENEGRIN RESEARCH  
INFRASTRUCTURES ROADMAP  
2015- 2020**

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## Contents

Executive summary .....	4
1. Introduction .....	5
1.1. Definition of research infrastructure .....	5
1.2. Purpose of the Roadmap .....	6
1.3. Implementation of the Montenegrin Research Infrastructures Roadmap.....	7
2. National Research Infrastructure Overview and Priorities .....	8
2.1. National priority areas .....	9
2.1.1. Energy .....	9
2.1.2. Information and Communication Technologies .....	10
2.1.3. Agriculture and food .....	10
2.1.4. Medicine and health .....	10
2.1.5. Sustainable development and tourism .....	11
2.1.6. New materials, products and services .....	11
2.2. Financial instruments for RI development in Montenegro .....	11
2.2.1. Higher Education and Research for Innovation and Competitiveness Project (HERIC)..	12
2.2.1.1. BIO-ICT project - the first Centre of Excellence in Bioinformatics.....	14
2.2.1.2. Collaborative R&D projects- Grants.....	15
2.2.2. The establishment of the first Science and Technology Park and innovative- entrepreneurial centres (impulse centres) .....	19
2.2.3. Projects funded by EU programmes .....	21
2.2.4. Other projects related to the research infrastructure .....	24
3. Pan-European Research Infrastructures .....	26
3.1. eLIXIr - European Life-Science Infrastructure for Biological Information .....	26
3.2. eMBrC - European Marine Biological Resource Centre.....	27
3.3. EURO-BIOIMAGING - European Research Infrastructure for biomedical imaging .....	28
Appendix .....	29
ANNEX – LIST OF CAPITAL EQUIPMENT AT PURCHASE PRICE HIGHER THAN 50,000.00 EUR.....	29

## **Executive summary**

The main objective of the Roadmap is to define and present the priorities and potentials of Montenegro in the field of research infrastructures (RI). By its content, the Roadmap is complementary to the Strategy for scientific research activities in Montenegro for the period 2012-2016, in the first place, but also to the other strategic and legal framework in the area of science and research up to 2020.

The Roadmap provides a comprehensive overview of the current and planned activities at the national level, related to the RI field, their synergy and effective distribution of available funds, to serve as the focal point for governmental authorities in order to make future plans for RI investment at national and international level and direct RI development. Thus, this document provides a level of predictability and understanding of the national plans, as well as monitoring the implementation of public policies and objectives in the RI field.

A coordinated approach to RI investment encourages greater collaboration between public and private bodies/organizations and researchers, stimulating multidisciplinary research and fostering linkages. This in turn facilitates entirely new research outcomes.

The document is not legally binding and is a living document which means that it will be continuously updated in accordance with the new plans, goals, activities, and availability of funds.

# 1. Introduction

## 1.1. Definition of research infrastructure

The definition of “research infrastructure” which is used through this document corresponds to the one used for the research infrastructure action within the EU Framework Programme for Research and Innovation - Horizon 2020 (2014-2020).<sup>1</sup>

The Regulation on Horizon 2020 defines research infrastructures as facilities, resources and services that are used by the research communities to conduct research and foster innovation in their fields. Where relevant, they may be used beyond research, e.g. for education or public services. They include major scientific equipment or sets of instruments; knowledge-based resources such as collections, archives or scientific data; e-infrastructures, such as data and computing systems and communication networks; and any other infrastructure of a unique nature essential to achieve excellence in research and innovation. Such infrastructures may be 'single-sited', 'virtual' or 'distributed'.

Among the scientific domains, there is no general classification upon class sizes of research infrastructures. Within this document, the following categorisation will be used:

- "large research infrastructures" describing infrastructures in which it is possible to perform all the research activities in individual research processes in the scientific field of the research infrastructure, while at the same time, they operate as units with their own administrative structure;
- "medium-sized research infrastructures" enabling performance of individual or several phases of the research process or (as, for example, regional centres) are to be integrated into large research infrastructures as their integral part; and
- "small research infrastructures" enabling only the execution of individual tasks within research processes and provide support for those tasks.

These notions encompass data infrastructure, presenting the framework of data, metadata, standards and tools integrated in mutually dependent manner that ensures their processing, distribution, maintenance, supplementation and usage for further scientific and research work.

Research infrastructures are of the national strategic importance for the respective area of science. It also makes key contributions to enabling top-level research in the respective research areas, and so often it has a key importance for the excellence of such work and for conducting the most demanding research. Therefore, it is widely accepted that public R&D investment plays a significant role in building innovation capacity and driving productivity.

Investment in construction and development of the most modern research infrastructure do not present just expenditures for the states, but also a measure of encouragement of research, innovation and economy, since they most often involve development of unique, as of yet unknown technologies, methods and solutions, directly influencing the structure and

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<sup>1</sup> Article 2, Paragraph 6 of the REGULATION (EU) No 1291/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 establishing Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020) and repealing Decision No 1982/2006/EC

competitiveness of their economy. Furthermore, their operation, in addition to the importance it has for the scientific progress, significantly supplements the capability of the economy to create higher added value and technologically more demanding products and services.

Thus, infrastructures are among the first conditions for enrichment of knowledge and development of all sciences. Also, they present the flagships of science and progress, highlighting scientific and technological achievements, and contribute to the popularisation of science and to the attracting of young talents to the research profession.

With available R&D resources, Montenegro needs to target its investment in research infrastructure focusing on the priorities on both levels, national and international. This Roadmap is primarily related to the national research infrastructure from the medium to the large scale, identifying capacities likely to have a strategic impact on the research and innovation in Montenegro.

## **1.2. Purpose of the Roadmap**

The Roadmap has been developed through extensive consultation with the research sector to identify strategic priorities for Montenegro over the period 2015-2020. It relies on national strategic documents related to the infrastructure planning and investment in recent years.

The Roadmap presents coordinated and consistent approach, with the aim to:

- To support the decision-making process in compliance with strategic priorities in research, aiming to enhance the effectiveness of investment planning for research infrastructures, at national and regional levels;
- To support the development of an evidence-based national strategy, linked to EU priorities, particularly to the European Strategy Forum on Research Infrastructures (ESFRI).

Large scale and medium-sized infrastructure is in the national interest and of the long-term strategic importance for development of research area of Montenegro, having potential to become significant in respected field at the European level. Involvement and participation of the research teams from Montenegro in international RI projects is of the crucial importance for strengthening and developing national RI, and providing support and linking with relevant international partners.

The Roadmap covers six years period, but it is a living document which will be periodically updated. Therefore it is recommended that consultative road-mapping is undertaken approximately every three years.

### **1.3. Implementation of the Montenegrin Research Infrastructures Roadmap**

Successful implementation of Montenegrin Research Infrastructures Roadmap requires several steps;

- to identify strategic directions for the development of infrastructure on national level;
- to enable the use of available EU funds and programmes for recognized projects aimed at improving and building the research infrastructure;
- to encourage institutions to cooperate in planning and implementation of major infrastructure projects of national significance in order to avoid overlapping and to increase investment efficiency;
- to coordinate research infrastructure investment policies;
- to set out performance monitoring of public policies and investments in science;
- to lay the groundwork for long-term investment planning for major research infrastructure available to the research community; and
- to harmonize the principles of use and integration into Pan-European infrastructures.

## 2. National Research Infrastructure Overview and Priorities

The main objective of the Montenegrin Research Infrastructures Roadmap is to identify:

- the state of the existing infrastructures at national level,
- the opportunities arising from the new research infrastructures, and
- the benefits for the research community, and broader for the economy and society as a whole.

This overview is prepared in accordance with the ESFRI<sup>2</sup> Roadmap and identified needs and priorities at national level in Montenegro.

In order to develop an integrated framework of the research infrastructure in Montenegro, a particular attention is put on the priority research areas and identification of the long-term objectives for achieving the critical research infrastructure and directions of Montenegro in the field of research and development (R&D).

