Results of the Spanish Nuclear Sector in the "Analysis of the Potential Development of Energy Technologies in Spain"

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INTRODUCTION

On June 30, 2011, driven by the Minister of Science and Technology Cristina Garmendia, the ALINNE Alliance (Alliance for Energy Research and Innovation) was established. ALINNE is a non-profit initiative created to unite and coordinate efforts among all actors in the value chain of R & D in energy, allowing to respond to the main policy challenges that the R&D have in the field of the energy sector, contributing to the definition of a work patterns nationwide and European positioning. The founder members of ALINNE are composed of eleven representatives of the private sector who are the presidents of the nine Spanish companies with active participation in the field of R&D and leading the IBEX 35 at the time, two SMEs, and nine representatives of the public sector. The CIEMAT currently holds the secretariat of the Alliance.

In the field of ALINNE it was launched on March 2014 the "Analysis of the Potential Development of Energy Technologies in Spain". This is a comparative analysis to assess abilities, potential, development, positioning and technological coherence of the different energy technologies. In the study were involved 13 technology platforms in the field of energy:

- Platform for Energy Efficiency.
- Spanish CO_2 Technology Platform.
- Platform for Hydrogen and Fuel Cells.
- BIOPLAT Platform (Biomass).
- GEOPLAT Platform (Geothermal).
- Natural Gas Platform for Mobility
- Nuclear Fission Energy technological platform, CEIDEN.
- REOLTEC Platform (Wind).
- Marine Platform.
- FUTURED Platform (Intelligent Networks).
- Fotoplat Platform (Photovoltaic).
- ASIT Platform (Solar Thermal Low Temperature).
- Concentra Solar Platform (Solar concentration).

With the main objective of employment, industry and to built a knowledge society, this exercise aims to identify the energy technologies that are strong themselves for its clear expectations of market and their alignment with the European energy policy, technologies in which Spain is strong or it can be and technologies that can have a better impact in reducing emissions, improve the balance of payments and the external dependence, and that have a greater tractor effect for the industrial technological development.

The representation in this exercise of the Spanish nuclear sector has been carried out through the Fission Nuclear Energy technological platform, CEIDEN, which has actively participated in all the phases of the process, involving all the actors in the Spanish nuclear sector.

The aim of this article is to present the results in the exercise of the Spanish nuclear sector.

METHODOLOGICAL ASPECTS, CRITERIA AND OBJECTIVES

In the ALINNE workshop of September 25, 2013, in the Spanish Energy Club, made before the effective launch of the exercise, the general criteria for carrying out the analysis of the potential of technological development of energy technologies in Spain were defined. These criteria are based on the use of quantitative and qualitative indicators.

In the ALINNE workshop of March 5, 2014, held in CIEMAT, the EXCEL tool to use for technology platforms was introduced for those interested in participating in this study, and it defines the criteria grouped into 5 categories:

1. Economy and Employment.
2. Capabilities in Science, Technology and Innovation.
3. Technological Status.
4. Infrastructure Capabilities of R&D for homologation and certification.

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5. Contribution to energy and environmental objectives.

To obtain the information to value these five criteria was needed a previous general data gathering among the sector. Data from 2012 and a future projection (2030) was asked, all of it based on reliable sources, and providing data, assumptions and methods used in the calculations made.

Besides these five criteria, two additional criteria have been contemplated during the exercise. These two criteria have not been included in an Excel tool as above, but were presented to the committee of experts of GEVAL group, an evaluation group of 45 volunteer members of the institutions belonging to ALINNE, along with two outside experts, who know the economics of innovation in the scientific area. These two additional criteria are:

1. Technological consistency in order to present the roadmap adjusted to national, European and international technology sector environment.
2. Availability of financial resources and instruments, in order to identify the necessary support to meet the challenges identified in the above criteria.

In the following sections, the results of this exercise for the nuclear sector are detailed.

GENERAL DATA OF THE NUCLEAR SECTOR

In the exercise, general data for the nuclear sector have been requested, based on verifiable references.

