COLLABORATIVE R&D IN THE INDUSTRY OF SCIENCE

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Abstract

The construction and operation of Large Research Infrastructures are based on projects that need a highly technological and innovative content and involve extensive collaboration and coordination with the industry.

Spain has identified the Industry of Science as a priority innovative market for the *Spanish State Innovation Strategy E2I* and has defined a specific strategy that promotes business R&D funding programmes for this Science Industry.

A fruitful relationship between research facilities and industry requires close collaboration that is not always easy to achieve. Collaborative R&D is the most interesting mean to get the best out of both worlds. Examples of this collaborative approach within the Basque Innovation system are presented.

The capacities of the Spanish Industry of Science and the experience of the Basque Innovation System in collaborative R&D have in the European Spallation Source a perfect opportunity to develop further and provide advantage in the construction of the world's most powerful source of slow neutrons for the study of materials.

INTRODUCTION

Large Research Infrastructures are unique sites of its kind that allow performing research on the frontier of knowledge. Their construction and operation are based on projects that need a highly technological and innovative content and involve extensive collaboration and coordination with the industry.

Europe has more than 600 research infrastructures, of which approximately half are classified as Medium and Large Research Infrastructures. The disciplines covered are very varied, ranging from humanities, social sciences, environment, land and marine sciences, energy, biomedicine and life sciences to materials science, nuclear physics and particle physics, astronomy and astrophysics, engineering, computing and data processing.

The combination of science and high technology offered by the construction and operation of these facilities is an interesting opportunity for industrial diversification towards knowledge intensive sectors.

A fruitful relationship between research facilities and industry requires close collaboration that is not always easy to achieve. Building and operating research facilities requires state of the art solutions that in many cases depends upon the expertise and technologies that emerge from the private sector, for whom providing these solutions opens an opportunity to work on the frontiers of science and technology. Collaborative R&D is the most interesting mean to get the best out of both worlds.

THE INDUSTRY OF SCIENCE

The Industry of Science is formed by a set of companies that work for organizations in charge of the conception, design, construction, exploitation and maintenance of scientific facilities and instrumentation in any area that contributes to the advance of science and technology and to the support of scientific communities researching in the frontiers of knowledge [1].

Some of these companies have been established specifically as providers of research facilities, but most of them belong to different industrial sectors from which interesting experience and knowledge is transferred to this "new market of science". Providers of aerospace, energy, automotive, machine-tool, steel industries for example, become excellent collaborators for research infrastructures.

There is also an interesting possibility of technology transfer in the opposite direction. Another important aspect to consider in the context of this collaboration framework is that the high-technology acquired by industries working for research facilities can be transferred to other markets. And in many cases this is the key point to ensure the sustainability of this industry. For example, technologies developed for particle accelerators and detectors have applications in emerging sectors such as energy and medical instrumentation.

Large Research Infrastructures require a high investment for their construction and operation, very difficult to deal out of a framework of international collaboration. This framework gives to the Industry of Science an interesting international experience very useful for the opening of new markets in a global context.

During the time of the Spanish candidature to host the European Spallation Source in Bilbao, a preliminary study to detect in-house capabilities was performed and a map of Spanish technology agents and suppliers of Large Research Infrastructures was produced as an open-ended publication that showed that there are two major concentrations of agents in Spain, the Basque Country and the Madrid area. The study analysed 33 companies, 14 of them established in the Basque Country [2] .

This high concentration of Industry of Science in the Basque Country led to some of these Basque companies to organise themselves as an association following the cluster strategy established by the Basque Government in its industrial policy. This association aims to become the Spanish reference for the Industry of Science with joint actions that may lead to the increase of their participation in the delivery of projects, equipment, systems and services for large national and international scientific facilities, as well as working together to contribute to the creation of advanced knowledge useful in other areas of the industry [3].

The above mentioned association is a non-profit, private organization formed by Spanish companies who work for institutions involved in the conception, design, construction, operation and maintenance of installations and scientific instruments from any field. It aims to contribute to the advancement of science and technology and to the strengthening of innovation. Its scope is throughout the country; its philosophy is that of seeking cooperation between companies, research centers, universities and organizations and supporting institutions [3].

THE SPANISH STRATEGY FOR THE INDUSTRY OF SCIENCE

The Spanish contribution to European Large Research Infrastructures amounts to 160M€/year, a contribution which is usually done by agreements between the Spanish Government and institutions that operate major infrastructures through the payment of an annual fee that allows Spanish researchers to access the infrastructure, but also, increasingly, through the participation of Spanish companies in tenders for construction and improvements during operation [1].

The investment made by Spain in international scientific infrastructures to support our scientists with the use of the sophisticated tools they need to perform their research provides a unique opportunity to build high technological value in the Spanish industry and is an exciting opportunity to develop an specific strategy for the Industry of Science, a strategy that forms a cornerstone in the development of a *Spanish State Innovation Strategy E2I* and that fulfils three complementary objectives: to promote the scientific development of Spain and to achieve an impact on a high technology industry, both in a framework of international collaborations of great interest [1].