The Government of Montenegro adopted the *Amendments to the Strategy for scientific research* (2012-2016) in order to achieve compliance with the new Law on Scientific Research Activity (2011), which introduced new instruments for development of the scientific research system that did not exist in the previous version, i.e. possibility of establishing the new RI, such as centres of excellence, science and technology parks and innovative-entrepreneurial centres.

One of the long-term objectives in the field of the national research infrastructure is to create a unique institutional framework in the form of the Centre of Excellence (CoE), achieving the critical mass of the RI and scientific excellence through interdisciplinary research, involving international research partners and partners from the industry, in order to follow the EU standards in the RI development.

The creation of the first Science-Technology Park in Montenegro and Innovative-Entrepreneurial Centres will create conditions for strengthening cooperation between scientific research institutions and private sector. This should enable public-private partnerships in terms of working on R&D projects and enhance innovation activities, resulting with new and innovative products and services.

In addition, the Ministry of Science conducted the *Study of existing research capacities and capabilities for creation of common research area, in order to map existing infrastructure and needs of Montenegrin research community*. The study has shown that the research equipment and data infrastructure in Montenegro is dispersed. At the national level, the overview of the interconnection of this equipment, which would attain the critical mass of the medium-sized or large research infrastructure centers, is not appropriate. Some particular equipment and data infrastructure among institutions are duplicated, and in some cases, even duplicated within an institution.

Optimal use and sharing of research equipment and infrastructure between scientific research institutions are one of the biggest challenges that domestic research teams are facing with.

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<sup>2</sup> The strategic goals and prioritisation of support to ESFRI Roadmap used in this document corresponds to the latest document established on 7<sup>th</sup> April of 2014.



Optimization and effective management of research resources will contribute to the increased productivity and more effective expenditure of funds.

Through this study, as well as through some international initiatives (WBC-INCO.NET project, WBC-INNO project), an inventory of large and medium-scaled research infrastructure has been created.

In order to overcome fragmentation, poor transparency and inappropriate utilisation of current capacities, main objectives are:

- increasing visibility and promoting of the existing RI;
- creating the rules for joint use and sharing the RI; and
- establishing the virtual infrastructure node.

Regarding the establishment of the virtual infrastructure node, the Ministry of Science has already undertaken the activities on upgrading the national research information system (Science Network of Montenegro), with integrated data about research infrastructure. The platform will be available in 2016, and presented in easily reviewable manner. It will present data on available equipment within the scientific research institutions, including those offered for collaboration purposes (for each interested scientific research unit /lab/ department/ institute/ faculty), with appropriate contacts of persons responsible for the listed equipment.

## 2.1. National priority areas

Based on the proposal of the Council for scientific research activities in 2011, the Ministry of Science defined 10 research priorities with their specific research subareas, which is strategic orientation of Montenegro in the field of R&D in long term period. The identified priorities are: Energy; Identity; Information and Communication Technologies; Competitiveness of the national economy; Medicine and health; Science and education; New materials, products and services; Sustainable development and tourism; Agriculture and Food; and Transport.

Among the above priority areas of research, the Council for Scientific Research Activity identified areas of research that are of particular importance for the short-term development of Montenegro, such as: **Energy; Information - Communication Technology; Medicine and health; New materials, products and services; Sustainable development and tourism; Agriculture and Food.**

In the last two years, the Government and the Ministry of Science significantly increased their support for development of these areas as the major topics in the field of research, technology and innovation. These areas are in line with EU policy actions recommendations and initiative. Montenegro put special emphasis on: applied and developmental research, strengthening the links between science and industry, as well as the innovation that will largely contribute to the development of not only science, but also development of Montenegro in general.

### 2.1.1. Energy

Development of new technological solutions leading to more cost-effective, environmentally acceptable and reliable energy production. Research devoted to improvements in energy conversion efficiency and reductions in the cost of electricity production from renewable

energy sources (hydro potential, wind, thermal-solar, and biomass). Research into new technological solutions that include energy efficiency and energy saving. Research devoted to increasing the efficiency of multiple energy sources. Research that may constitute a quality basis for the promotion and development of strategic documents in the field.

### **2.1.2. Information and Communication Technologies**

Research leading to the development of health-care system, extending the life/ working life of the population and improving the living/working conditions of persons with disabilities. Research that contributes to increasing the competitiveness of our business environment in terms of faster adaptability, better integration and economic sustainability. Development of technological solutions that imply safer means of transport. Research in the field of ICT, services and infrastructure of the future that presents the innovation basis for development of the technology sector in Montenegro. Scientific projects related to the resolution of problems related to the performance of electronic communications infrastructure, information protection, control of content for sensitive groups of the population, and the development of services adapted to the needs and requirements of users. Developing new skills of the population using the cultural resources, which should be made widely available and efficient through ICT.

### **2.1.3. Agriculture and food**

Research aimed at conservation, protection and sustainable use of genetic plant and animal resources in agriculture. Research that are, through conventional and molecular breeding methods, in addition to identification, aimed at obtaining productive varieties / clones / hybrids / breeds that will serve as the basis for production of healthy food. Research that will contribute to a better exploitation of potential resources for food production aimed at better use of land, water and models of protection from diseases and pests with modern information support and control. Research aimed at more effective and safer healthy food production, especially organic. Research devoted to increasing and improving the quality and safety of production of food, medicinal and aromatic plants. Research into aquatic, particularly marine, food production. Research that contributes to the development of new products in the Montenegrin food industry using domestic resources (raw materials). Research aimed at improving control-monitoring with a view to increasing the efficiency and profitability of production while preserving the environment. Research aimed at development of the rural economy, with special emphasis on farm management. Research into forest complex of Montenegro.

### **2.1.4. Medicine and health**

Research into diseases that tend to increase in the population of Montenegro (cardiovascular, oncology, diabetes and other chronic diseases). Research into diseases whose socio-epidemiological, preventive, diagnostic, therapeutic, rehabilitative and predicting approach is based on modern, sophisticated methods, techniques, requirements and approaches. Research into diseases, which will provide an individualized determination of therapy for each patient. Research that opens the possibility of cooperation with primarily non-medical disciplines. Medical research that meet the principles of compatibility with global health and medical scientific trends. Research that provides an insight into the processes that take place at subcellular level in physiological and pathological processes. Research into morphology, function and condition (or existence of disorder) of normal, altered and malignant cells. Research into functioning of organs in various diseases and / or experimental models.

### **2.1.5. Sustainable development and tourism**

Research aimed at studying, protecting and branding biodiversity of Montenegro. Research into environmental protection and natural resources management in terms of sustainable development. Research aimed at touristic valuation of space and activating less exploited areas in accordance with the rules of sustainable development. Research into development and application of tools and technologies for monitoring, preventing, and mitigating consequences of threats to the environment and human health in particular. Research into climate change and its effects on the environment. Research aimed at developing the system of predicting and managing weather, seismic and other environmental risks. Research directed toward the development of the technology needed to ensure the safety of citizens from threats such as natural disasters and industrial and other incidents.

### **2.1.6. New materials, products and services**

The development of new materials, products and services with high added value, with particular emphasis on the application of nanotechnology and biotechnology. Synthesis and characterization of “smart” materials for specific purposes. Development of new products for medicine, pharmacy and public health. Development of new market-competitive materials and products based on domestic natural resources.

The abovementioned priorities are in line with the Montenegro Development Directions (2015-2018). This is one of the most important strategic documents for Montenegro, which identifies 4 priority development sectors of Montenegro:

1. Tourism,
2. Energy,
3. Agriculture and Rural Development and
4. Manufacturing Industry.

In the framework of the basic directions of development (smart, sustainable and inclusive growth) and policy areas, key measures, projects and way of their funding have been identified. Science is one of the priorities of the Smart Growth.