After the analysis of data collected in this area, CEIDEN concludes that the Spanish nuclear sector is a major contributor to the national electricity sector, supplying electricity in a stable, predictable, competitive, and safe manner.

Figure 1 shows the essential data provided by CEIDEN regarding the electricity production coming out of nuclear sources. Industry data to 2012 and forecasts to 2030, were obtained from the Spanish Nuclear Forum [1], the report of the IEA WEO 2013 [2] and the "Foresight 2030" UNESA report [3].

The hypothesis considered in the calculation of the electricity production is to maintain the percentage contribution of nuclear energy in the current national energy mix (about 20%) to 2030. The increase in nuclear output between 2012 and 2030 involves the installation of 3,000 additional MW, maintaining the existing assets in a context of long-term operation.

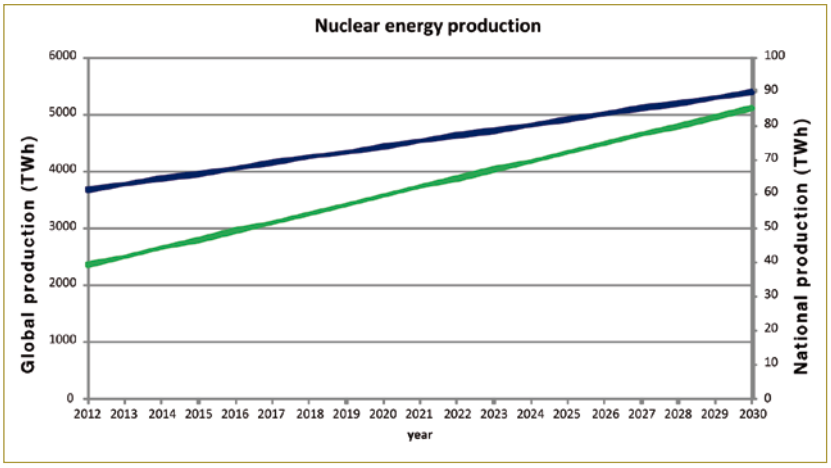

Figure 1. Worldwide and Spanish energy production.

With the purpose of having more detailed information of the sector, data were broken down into three subsectors: nuclear fuel companies, engineering and services companies and component manufacturers, as the main contributors regarding technological development (the objective of the exercise). It has not been specifically included the subsector related with management of spent fuel and waste.

- Nuclear Fuel subsector. The data in this subsector is the one in the Spanish market. In 2012 this subsector captured 46 M €, with a projection to 2030 of 67 M €. The value of exports in 2012 was 70 M €, with a projection to 2030 of 102 M €.
- Service and Engineering companies. The data in this subsector is the one in the Spanish market. In 2012 this subsector captured 240 M €, with a projection to 2030 of 415 M €. The value of exports in 2012 was 120 M €, with a projection to 2030 of 390 M €.
- Equipment companies. The data in this subsector is the one in the Spanish market. In 2012 this subsector captured 45 M €, with a projection to 2030 of 206 M €. The value of exports in 2012 was 210 M €, with a projection to 2030 of 455 M €.

To conclude this analysis by subsectors, it is highlighted that in the subsectors that provide technological value, exports are highly relevant and have a significant growth potential. The Spanish companies have managed to internationalize their activities in moments of crisis in the sector, and compete in the international markets. One of the reasons of this internationalization of activities is the investment in R&D, which has allowed them to be competitive in foreign countries, some with a mature and developed nuclear industry.

CRITERIA APPLIED TO THE NUCLEAR SECTOR

Below the detailed outcome of the nuclear sector for each of the criteria defined in the exercise ALINNE.

Economy and employment

The economy and employment data from the Spanish nuclear sector was requested in the exercise. The nuclear sector has an important contribution to the economy and employment in Spain, one of the main sources of electric power supply.

In 2012, the Spanish contribution to GDP, excluding the sale of electricity, has been evaluated in 699 M€, with a projection to 2030 of 1,514 M€. It is important emphasize the uniqueness of the nuclear sector over other technologies involved in the exercise. This contribution to the country's GDP comes from the operation of nuclear power plants, not the construction of new units. This means that the operation of nuclear power plants is an important economic activity.