Besides the participation in international Large Research Infrastructures, Spain has also made a big effort in the consolidation of the ***Spanish Singular Science and Technology Infrastructures Map***, a set of more than 50 facilities in different areas of research distributed along the country with the aim not only to decentralise the research and extend the science, but also as a mechanism for regional economic boosting taking into account the industrial implication in the facilities construction and exploitation [4].

Therefore the Industry of Science becomes a priority driver for the *Spanish State Innovation Strategy E2I* as an innovative market alongside with the Health and Welfare Economy, the Green Economy and the Administration Modernization [5],

The Strategy for the Industry of Science tries to join forces and direct institutional support so that the management of international contributions in international Large Research Infrastructures, the investment in Spanish Singular Science and Technology Infrastructures and public programs to support business R&D walk together in the same direction. These three vectors are the basis of the strategy and provide it with some distinguishing features compared to other industrial development strategies in other sectors. Moreover the Industry of Science strategy becomes not only an innovative market but also fulfils other objectives of the Spanish State Innovation Strategy E2I such as the strengthening of regional cooperation and the international projection [5].

Thus, programs to support business R&D will be a key instrument for the implementation of the strategy and should include, as in other industrial development strategies, R&D projects, technology transfer, training, etc., but only the combination of this actions with the other two dynamization vectors (international contribution to Large Research Infrastructures and investment in Spanish Singular Science and Technology infrastructures) will allow a successful strategy [1].

For the sustainability of the Industry of Science, the technological areas of greatest potential for transfer to other markets should be particularly observed in the implementation of the strategy.

INDUSTRY – RESEARCH FACILITIES COLLABORATION IN THE BASQUE STRATEGIES FOR INDUSTRIAL DIVERSIFICATION

The Basque Ministry of Industry proposes for the Basque Plan of Science, Technology and Innovation strategies for selective diversification in emerging fields – bioscience, nanoscience and energy – based on the generation and application of market-oriented knowledge. Each strategy has a different focus since they address very different contexts, but all three are structured around three core ideas: generation of knowledge, business development and new industrial sectors dynamization.

The *bioBasque Strategy* was designed with the goal of generating significant business activity in the field of biosciences in the Basque Country at international level [6]. The *nanoBasque Strategy* tries to get advantage of the enabling nature of nanotechnologies twofold: by exploiting their great potential in the different Basque industrial sectors and by promoting the creation of new technology based companies [7]. The *energiBasque Strategy* aims to consolidate the existing driving companies in the Basque Country in the energy sector, to use their driving impact in their value chain and to build new business activity related to the generation, transport and consumption of energy [8].

The Basque Ministry of Industry has made an important economic effort in the construction of research facilities to support the knowledge generation needed for the successful deployment of these three strategies. These research facilities have been created as centres for cooperative research (CICs) with the objective of bringing discoveries to the society by partnering with industry, contributing to the economical and social development of the Basque Country through the generation of knowledge and speeding up the process that leads to technological innovation.

The CIC bioGUNE (Centre for Cooperative Research in Biosciences) is a non-profit biomedical research organization, founded in 2002 at the initiative of the Ministry of Industry of the Basque Government. Since then, the CIC bioGUNE has been playing a strong role in advancing biomedical research and technological innovation in the Basque Country. To support the research activities, the CIC bioGUNE made an investment of more than 35M€ in state-of-the-art research infrastructure - in genomics, gene silencing, proteomics, metabolomics, NMR, electron microscopy, X-ray diffraction, and computer and animal facilities, among others [9].

The CIC biomaGUNE (Centre for Cooperative Research in Biomaterials) was officially opened in December 2006. The CIC biomaGUNE is a non-profit research organization created by the Ministry of Industry of the Basque Government to promote scientific research and technological innovation at the highest levels following the *bioBasque* and *nanoBasque* strategies as a key actor for the nano-bio convergence. It hosts the Molecular Imaging Unit that belongs to the *Spanish Singular Science and Technology Infrastructures Map* [10].

The CIC nanoGUNE is a newly established centre promoted by the Ministry of Industry of the Basque Government as part of its *nanoBasque Strategy* with the mission and commitment to contribute to the competitive growth of the Basque Country, through the development of nanoscience and nanotechnology. It seeks the promotion of a solid knowledge community with the vocation of transferring the results of research to an industrial sector that needs to become increasingly more competitive by means of a world-class research team, state-of-the-art facilities and close collaboration with other research laboratories and with industry [11].

The CIC microGUNE is a Cooperative Research Centre promoted by Ministry of Industry of the Basque Government with the aim of becoming a new model of scientific/technological alliance for carrying out excellent research, integrating the capacities of different agents in the Basque Science, Technology and Innovation Network in the strategic field of microtechnologies, to contribute to raising the competitiveness level of the Basque Country's business sector while collaborating to achieve diversification towards emerging sectors through knowledge and technology transfer [12].