## **2.2. Financial instruments for RI development in Montenegro**

Scientific research activities in Montenegro are financed from the following resources: the Budget of Montenegro, Capital budget, budget of the scientific research institutions, private sector investment, EU funds (IPA, HORIZON 2020, EUREKA, COST) and other international funding (UNESCO, IAEA, ICGEB etc.). The realization of the common interests and strategic objectives in the science, research and innovation in Montenegro is mainly based on the national state funding, mostly from the budget of the Ministry of Science (MoS). This support is mainly related to the financing of the programmes of general interest, and programmes for strengthening cooperation at international level. Also, commercialization of knowledge, innovation activities and transfer of the new technologies are encouraged and co-financed by different programmes to support technology development and innovation in SMEs and to promote modern entrepreneurship.

For the set-up of the research infrastructure in priority areas, strong inter-ministerial cooperation has been established, as reflected by the announcement of a call for proposal co-funded by seven ministries to finance national research projects for the period 2012-2015, with a budget of €5 million. In this case, the MoS is responsible for the coordination of the preparation, monitoring and administration of 104 selected projects.

One of the main funding instruments used to develop RI capacities, is the project HERIC (Higher Education and Research for Innovation and Competitiveness Project), introduced in 2012 and financed by the World Bank loan.

In addition to this instrument, it is necessary to create adequate environment for cooperation between research and business sectors. In this sense, through the establishment of the first Science-Technology Park in Montenegro and Innovative-Entrepreneurial Centres in different regions of the country, will create ground for more investments and develop new infrastructure that will strengthen this cooperation and would have potential to join international RI initiatives.

In order to encourage science, research and innovation, Montenegro will continue to strengthen its institutional, administrative and financial capacities, in order to reach higher levels of public and private R&D investment, as well as increase the absorption of the EU funds, particularly Instrument for Pre-Accession Assistance (IPA), HORIZON 2020, EUREKA and COST, but also other international funds.

Current activities, aiming at the improvement of the national research infrastructure, are focused on financing and implementation of the research projects at the national and international levels. Due to funding sources, the projects can be divided into two major groups: (i) projects funded from the Montenegrin budget and (ii) EU and other international projects.

In the following paragraphs, the overview of the on-going and completed successful projects is presented. The overview is made in accordance with the categorisation commonly used in ESFRI Roadmap and priority research areas of Montenegro.

### **2.2.1. Higher Education and Research for Innovation and Competitiveness Project (HERIC)**

Strengthening the human resource and research infrastructure capacities is a pre-requisite for effective participation in the EU framework programmes and for integration into the European Research Area. The *Higher Education and Research for Innovation and Competitiveness Project* (HERIC) project is an important instrument for promotion of the large-scale improvements in Montenegro's higher education and research sectors and will strengthen national R&D system in order to create better links between universities and businesses.

The Government of Montenegro implements this project, through the Ministry of Science and Ministry of Education, supported by the World Bank loan of 12 M € in a period 2012-2017.

*The HERIC Project development objective is to strengthen the quality and relevance of higher education and research in Montenegro through reforming the higher education finance and quality assurance systems and by strengthening research and development capabilities.*

The HERIC Project is composed of four components:

1. Higher Education Finance Reforms and Implementation of Quality Assurance Norms;
2. Human Capital Development through Internationalization Initiatives;
3. Establishing a Competitive Research Environment;
4. Project Management and Monitoring and Evaluation.

These components are in accordance with two Government's initiatives: the Strategy for the Development and Financing of Higher Education and the Law and Strategy of Scientific Research Activity.

Legislation and regulations have been developed and adopted in these areas, and aim of the Project is to make some identified reforms into reality. In addition, HERIC Project is helping to deepen ongoing reforms and align them with the broader EU integration agenda. As Montenegro moves closer to EU accession, the Project is helping the Government to meet the EU's Acquis standards in the area of science and research, as well as to align its economic directions with the priorities expressed in the Europe 2020 Strategy.

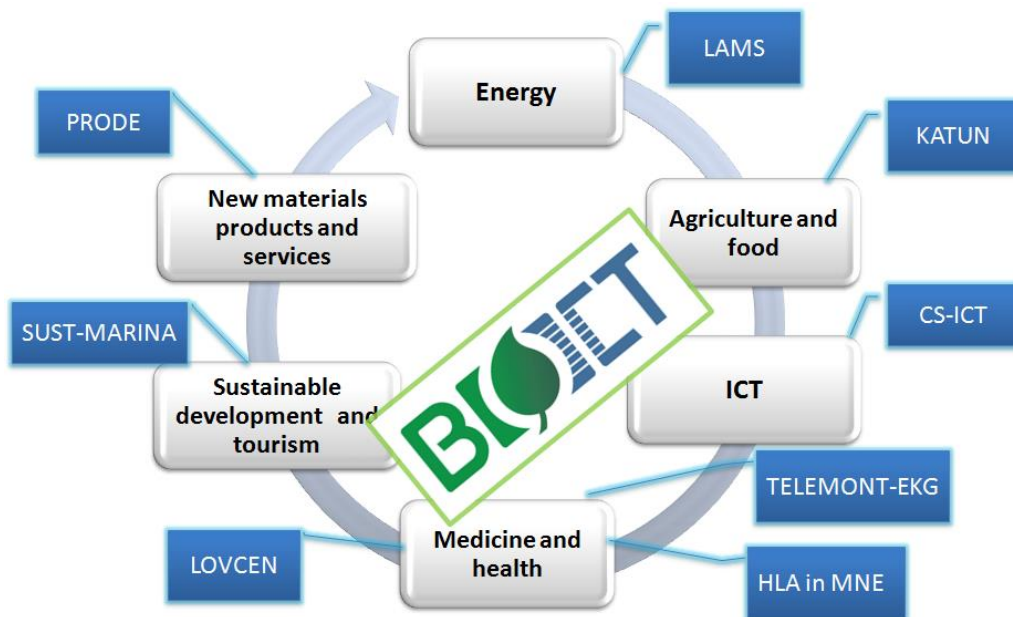
Through the HERIC Component 3 ("Establishing a Competitive Research Environment") are funded main research activities such as establishment of the first Centre of Excellence (CoE) in Montenegro and competitive grants for Collaborative R&D Subprojects (CRDS) financing.

Funds for this component are allocated with the following main goals:

- Foster an interdisciplinary approach to the research;
- Nurture collaboration with international research institutions;
- Ensure cooperation with the private sector in Montenegro or abroad; and
- Demonstrate a strong potential to generate commercial innovation through the commercialization of knowledge and intellectual property.

The pilot CoE is selected through a competitive process and the total awarded grant amount is 3,42 M€. "CoE in bioinformatics"- BIO-ICT will use the latest ICT technologies in agricultural and food production sectors, which are strategic priorities of the country's development (technologies in the areas of sustainable agriculture, monitoring of the crops, forest and water/sea ecosystem, development of techniques for controlling and reducing air pollution, analysis and standardization of food products, control of land quality, improvement in the public health area).

The Grants Programme supports projects that strengthen the Montenegrin economy with funds up to 0,4 M€ per project. Development of innovations, patents, commercial and other scientific results are financed, as well as development of new and existing laboratories. Grants support quality and sustainable partnerships that have potential to integrate research into mainstream economic drivers for Montenegro and to grow into the future centers of excellence. Also, selected grants are supporting research that will be competitive at the international level and supports scientific excellence and improvement of education for researchers in order to make Montenegro a desirable place for top scientists from abroad (including those from Diaspora).



Picture 1: Selected projects/grants for funding through the HERIC project

#### 2.2.1.1. BIO-ICT project - the first Centre of Excellence in Bioinformatics

BIO-ICT Centre of Excellence is the first Centre of Excellence in Montenegro, implemented as a three-year research programme led by the University of Montenegro - Faculty of Electrical Engineering, financed by the Ministry of Science of Montenegro with budget of 3,42 M € for the period June 2014-May 2017.

Partners on the project are four leading Montenegrin research institutions: Faculty of Electrical Engineering, Biotechnical Faculty, Institute for Marine Biology, Institute of Public Health; two international research institutions: St. Petersburg Scientific Research Centre for Ecological Safety and Centre for TeleInfrastruktura (CTIF); and two successful Montenegrin SMEs: COGI doo and Green House Jovović doo.