In the case of new nuclear constructions in the future, it is estimated that the GDP contribution of nuclear energy can increase significantly, since the sector has maintained the skills acquired during the construction of nuclear units currently in operation. These capabilities have been maintained through the internationalization of the activities of the entities of the Spanish nuclear sector. These capabilities has been studied in CEIDEN in two published reports in 2011 [4] and 2013 [5].

Regarding employment, in 2012 the sector contributed with 18,500 direct jobs and 7,300 indirect jobs, with

a projection to 2030 of 30,000 direct jobs and 16,700 indirect jobs.

Regarding the professional qualifications of these jobs, 50% of them are of high degree, 10% of average education, and 40% of basic training. It is noteworthy the high degree of qualifications of the Spanish nuclear sector, leading to quality jobs, and technological knowledge required associated with these highly skilled positions. In addition, it was highlighted the existing programs of specialization for certain positions, additional to the entry qualifications of the employees. The provision of training in the nuclear sector is extensive and relevant.

For the assessment of these criteria it is also requested the total investment made by the sector in R & D (both public and private sectors). The data obtained through an annual exercise conducted within CEIDEN Technology Platform, with a request for data to all entities in the sector on the investment of R & D, origin and destination of these funds, resulting in an expense of R&D in 2012 of 46 M € (2013 analysis shows a similar result of that of 2012), with a projection to 2030 of 68 M €. Most of the investment in R&D comes from own resources of companies and institutions in the sector (over 70%).

In the exercise it is also requested a value of the production cost (€/MWh) of nuclear, for new nuclear facilities, using the known LCOE (Levelized Cost of Electricity), for comparing the results of different technologies. There is a big dispersion of sources and data concerning this subject, depending on the origin of the sources. For the exercise, it has been taken as reference data, in 2012, a production cost of 75 € / MWh for new construction of Generation III reactors [6], with a projection of 60 € / MWh in 2030 [7]. This decrease in generation costs from 2012 to 2030 has its reason in the decrease of cconstruction cost due to the learning curve of GIII technologies, whose first units are currently under construction. It is hoped that by learning from previous projects, for a NOAK (Nth of a Kind), the construction cost can decrease.

Capabilities in Science, technology and innovation

The nuclear sector is an energy technology with a high degree of knowledge of nuclear technology and nuclear processes required. Nuclear sector is highly internationalized, because much of the efforts are focused in the safe operation of nuclear power plants, of interest to all countries using this energy source. Efforts in this field are usually based on international collaborations of countries with nuclear generation.

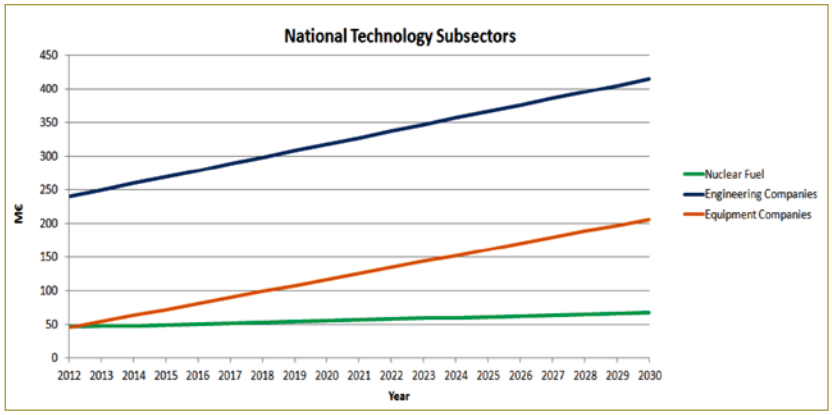

Figure 2. Data from the subsectors of nuclear fuel, utilities and engineering companies and capital equipment.

In response to the information requested on the exercise ALINNE, the number of publications in the sector during the period 2009-2013 in 184 (high impact publications). R&D funds received from domestic and international programs for the same period were 52 M€. Public funding for R & D of the sector was 30 M €. Private funding was 140 M€.