The CIC energiGUNE is the new energy research centre created by the Ministry of Industry of the Basque Government which aims to become an international benchmark in its field. The CIC energiGUNE is in charge of meeting the targets set in the Energy Strategy of the Basque Country. Its work will be decisively important in promoting new global business groups operating in new market niches and will help position the Basque Country as a major reference in research excellence in the area of energy [13].

All these research centres have been created with a clear aim of improving Basque competitiveness and close collaboration with industry, local and international, is stated in their missions. The collaboration with industry is mainly through collaborative research projects in their areas of expertise, but also, as hosts of research equipment, some of them have established interesting relationships with equipment providers. Although most of their equipment is commercial and "off –the-shelf" and providers are international well-known established companies, the relationship between the research facility and the provider has gone beyond a customer-supplier relationship and has positioned the Basque Country and its industrial fabric as potential partners of these international companies.

This is the case of the Molecular Imaging Unit, which hosts, among other equipment, a cyclotron for the production of the molecules labelled with radioactive isotopes needed for the centre own research with positron emission tomography (PET). The company that manufactured this cyclotron and CIC biomaGUNE got an agreement for using this facility for the industrial production of radiopharmaceuticals that are distributed for diagnostic test of diseases such as cancer or Alzheimer in the health network. This agreement allows CIC biomaGUNE to have some economic return as a complement of its research activity while it maintains a close collaboration with the cyclotron provider for maintenance and further improvements that interest both partners, collaboration that materialises in joint R&D projects [10]

The CIC nanoGUNE has recently opened its advanced electron microscopy laboratory, with three new advanced electron microscope systems, including the world's most advanced commercially-available microscope, from a leading American scientific instrumentation company. This company has chosen CIC nanoGUNE as reference centre for the installation and demonstration of these equipments and has signed an agreement for the joint development of five R&D projects. This agreement supports the aim of CIC nanoGUNE to become an international reference in its field and to attract a driving leading company to collaborate with the Basque innovation system [11].

These two cases may have an indirect impact in the local industry with the research facilities acting as attractors and catalysers of potential future collaborations with the Basque Industry of Science. The *energiBasque strategy* also uses a research infrastructure for the raising of Basque industry competitiveness with the construction of BIMEP, the Biscay Marine Technology Platform, an infrastructure for research demonstration and operation of off-shore wave capturing systems for energy generation. BIMEO has open installations that allow worldwide manufacturers to install their own equipment for demonstrating and testing purposes. The Basque Country has a long and closely-knit relation with the sea and its energy. Since the middle ages, the Basque coast has always boasted a strong shipbuilding industry. The tradition has continued to this day, with large shipyards and other auxiliary industries of importance for marine

energy. In the field of energy, the Basque Country is home to some of the world's top names, including the world largest developer and operator of wind farms, one of the top manufacturers of wind turbines, a key company in the technological development of solar thermoelectric energy and a group of electrical manufacturers who together amass a similar size to the leading multinationals in the power transport and distribution industry. Given the strength of these two industries, the Basque Country offers more than 70 organisations with capacity in the complete value chain for the construction of wave farms. The business opportunity of marine energy is a key component of the *energiBasque strategy* and research facility BIMEP offers the platform to link international wave energy converters manufacturers with the Basque industrial capacities [14].

THE ESS OPPORTUNITY

The capacities of the Spanish Industry of Science and the experience of the Basque innovation system in collaborative R&D have in ESS a perfect opportunity to develop further and provide advantage in the construction of the world's most powerful source of slow neutrons for the study of materials.

ESS will be a 5MW long pulse source of slow neutrons, with 22 instruments, driven by a superconducting proton linac. ESS will be a very powerful neutron source [15]. The challenge of its construction and exploitation is a clear driver for innovation. Some ideas have already aroused about how to harvest this potential for innovation.

ESS is currently concentrated upon the delivery of a Design Update report which will form the basis of the building process due to start in February 2013. Recent progress has, among other things, a continuous and growing international cooperation with other scientific institutes and universities, necessary for attaining the scientific and technical levels required for the facility. [16]. These collaborations are being arranged in the framework of the in kind contributions of the 17 country partners. It seems that industry cannot pay a relevant role at this stage of development of the ESS project, although there is clear interest from industry as it was shown at the ESS Industry Day organised in Copenhagen in February 2010, with the attendance of more than 400 industrialists.

A possibility for making the industry participate in this early stage of ESS without compromising the competence nor favouring any company could be to involve interested companies in the technical review process of the deliverables produced by the international cooperation of partner institutions of ESS as results of the design update projects. The technical review process is already defined and an expert pool is being built with the concurrence of experts coming from public research institutions. But this expert pool could be opened to experts that belong to private institutions in a similar way the European Commission work with experts for evaluating and reviewing R&D proposals to their Framework Programme funding calls. Interested companies could this way have access to the design update process in its earliest stage and could provide, through recommendations in the review. the industrial point of view and constructive input.

In the long term, the scientific exploitation of ESS is an important topic deserving of much reflection. The way ESS capitalises upon its intellectual property [15] could open new ways of harvesting innovation.

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