BIO-ICT project aim is the development of modular and state-of-the-art ICT platform in the areas of sustainable agriculture, monitoring of the crops, forest and water/sea ecosystem, development of techniques for controlling and reducing air pollution, analysis and standardization of food products, control of land quality, and improvement in the public health area. This open service platform will be scalable in order to be extended on other areas like health, transportation, smart cities, smart objects etc. The main applications that will be studied in the project are in the area of sustainable agriculture, monitoring of the crops, forest and water/sea ecosystem, development of techniques for controlling and reducing air pollution, analysis and standardization of food products, control of land quality, and improvement in the public health area. Delivering cutting edge results and novel products and services in these areas is possible through synergy between the FEE and national RSRI working in the area of life sciences. This multidisciplinary approach provides the means of resolving numerous issues in life sciences in Montenegro through the incorporation of the ICT solutions developed in Montenegro.

The implementation methodology of the BIO-ICT includes cutting edge research in the area of the ICT and life sciences (agriculture, health, ecology etc.). Results of the research will be:

- Development of 2 new laboratories at Faculty of Electrical Engineering and Institute for Marine Biology and upgrade of 4 with new equipment and facilities (EUR 1,5 M).
- Development of new tools and services based on the research results verified on the international level, and their commercialization.
- Strengthening of human resources and Montenegrin capacity in general, in these areas by recruiting number of young researchers trained on the international level.
- Research results will be verified through international journals and international conferences and they will result in MSc thesis and work on PhD dissertations. Some of these thesis and dissertations will be supervised jointly with international partners. Organization of conferences, summer schools, massive open on-line courses (MOOC - trend in higher education and science nowadays).
- Inclusion of two companies in consortium, which will benefit from products and services developed during the lifespan of the project. In particular, within the BIO-ICT, pilot facility will be created for sustainable smart agriculture for one of commercial consortium members.
- Establishment of one new commercial entity, owned by the BIO-ICT or as a joint venture. Other potential commercialization means will also be considered.

### **2.2.1.2. Collaborative R&D projects- Grants**

The Ministry of Science published two calls for R&D projects with long term goal is to help research institutions in Montenegro through the grants to raise the level of their research and laboratory equipment and to be ready in the future to achieve the status of Centre of Excellence. It resulted with 8 projects accepted for financing through the HERIC project with 2,6 M € til the end of 2017. Short description of the projects follows:

#### ***Project CS-ICT: New ICT Compressive sensing based trends applied to: multimedia, biomedicine and communications***

The concept of this project aims at establishing a widely recognized research laboratory which will be dedicated to the development of advanced signal processing algorithms and methods, and to the development of practical signal processing application in the collaboration with the partner institutions. This research grant (EUR 372k) will help the laboratory to become the main research innovation centre in the region, as well as a very recognizable institution in the world.

The main idea behind the project is to merge all research experience concentrated within the two research laboratories at the University of Montenegro-Faculty of Electrical Engineering. Further, with the help of all partners, the aim is to design interesting applications in order to become the most attractive and competitive laboratory for considered research field. The main goals of this project are focused to the development of new algorithms and techniques for compressive sampling/sensing and spectral analysis of signals. Compressive sensing aims to provide the possibility to acquire a significantly smaller amount of data, but to be able to achieve the same quality of the final information/representation as it is the case when the entire physical phenomenon is sensed according to the Sampling Theorem. Therefore, it is actually possible to simplify the very expensive devices and apparatus for data recording,

imaging, sensing (for instance MRI scanners, PET scanners for computed tomography, high resolution cameras, etc.).

The goal is to define new compressive sensing algorithms which will be amenable to practical applications, and then on the basis of these results to produce hardware based solution (using programmable logical devices) which will perform the functions of these algorithms. In the cooperation with the partners, the development and implementation of new techniques will be primarily for the applications in multimedia systems, biomedicine and communications.

On the basis of achieved results, aim is to produce a hardware based solution (using programmable logical devices) which will perform the functions of the developed algorithms. In the cooperation with the partners, we will be working on the development and implementation of new techniques primarily for the applications in multimedia systems, biomedicine and communications

Granted amount is 372.000 € and project implementation period is June 2014 - May 2017.

Institution - Coordinator: University of Montenegro-Faculty of Electrical Engineering

***Project PRODE: Lab for product design, including disciplines like graphic, interior and fashion design***

The main goal of the PRODE project is to create and develop a prototype laboratory that will become a local and regional centre for creating and developing prototypes for various products, such as products made out of cardboard, plastic, textile, wood, stone and marble.

An internal research has shown that there is no similar applied scientific research concept in Montenegro at the moment, which prevents creative ideas to be transformed into tangible and quality products and be further commercialized. Establishment of such laboratory will provide both individuals and companies with opportunity to give life to their ideas and more importantly to benefit from their commercialization. This will enhance individuals' employability and companies' competitiveness. Moreover, the laboratory will provide full support when it comes to commercialization and patenting activities, so there will be no risk for the idea holder that its idea will be compromised.

A key activity that will be undertaken during the project duration is related to establishing, organizing and equipping a professional prototype laboratory at University of Donja Gorica, which will become an academic and professional prototype and product development centre. Further activities are related to the laboratory utilization through prototype building, transformation of prototype into a final product, commercialization and patent activities, provision of sustainability, and dissemination activities.

The product design laboratory will help by producing a prototype of the packaging in accordance with the EU standards and offer it to Montenegrin and foreign producers.

Granted amount is EUR 337k and project implementation period is June 2014 - May 2017.

Institution - Coordinator: University of Donja Gorica - Faculty of Electrical Engineering

***Project LOVCEN: Surveillance of invasive and native mosquito vectors and pathogens they transmit in Montenegro***

Mosquito vectors and mosquito-borne diseases are raising threat to Europe, which impact strength is difficult to predict. The main infection sources are dependent on vector and



environmental factors; hence the best choice for prevention and control of diseases is surveillance and control of mosquito vectors. For this reason, their surveillance and control require efficient and appropriately standardized methods, integrated knowledge and awareness among researchers, academic educators and policy-makers as well as well-trained young scientists.

Project LOVCEN aims to promote all of these values and apply them in the field of vector mosquitoes and mosquito-borne pathogens (viruses, bacteria, protozoa and nematodes) and will lead to further improvement of the Montenegro Consortium Members (MCM) research and innovation capacities through collaborative research with prestigious European centers, exchange of experience and knowledge, strengthening of human, infrastructural and material resources, establishing the strategic international research partnerships on RTD in vector/pathogen surveillance and control, monitoring and predictions and getting prepared for Horizon 2020.

Granted amount is EUR 392k and project implementation period is June 2014 - May 2017.  
Institution - Coordinator: University of Montenegro- Biotechnical Faculty

***Project SUST-MARINA: Applying and promoting the concept of sustainable development to Marina***

In response to the growing need for marina sustainability, project will develop approaches and strategies that allow better planning and management of sustainable development in second ranking marina in Montenegro, AD Marina Bar in order to reach ISO certification and standards in water quality, environmental management, environmental education, safety and security. Also, some novel techniques in marina will be introduced such as: Oil pollution prevention from the vessels, Sewage collection from vessels, Electricity supply to the vessels in all commercial berths, Investigating noise measurements, Using biodegradable detergents for vessel washing, Investigate vessel emission of air pollutants, realization of cathode protection for docks, use of alternative energy resources such as photovoltaic and wind energy.

Granted amount is EUR 240k and project implementation period is June 2014 - May 2017.  
Institution - Coordinator: University of Montenegro - Maritime Faculty

***Project LAMS – Construction of monitoring station for lightning research on the mountain Lovcen***

LAMS project will create, develop and maintain a station for researching the lightnings on mountain Lovcen. The expected results are to obtain very significant measurement system for monitoring parameters of lightning current. The measurement system, together with the central server would operate completely automatically and in real time. The entire system is being based on the latest information, communication and measurement technologies. The developed software and modern communication technologies would have all the features of "Cloud Computing".