It´s worth mentioning that efforts in R&D of the nuclear industry have historically come mostly from own resources of the sector (for public or private entities). Funds received both for national and international programs have always been minor. In the exercise, this fact was highlighted, and used to make a request to improve the situation for the nuclear sector, with the aim of at least match the national funding level with other energy technologies.

Technological position

In the area of technological position, the objective of the exercise is to determine the positioning of Spanish companies at European level, patents, etc.

It is important to emphasize that although Spain is a country with a significant contribution of nuclear energy in the electricity mix, with the operation of 8 nuclear units and 2 units in decommissioning, Spain has not its own nuclear technology. The technology of nuclear reactors in operation or decommissioned in Spain comes from US, France and Germany.

As a positive example in this section, it became clear that the assets of Spanish nuclear equipment companies are very competitive at international level, for example in the construction of steam generators for PWR plants.

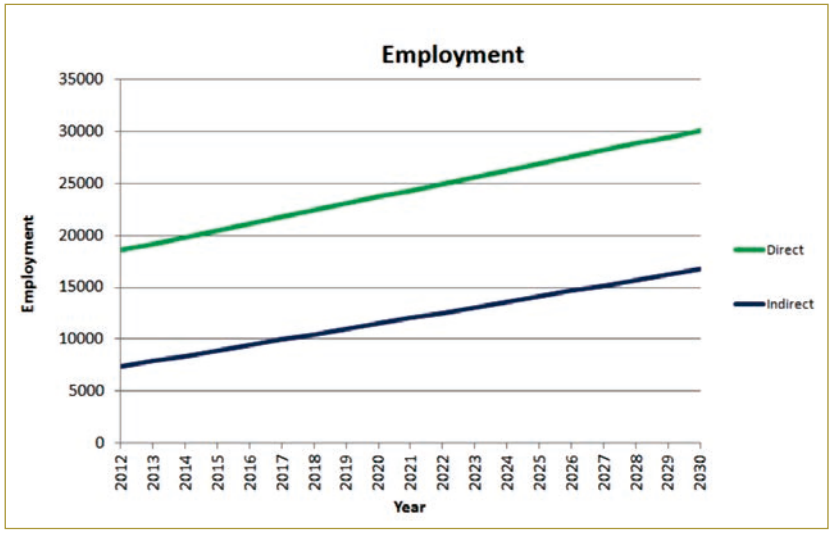

Figure 3. Direct and Indirect employment generated by the nuclear sector.

Technological capabilities of R&D for Homologation and Certification

In the criteria concerning the technological capabilities of R&D, the aim of the exercise is to carry out an analysis of the R&D nuclear capabilities in the country. In this context, by the nuclear industry it was noted that, in Spain, the capabilities of R&D grew in parallel with the construction of new nuclear plants. The operation of the facilities was well supported by the above-mentioned sub-sectors, with the construction of associated research reactors at different points of the Spanish geography, hot cells for irradiated material management and other research facilities.

These capacities have declined, in relative terms, as it was decreasing the interest in new nuclear constructions, which has led to situations where the R&D of the Spanish nuclear sector have had to be carried out abroad, due to lack of capacities. One of the conclusions in this subject is the need to improve these facilities, launching new nuclear projects such as the Centralized Temporary Storage (ATC) of spent fuel, with its R&D laboratory associated.

The number of nuclear R&D centers identified in Spain in the exercise was 14, with about 500 workers dedicated to nuclear R&D activities in such centers. In parallel, within the activities of CEIDEN, an initiative to identify all the centers of nuclear investigation in Spain and make a map of research capabilities in the centers has been launched.

Contribution to energy and environmental objectives

This criterion is related to the contribution of nuclear energy to the energy and environmental objectives in Spain. The analysis performed concludes that nuclear power does not emit CO_2, and contributes significantly to the reliability of energy supply of the country. That is, for a country like Spain, nuclear power is essential to meet the commitments of the Kyoto protocol on greenhouse gas emissions and combat climate change. Uranium reserves are spread throughout the world geography, existing important reserves in developed countries (Canada, Australia, etc.), so the contribution to this objective is very relevant.