In the first stage of the project, measurement results would be delivered in real-time to the institutions that the project investors determine. In addition, the results would be available to faculties participating in project implementation.

Since the parameters of lightning current are of great interest at the international level, it is planned to link this system to the international networks and systems. Given that

measurement results are available in real time, they are of great importance to international organizations and institutions.

Key activity that will be undertaken during the project relates to the establishment, organization and equipping unique measuring station for researching the lightning, which will become an academic and professional centre for top scientists from the country and abroad, and encourage the performance and improving the education of researchers. Further activities are related to the use of monitoring station, commercialization and patent activities, ensuring sustainability and dissemination activities.

Granted amount is EUR 325K and project implementation period is April 2015 - March 2017.

Institution - Coordinator: University of Mediterranean – Faculty of information technology.

***Project KATUN: Valorising Montenegrin Katuns through sustainable development of agriculture and tourism***

The main goal of the KATUN project is to provide knowledge bases for sustainability of the mountain agriculture and to enhance its competitiveness, to preserve important part of the cultural heritage of rural areas and boost the agro-tourism at the katuns, as specific spots or nuclei for further social-economic development on Montenegrin mountains. KATUN will link mountain agriculture and new tourism initiatives for the benefit of the rural society and thus for the whole country. The KATUN project has holistic approach (multidisciplinary and comprehensive treatment of all the aspects of the katuns in line with rural society expectations to breathe new life into the katuns by high integration of the sustainable development of agriculture and agro-tourism) and in the outcomes (specific forms of knowledge transfer, new dairy products, new types of tourism offer and for the first time valuable data on cultural-historical heritage).

Granted amount is EUR 315K and project implementation period is April 2015 - March 2017.

Institution - Coordinator: University of Montenegro- Biotechnical Faculty

***Project TELEMONT-EKG: Development, validation and application of telemedicine system TELEMONTTEKG test for fast detection of heart diseases in Montenegro***

The content of the project is the development, validation and application of telemedicine systems TELEMONTTEKG (TM EKG) for the rapid diagnosis of heart diseases in Montenegro. The aim is that, during the project, the system develops by the first prototype of device, to conduct validation of the system, as well as to put into pilot use and patents.

Intention is, in the manner comfortable for the patient and reliable and informative for doctors, to record changes in heart rhythm that are important for assessing the state of health of the patient. TM EKG will assist us in discovering the cause of paroxysmal (intermittent) signs and symptoms that can be caused by dangerous cardiac arrhythmias to adults and children organism.

The project will enable rapid diagnosis of rare and dangerous heart arrhythmias, but will also provide urgent referral of patients to tertiary institutions where patients are quickly processed and treated. TM EKG allows extremely quick consultation with experts anywhere in the world, by simply transfer ECG (e.g. seeking second opinion).

Granted amount is EUR 315k and project implementation period is June 2015 - May 2017.

Institution - Coordinator: Clinical Centre of Montenegro

### ***Project HLA in MNE: HLA typing and HLA laboratory in Montenegro***

This project would have as a goal the establishment of resources and capacity in the health system of Montenegro for performing HLA typing and other immunological tests required for transplantation program in general and for HLA typing in general population.

Introduction of HLA laboratory would have the importance for population HLA typing, diagnosis of other diseases, not only for the preparation and selection of patients for transplantation. Endemic diseases that occur in Montenegro could be traced and monitored in this way. Such diseases could be due to HLA typing and immunological tests monitored with clinical and scientific point of view. It would get the results of the monitoring and movement of various diseases in Montenegro, which could be kept under better control and get to a very important scientific research results in the field of basic and clinical medicine that would Montenegro and its medical institutions have introduced not only in the system Eurotransplant, but in serious scientific research centres that contribute to the overall development of medical science.

Granted amount is EUR 315k and project implementation period is September 2015 - August 2017. Institution - Coordinator: Clinical Centre of Montenegro

### **2.2.2. The establishment of the first Science and Technology Park and innovative-entrepreneurial centres (impulse centres)**

The Ministry of Science of Montenegro implements the project of the establishment of the first Science and Technology Park (STP) in Montenegro in accordance with the “Feasibility Study for Establishment of the STP in Montenegro” and “Strategic Plan for Establishment of the First STP in Montenegro”.

The general objectives to be achieved by the establishment of the STP are as follows:

- Economic development of Montenegro by establishment of the STP as a generator of the SME development, in order to strengthen competitiveness of Montenegro in the wider economic context;
- Strengthening the cooperation between academic and research institutions, on one side, and private sector, on the other, in order to enhance innovative activities;
- Supporting the cluster connectivity of enterprises and/or institutions based on the principle of related activities and common market;
- Promotion of the concept of the sustainable establishment of the STP and other instruments of support to the entrepreneurship and development of the high value products at the territory of Montenegro; and
- Raising the general level of knowledge and awareness regarding development of centers of excellence, science and technology parks, innovative-entrepreneurial centres, business incubators, etc.

Pursuant to the “Feasibility Study” the general thematic focus of the STP should be on the following topics:

- Energy efficiency and renewable energy;
- Agriculture and food technologies;

- Information and communication technologies;
- Health and medical technologies;
- Wood processing; and
- Interdisciplinary research.

Regarding the organizational structure, it is basically planned to be divided into a central unit, to be based in Podgorica, and three innovative-entrepreneurial centres, so called impulse centres, to be based in Nikšić, Bar and Pljevlja.

The implementation of the STP project started with the activities on the establishment of **the Innovative-Entrepreneurial Centre "Technopolis" in Nikšić**.

The project "Technopolis" has been implemented by the Ministry of Science, in collaboration with the Ministry of Agriculture and Rural Development, the Investment and Development Fund of Montenegro, the Directorate of Public Works and the Municipality of Nikšić. Total investment in this project from the state budget for 2015 and 2016 will be EUR 1.7 million.

"Technopolis" will enable the generation and commercialization of the innovative ideas in a specific product or service, which then needs to be placed on the market, which is an ideal opportunity for all potential actors with good ideas and entrepreneurial spirit. In addition, the need to create conditions for strengthening cooperation between academic and research institutions, on the one hand, and the private sector, on the other hand, in order to strengthen the innovative activities. By its establishment, the conditions for a public-private partnership will be created in terms of working on R&D projects, and creation of innovative products and services. With the registration in the Central Register of Business Entities, the Innovative-Entrepreneurial Centre "Technopolis" began its work on 11 September 2014 in temporary business premises in Nikšić, provided by the Municipality of Nikšić, until completion of the reconstruction of the Army Centre in which it is to be placed permanently. The Board of Directors has also been constituted and began its operations. In addition, actual executive director has commenced work and will perform this function until the appointment of the executive director on the basis of a public competition. During 2014, three employees were hired in "Technopolis", while the engagement of 2 interns was approved through the Programme for Professional Development of Graduate Students for 2015.

The contractor started the construction work in the old Army Centre in Nikšić on 29 July 2015, planned to be finalized in 8 months.

The next step is the establishment of the central unit, **the Science and Technology Park in Podgorica**, in the period 2015-2018.

The STP in Podgorica will be established with the following objectives:

- To integrate entrepreneurial, innovative, scientific and business potentials;
- Create a strong connection with the local and regional business centres, incubators, clusters and voucher schemes; and
- To foster internationalization and commercialization of the research and to enhance request for consulting services, innovative products and services, business procedures, organization and marketing.

The STP in Podgorica will be focused on the following topics:

- Energy efficiency and renewable energy;
- Agriculture and food technologies;

- Information and communication technologies;
- Health and medical technologies; and
- Interdisciplinary research.

The preparatory activities on the Conceptual Solution and the Main project are underway. The project will be implemented by the Ministry of Science, in collaboration with the Municipality of Podgorica and other ministries.

The dynamics on the establishment of the innovative-entrepreneurial centres in Bar (2017-2019) and Pljevlja (2018-2020) will be determined in the forthcoming period.

The Innovative-Entrepreneurial Centre in Bar will be focused on the agriculture and food technologies and information and communication technologies.

The Innovative-Entrepreneurial Centre in Pljevlja will be focused on the wood processing.

### 2.2.3. Projects funded by EU programmes

The Seventh Framework Programme (FP7) covered research actions on several key sectors and played a key role in promoting growth, competitiveness and employment. Montenegro was associated to FP7 as from 2008 to 2013, through a Memorandum of Understanding signed in Brussels on 25<sup>th</sup> January 2008. Montenegro nominated observer member in the European Research Area Committee (ERAC) and followed closely the policy developments at EU level on research and innovation.

During the same period is completed or work in progress several projects that have great significance for the development of research infrastructure in Montenegro:

#### ***FP7 Project FOREMONT - Fostering innovation based research for e-Montenegro (funded under FP7-REGOT)***

Fore-Mont is an EU project, supported through Coordination and Support Action funding scheme, addressing FP7-REGPOT. Its budget in amount of EUR 1.4 million is over the period 2013-2016 and its beneficiary is University of Montenegro (UoM), through its Faculty of Electrical Engineering (FEE) which is an actor of excellence for education and research in the field of ICT in Montenegro.

Fore-Mont aims at strengthening the UoM (FEE)'s excellence by improving its research infrastructure, human resources fostering and long-term partnerships. The main objective of the Fore-Mont project is strengthening the development of University of Montenegro's innovative research performances in Information and Communication Technologies and applications.

The major tool of the project is the establishment of the Research Centre for Info-Communication Technologies (Centre), at the Faculty of Electrical Engineering (FEE). Through its operation, this Centre will enable better results of its researchers when working on a crucial project's topic: building a sustainable strategy, knowledge, and infrastructure to be able to support the development of e-Society for Montenegro.

The Fore-Mont project relies on 5 collaborative partners from 5 different countries all over EU: Centre for TeleInfrastructure (University of Aalborg), CEA-LETI from Grenoble, Ericsson Nikola Tesla Zagreb, Institut Jozef Stefan and iMINDs. Apart from that, the project is supported by 8 entities, from state authorities to SMEs, industries or regional organisations. This project will also support UoM (FEE) to integrate into ERA, becoming the major actor in ICT innovative research at national/regional level and a competent partner for Horizon 2020 projects. Finally, the project will create opportunities for the UoM (FEE) to be granted patents and to provide applied solutions and products in different domains which will reach expectations and demands of e-Montenegro development.

The project is still ongoing and 1st phase of the project implementation has been completed, marked with launching of the new Research Centre for ICT at the UoM (FEE). The Centre gathered different FEE research groups together with the recruited researchers and the synergy effects of their closer cooperation have been already visible. The Fore-Mont project created better infrastructure conditions through establishment of the new laboratory space and the level of knowledge of the researchers has been increased through various project activities, including seminars, workshops, secondments, and conferences. Also, main directions of the new Centre's research strategy have been adopted and a number of results of joint research efforts have been achieved, with the major one being the World Bank grant for the Pilot Project Centre of Excellence in Montenegro (Centre for Bio-Informatics). Consequently, it is considered as a flagship project of the Research Centre for ICT, having a major impact on UoM (FEE)'s positioning in the field of applied and innovation based ICT research at national and other levels.

### ***AGRISCIMONT - Fostering a Science-based Development of a Sustainable Montenegrin Agriculture (funded under FP7-REGOT)***

AGRISCIMONT is an EU project, supported through Coordination and Support Action funding scheme, addressing FP7-REGPOT. Its budget in amount of EUR 1.2 million was over the period 2010-2016 and its beneficiary is University of Montenegro (UoM), through its Biotechnical Faculty in Podgorica (BTF).

The Biotechnical Faculty in Podgorica (BTF), as a member of the University of Montenegro with longest research tradition, performs a very wide range of researches in dialogue with decision-makers (partner of the Ministry of Agriculture for food control and policy drafting) and directly or via extension services with many end-users (primary agriculture, processing industry, input suppliers).

The AGRISCIMONT project (42 months), funded under the EC Seventh Framework Programme (FP7), aimed at strengthening BTF's excellence through technological, human and partnership fostering and a reorganization around 3 interdisciplinary research areas (food and feed safety, agro biodiversity conservation and agro-analyses) to converge towards excellence on "Fostering a Science-based Development of a Sustainable Montenegrin Agriculture".

More specifically, AGRISCIMONT was fostering the integration of BTF within the ERA by increasing its leadership among European research institutions, covering the whole production food chain, providing high level data interpretation and influencing local and EU policy in the field of food quality and safety, agro-biodiversity and agro-economics.

In order to reach such objectives, BTF collaborated with 5 excellent European Research Institutions (University of Ljubljana, Slovenia; Swedish Biodiversity Centre, Sweden; University of Natural Resources and Applied Life Sciences, Austria, University of

Hohenheim, Germany, and Wageningen University, Netherlands), through two-way mobility trainings and intense and high-quality dissemination events.

In terms of the research infrastructure, the most important project results were as follows:

- Seven existing laboratories (forestry, livestock, veterinary, wine, milk, plant protection and seed testing) were upgraded through the complementary pieces of the equipment; and
- Two new laboratories (Laboratory for plant and animal molecular genetics analyses) were established.

Thirty-five new pieces of equipment for seven existing and two new laboratories were purchased in amount of EUR 296 k.

AGRISCIMONT project was a powerful tool for improvement of BTF's technical capacities enabling it to place first position at University of Montenegro in terms of the labs equipment.

### ***HP-SEE High Performance Computing Infrastructure for South East Europe's Research Communities***

HP-SEE is an EU project, supported through Combined Collaborative Project and Coordination and Support Action funding scheme, addressing FP7-INFRASTRUCTURES. Its budget in amount of EUR 3.9 million was over the period 2010-2013 and its beneficiary from Montenegro was Centre for Information System - University of Montenegro (UoM), acting as a project partner.

HP-SEE linked existing and upcoming HPC facilities in South East Europe in a common infrastructure, and provided operational solutions for it. As a complementary action, the project established a GÉANT link for Southern Caucasus. The initiative opened the South East European HPC infrastructure to a wide range of new user communities, including those of less-resourced countries, fostering collaboration and providing advanced capabilities to researchers, with an emphasis on strategic groups in computational physics, computational chemistry and life sciences.

HP-SEE ensured that all participating countries in the region had access to latest HPC facilities in the region and if necessary in Europe, through suitable and sustainable organizational and operational models. HP-SEE aspires to contribute to the stabilisation and development of South-East Europe, by overcoming fragmentation in Europe and stimulating e-Infrastructure development and adoption by new virtual research communities, thus enabling collaborative high-quality research across a spectrum of scientific fields

Finally, HP-SEE enhanced further the regional and national-level Human Network, reaching out to as wide as possible range of local and national virtual communities, via strong dissemination and training campaign. Particular was on large, production-level users in crucial SEE communities of computational physics, computational chemistry, and life sciences.

### ***SEE-GRID-SCI - eInfrastructure for regional eScience***

SEE-GRID-SCI is an EU project, supported through Coordination and Support Action funding scheme, addressing FP7-INFRASTRUCTURES. Its budget in amount of EUR 3.2 million was over the period 2008-2010 and its beneficiaries from Montenegro were Hydrometeorological Institute of Montenegro (HIM) and University of Montenegro (UoM), acting as the project partners.

eInfrastructure in Europe has reached a mature state where the GEANT network forms a communications backbone on top of which a distributed computing infrastructure - the Grid - provides processing and storage services for eScience research. The South-East European eInfrastructure initiatives are committed to ensuring equal participation of the less-resourced countries of the region in European trends. SEEREN initiative has established a regional network and its GEANT connection and the SEE-GRID initiative the regional Grid.