ADDITIONAL CRITERIA: "TECHNOLOGICAL COHERENCE" AND "AVAILABILITY OF FINANCIAL AND OTHER INSTRUMENTS"

The assessment of the criteria 6 and 7 are more subjective. "Technological coherence" is associated with the challenges that the sector faces, and the "availability of financial and other instruments", with the support that the sector needs to meet these challenges.

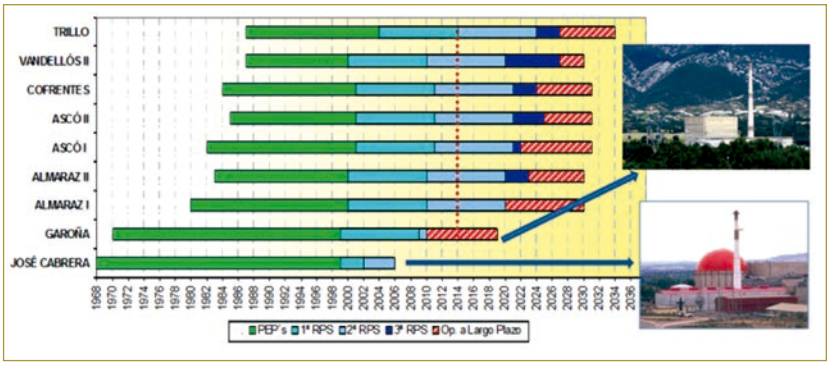

Figure 4. Long-term operation of Spanish nuclear power plants.

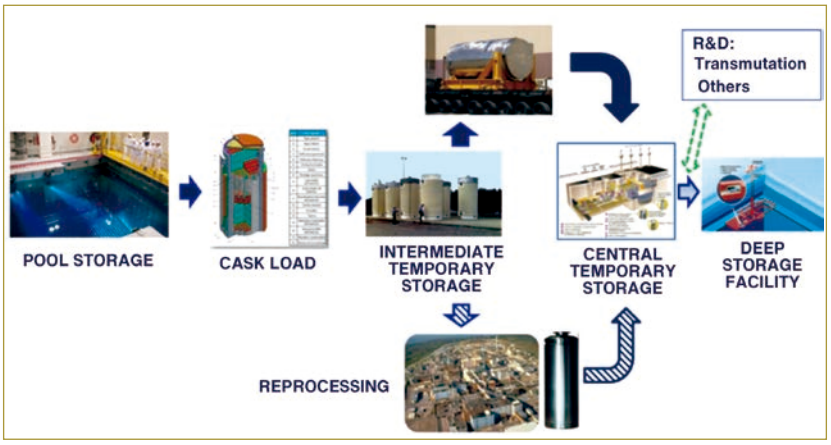

Figure 5. Alternatives for the management of spent fuel.

Figure 6. Jules Horowitz Reactor Project.

Technological coherence

In this section, the Strategic Agenda of the CEIDEN Platform, updated in 2014, was presented, where the three main challenges facing the nuclear sector in Spain are identified. These three challenges are:

The safe long term operation of the existing nuclear fleet

The safe long term operation of the existing nuclear fleet is now a reality in Spain, with the operation of Garoña nuclear power plant beyond the 40 year design life.

The long-term operation has, in turn, a number of challenges that in some cases require R&D efforts. This is the case of the study of material aging and obsolescence.

The decommissioning process of the Jose Cabrera nuclear power plant (Zorita) is allowing the development of R&D activities related to aging of materials under operating conditions of a nuclear power plant. This is the case of the internal vessel project (ZIRP), and of the concrete of Zorita project.

The management of spent fuel and radioactive waste

The management of spent fuel and radioactive wastes arising from the operation of the nuclear power plants in all the phases of the process is another technological challenge.