SEE-GRID-SCI leveraged the SEE eInfrastructure to enable new scientific collaborations among user communities:

- It stimulated widespread eInfrastructure uptake by new user groups extending over the region, fostering collaboration and providing advanced capabilities to more researchers, with an emphasis on strategic groups in seismology, meteorology and environmental protection. The initiative thus aimed to have a catalytic and structuring effect on target user communities that currently do not directly benefit from the available infrastructures;
- It aimed to enlarge the regional eInfrastructure to cater for demands of the communities by increasing the computing and storage resources and involving new partner countries in the region; and

Finally, it targeted to help mature and stabilize the National Grid Initiatives in the region, allowing them to join the new era of longer-term sustainable Grid infrastructure in Europe.

## 2.2.4. Other projects related to the research infrastructure

### ***Montenegrin Research and Education Network (MREN)***

In terms of networking, the communication network infrastructures have been developed continuously during the last ten years as a primary support for academic community. **Montenegrin Research and Education Network (MREN)** was established in June 2005 and its main mission is to connect MREN to GEANT- multi-gigabit pan-European data communications network, reserved specifically for research and education use, via fiber optic with high speed. Based on the National Research and Education Networks, all universities and research organisations in Europe are sharing the same communication infrastructure, of which the pan-European component is the GEANT network ([www.geant.net](http://www.geant.net)). Specific advanced services are available to the research community. It interconnects national research and education networks (NRENs) across Europe, enabling collaboration on projects ranging from biological science to earth observation and arts & culture. The GEANT project combines a high-bandwidth, high-capacity network with a growing range of services which allow researchers to collaborate, working together wherever they are located. Together with European NRENs, GEANT connects 50 million users in over 10,000 institutions and enables collaboration between researchers in over half the world's countries.

MREN is connected to GEANT since October 1st 2010 and collects all networking services and facilities, which support the communication and information requirements of the education and research community in Montenegro. MREN aims to create, promote, offer,



participate in and preserve the requisite basis for effective use of modern telecommunication technologies in the education and research in Montenegro.

The MREN's target is to support the substantial use of the Pan-European and world research networks by Montenegrin researchers, scientists, lecturers and students, as well as to facilitate the integration of Montenegrin educational, research and cultural resources in the international information space.

### ***Regional Maritime Training Center in Kotor***

The Maritime Faculty of Kotor – University of Montenegro has become a regional maritime training center, supported through a project funded by the Norwegian government in amount of EUR 1.5 million. The project is implemented jointly by the Maritime Faculty of Kotor from Montenegro and the Maritime Operations AS from Ålesund, Norway.

Due to the fact that the training of seafarers plays a major role in maritime safety and in the protection of the maritime environment, the project envisioned establishing a regional maritime training center, which would provide trainings on the most advanced ship simulators — delivered and installed by the Off-shore Simulator Center. The main objective is to develop a professional maritime workforce in Montenegro through the knowledge and experience of Norwegian experts.

As of next academic year, the Maritime Faculty of Kotor will introduce regular courses on the technology of oil platforms and supply ships for oil platforms. The Faculty is also planning similar activities in the time to come, in order to become the leading maritime training center in the Mediterranean.

“OSC OFF-SHORE” simulator, necessary for of shore operations related to supplying of the oil platforms, is the most advanced research infrastructure of this kind, with the value of EUR 900k.

Also, the following equipment was procured under the project: Rolls Royce Dynamic Positioning Simulator, Transas Navigation Simulator and Transas 3D touch screen marine console.

### **3. Pan-European Research Infrastructures**

Pan-European Research Infrastructures provide an important contribution to the development of European culture and competitiveness and have a successful track record in taking Europe to the forefront of Science, Technology and Innovation. The main goal is to provide an environment supporting research to address high priority areas. ESFRI research infrastructures aim to attract world-class scientists and to provide a high level of support for users allowing them to perform excellent research.

Bearing in mind the strategic orientation of Montenegro to the EU integration, particularly the full integration of the Montenegrin scientific research community into European Research Area (ERA), the importance of the involvement in the pan-European RI context has been recognized. This issue gain even more importance in the context of the newly established RI in Montenegro and emerging research challenges deriving from it.

Since the new research infrastructures in Montenegro, with a potential to become a part of the EU RI context, are in the very early phase of formation, the real state of the need for using the Pan-European RI will be formulated in the more advanced phases, i.e. when the infrastructure and equipment will be fully operational and when some concrete research results will be available. However, in this initial phase, the transfer of knowledge is needed in the form of training of staff and users in order to ensure cost-effective exploitation of the available resources and best use of the forthcoming scientific results. Particular attention should be put on the technology transfer issues. Also, some mobility schemes would help Montenegrin researchers to understand better the functioning of the EU RI to be able to provide some concrete and sustainable input to the Government of Montenegro which could assess and plan in detail the participation and usage of Pan-European RI and allocate funds for this purpose.

On the other hand, there are other excellent research teams in Montenegro working on the existing very good and operational research infrastructures addressing key research priorities, so some potential to use Pan-European RI can be recognized at the moment, but certainly need to be further elaborated and defined in the occasion of the preparation of the new Strategy on Scientific Research Activities (2016-2021) that will be adopted in 2016. It will present strategic orientation of Montenegro in the field of science and research with concrete action plan and financial framework, comprising the overview of the RI.

Some of the existing pan-European RI projects that might be topic of interest for Montenegro are described below.

#### **3.1. eLIXIR - European Life-Science Infrastructure for Biological Information**

The goal of ELIXIR<sup>3</sup> is to orchestrate the collection, quality control and archiving of large amounts of biological data produced by life science experiments. Some of these datasets are highly specialised and would previously only have been available to researchers within the country in which they were generated.

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<sup>3</sup> <https://www.elixir-europe.org/about>

For the first time, ELIXIR is creating an infrastructure – a kind of highway system – that integrates research data from all corners of Europe and ensures a seamless service provision that is easily accessible to all. In this way, open access to these rapidly expanding and critical datasets will facilitate discoveries that benefit humankind.

Science and technology change very quickly, and exploiting these advances can be a challenge. ELIXIR partners are building an intelligent, responsive and sustainable system that will deliver the fruits of these advances to the scientists upon whom so many hopes are pinned, and whose curiosity is the very cornerstone of progress.

The eight strategic objectives of the ELIXIR Programme are to:

- Establish a distributed infrastructure that scales with the challenge;
- Secure and deliver the core data resources underpinning life science research;
- Provide discoverable tools, services and connectors to drive data access and exploitation;
- Provide robust technical platforms and clouds for secure data access, data exchange and compute;
- Develop and maintain standards for data management, reuse and integration;
- Partner with user communities in a sustainable manner to ensure high and lasting impact;
- Close the computational biology skills gap through a comprehensive training programme for professionals; and
- Support innovation in “big-data biology”.

On 18 December 2013, ELIXIR became a permanent legal entity. EMBL and 11 countries ratified the ELIXIR Consortium Agreement (ECA), while six countries have signed a Memorandum of Understanding (MoU) to participate in ELIXIR and have status of ELIXIR Observers.

Bearing in mind that ELIXIR's Nodes are sited at existing centres of excellence in participating countries throughout Europe, Montenegro would have interest to apply for status of Observer in ELIXIR, especially because of potential of the Centre of Excellence in Bioinformatics (BIO-ICT) in Montenegro.

### **3.2. eMBrc - European Marine Biological Resource Centre**

The European Marine Biological Resource Centre (EMBRC) is a distributed research infrastructure that aims to provide a strategic delivery mechanism for excellent and large-scale marine science in Europe.

EMBRC builds on existing facilities, equipment and human capital of those coastal marine biological stations and laboratories in Europe. EMBRC's vision is the long-term collaboration and common development of strategies, best practices and standards related to the use of marine biological resources and marine biological research in general to fit user needs, drive marine science forward, and underpin the blue bio-economy in Europe.

EMBRC aims to provide its services foremost to users from academia, industry and governments, and it will support both basic and applied research. Services will include the provision of access to European marine, coastal ecosystems and biodiversity, marine model

organisms, culture collections, technology platforms including imaging, omics and structural biology facilities, e-infrastructure services, as well as culture, laboratory and training facilities and services.

Presently, EMBRC has nine European countries and associated countries as full members. The EMBRC national nodes comprise research infrastructure that is located in leading marine biological stations and laboratories in Europe.

Montenegro could consider in consultation with the relevant scientific research institutions to become a EMBRC partner because of the strategic importance of the marine biology field.

### **3.3. EURO-BIOIMAGING - European Research Infrastructure for biomedical imaging**

Euro-BioImaging is a large-scale pan-European research infrastructure project on the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap. Euro-BioImaging is now in the interim phase, with representatives of 14 countries and EMBL as international organization working together towards the implementation of the infrastructure and governing Euro-BioImaging development through Euro-BioImaging Interim Board.

The infrastructure is supported by the national imaging communities of 25 European countries and by the official Euro-BioImaging Industry Board.

The ESFRI research infrastructure Euro-BioImaging will provide open user access to a complete range of state-of-the-art imaging technologies in biological, molecular and medical imaging for life scientists in Europe and beyond. Euro-BioImaging will offer image data support and training for infrastructure users and providers and continuously evaluate and include new imaging technologies to ensure cutting-edge services in a sustainable manner. Through Euro-BioImaging, investment in imaging infrastructure will be used in the most cost-effective and efficient way by applying the highest quality standards in management, open user access and service of imaging facilities.

Bearing in mind some important ongoing projects in the field and the importance of the biomedicine, Montenegro could consider in consultation to the relevant scientific research institutions the involvement in the Euro-BioImaging.

## Appendix

### ANNEX – LIST OF CAPITAL EQUIPMENT AT PURCHASE PRICE HIGHER THAN 50,000.00 EUR

Equipment	Institution	Function	Equipment price (EUR)	Research area
BactoScan FC (100H)	Biotechnical Faculty University of Montenegro	Determination of total number of bacteria in 1 ml milk	150,000	Agricultural science
Atomic absorption spectrophotometer	Biotechnical Faculty University of Montenegro	Determination of nutritive contents in a ground and plant material	110,000	Multidisciplinary (Natural Sciences and Mathematics, Agricultural science)
MilkoScan 120FT	Biotechnical Faculty University of Montenegro	Chemical analysis of milk and dairy products	80,000	Agricultural science
Fossomatic 5000 basic	Biotechnical Faculty University of Montenegro	Determination of somatic cells number in 1 ml of raw milk	75,000	Agricultural science
MilkoScan 4000	Biotechnical Faculty University of Montenegro	Content determination of: fats, proteins, lactoses, dry materials, dry materials without fats and freezing point of milk	75,000	Agricultural science
HPLC system 1260	Biotechnical Faculty University of Montenegro	Identification and quantification of wine components	50,000	Multidisciplinary (Technical-technological sciences, Agricultural science)
Server room	Faculty of Information Systems and Technology - UDG	Integration of the whole information system of University of Donja Gorica	250,000	Multidisciplinary (Natural, Technical-technological sciences, Agricultural science)
Nautical simulator NTPro 4000	Faculty of Maritime Studies in Kotor, University of Montenegro	Ship command center simulator	120,000	Technical-technological sciences
Sailing boat with equipment	Faculty of Maritime Studies in Kotor, University of Montenegro	For student exercises and sailors training	67,400	Technical-technological sciences
OSC Off shore simulator	Faculty of Maritime Studies in Kotor, University of Montenegro	simulator for off-shore operations	400,000	Technical-technological sciences
Rolls Royce Dynamic positioning simulator	Faculty of Maritime Studies in Kotor, University of Montenegro	simulator for dynamic positioning	100,000	Technical-technological sciences

Transas NTPro 5000 with console	Faculty of Maritime Studies in Kotor, University of Montenegro	nautical simulator	70,000	Technical-technological sciences
Transas TechSim 5000, with console	Faculty of Maritime Studies in Kotor, University of Montenegro	brodomašinski simulator	70,000	Technical-technological sciences
Laboratory	Faculty of Mechanical Engineering, University of Montenegro	Lathes, drills, machine centers, cutting machines	200,000	Technical-technological sciences
Spectrometer system Pripjat-2m	Faculty of Natural Sciences and Mathematics, University of Montenegro	Spectrometry of samples	100,000	Natural Sciences and Mathematics
System for spectro chemical analysis	Faculty of Natural Sciences and Mathematics, University of Montenegro	System for spectro chemical analysis - Spectroscopy of plasma	86,500	Natural Sciences and Mathematics, Technical-technological sciences
Research boat 100-KT	Institute of Marine Biology, University of Montenegro	Terrain experiments at Montenegro sea	126,000	Multidisciplinary (Natural Sciences, Agricultural science)
Transmission electronic microscope (TEM) JEM-2000 EX with equipment for sample preparation	The Ferrous Metallurgy Institute AD Nikšić	For electronic metallography (up to the level of crystall lattice)	1,500,000	Technical-technological sciences
Machine for dynamical testing -Model 1333	The Ferrous Metallurgy Institute AD Nikšić	Investigation of tensile characteristics, by bending and compression	261,790	Technical-technological sciences
Servohydraulic machine INSTRON 1333	The Ferrous Metallurgy Institute AD Nikšić	Tension, bending, pressing, K1C, J-integral	250,000	Technical-technological sciences
Electromagnetic resonance machine – Pulsator, Model 1603	The Ferrous Metallurgy Institute AD Nikšić	Determination of dynamical strength, mechanism of fatigue crack formation	140,083	Technical-technological sciences
Plasma spectrometer	The Ferrous Metallurgy Institute AD Nikšić	Spectrometry of plasma	100,000	Technical-technological sciences
Atomic absorption spectrometer	The Ferrous Metallurgy Institute AD Nikšić	Spectrometry, 160-800nm	100,000	Technical-technological sciences
Atomic absorption spectrophotometer – AAS	The Ferrous Metallurgy Institute AD Nikšić	Everyday determination of chemical composition of steel, steel melts, non-ferrous metals, metal content in ground and water samples, metals in air dust, etc.	100,000	Technical-technological sciences, Agricultural science

Atomic emission spectrophotometer – AES ICP	The Ferrous Metallurgy Institute AD Nikšić	Everyday determination of chemical composition of steel, steel melts, non-ferrous metals, metal content in ground and water samples, metals in air dust, etc.	100,000	Technical-technological sciences, Agricultural science
Machine for statical testing-Model 1125	The Ferrous Metallurgy Institute AD Nikšić	Investigation of tensile characteristics, by bending and compression of metal materials	83,192	Technical-technological sciences
Optical emission spectrometer - quantometer	The Ferrous Metallurgy Institute AD Nikšić	Everyday determination of chemical composition of steel, steel melts, non-ferrous metals, metal content in ground and water samples, metals in air dust, etc.	55,000	Technical-technological sciences
Oxygen content determination device, RO 116	The Ferrous Metallurgy Institute AD Nikšić	Oxygen content determination in metal samples	55,000	Technical-technological sciences
UV-VIS spectrometer	The Ferrous Metallurgy Institute AD Nikšić	Spectrometry 190-750/900nm	55,000	Technical-technological sciences
N2 content determination device, TN 114	The Ferrous Metallurgy Institute AD Nikšić	N2 content determination in metal samples	50,000	Technical-technological sciences
Device for determination of C and S content	The Ferrous Metallurgy Institute AD Nikšić	Determination of C and S content	50,000	Technical-technological sciences
Device for determination of N content	The Ferrous Metallurgy Institute AD Nikšić	Determination of N content	50,000	Technical-technological sciences
Device for determination of O content	The Ferrous Metallurgy Institute AD Nikšić	Determination of O2 content	50,000	Technical-technological sciences
C and S content determination device	The Ferrous Metallurgy Institute AD Nikšić	Determination of C and S concentration in samples of metal, rock, ground, in a range of 0,009 – 3,18% for C and 0,0011 – 0,129% for S	50,000	Technical-technological sciences, Agricultural science