The management of spent fuel is an important issue to analyze. Now-

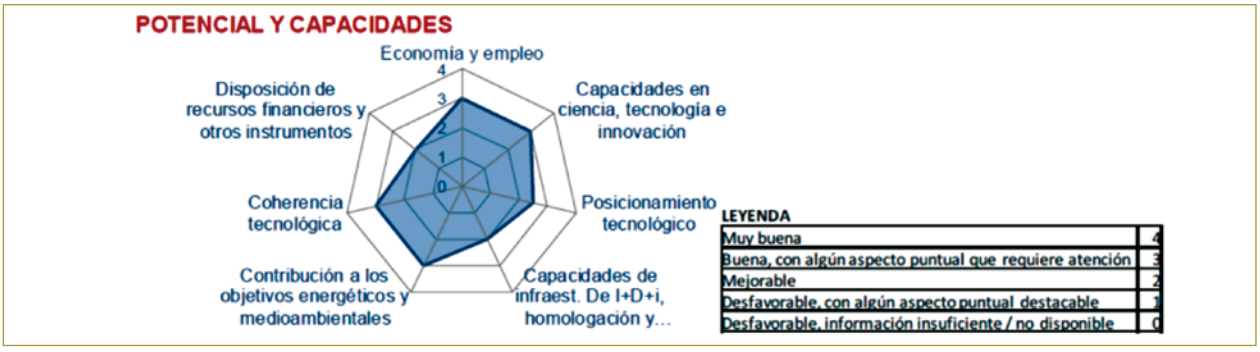

Figure 7. Results of the exercise "Analysis of the Potential Development of Energy Technologies in Spain" for the nuclear industry.

adays, the storage pools in the plants are getting saturated. Part from the spent fuel is being stored on site at Independent Storage Facilities (ATI). Currently, a centralized storage facility to collect the spent fuel of all the Spanish NPP is under licensing.

There are several research lines to analyze the conditioning, transportation, potential re-utilization and minimizing the radioactivity and volume of wastes, that includes reprocessing, transmutation, breeder reactors, etc. The option of closing the fuel cycle is an alternative to be considered, which can also give room to new specific lines of research.

In addition, the final disposal of the spent fuel and high-radioactivity wastes requires R&D efforts.

New technologies and new nuclear projects

There are currently 72 reactors under construction in the world, in over 15 countries. Besides these reactors under construction, there are new nuclear designs in development (the so-called Generation IV).

Other nuclear projects are related to R&D, as the Jules Horowitz research reactor (JHR), under construction in Cadarache (France), and in whose design and construction are participating Spanish entities.

The monitoring of new projects and new nuclear technologies results in new R&D projects, related to strategic aspects for the nuclear sector.

Moreover, the new technologies applied to these projects can be used in some cases for long-term operation of the reactors already in operation. A clear example is the application of advances in digital technology to I&C systems of the existing nuclear power plants.

Availability of financial resources and other instruments

Related to this criterion, it is exposed below the most relevant results obtained of the ALINNE exercise.

The challenges of the Spanish nuclear sector are clearly identified, as shown in the previous section. In addition, Spanish entities are prepared to meet these challenges. These entities have managed to internationalize their activities, leading to a group of companies, research centers and universities that make up a relevant R&D net in national and international scale.

However, funding of R&D has historically came from the entities that make up the nuclear sector of our country. National and international aid for R&D have been smaller, at least compared with other energy technologies.

To maintain these capabilities and enhance its international influence, it is needed institutional support that will be translated into the granting of

SÍNTESIS DE POSICIÓN EN CRITERIOS TÉCNICOS (ENERGÍA NUCLEAR DE FISIÓN)

CRITERIO	POSICIÓN GENERAL	ASPECTOS POSITIVOS DESTACABLES	ASPECTOS QUE REQUIEREN ESPECIAL ATENCIÓN
ECONOMÍA Y EMPLEO	◐	Aunque se trata de una tecnología madura, tiene un gran potencial de desarrollo tecnológico para dar respuesta a los retos sociales actuales (medioambientales, económicos y de seguridad), por lo que se prevé su crecimiento tanto en términos de empleo como de actividad hasta 2030.	Esta previsión de crecimiento se basa fundamentalmente en el crecimiento del mercado mundial (fundamentalmente el asiático), pero también del nacional. Sin embargo, esta evolución no se pone en relación con la evolución de la demanda de electricidad –impacto de las políticas de eficiencia energética e impacto del cambio económico estructural tras la crisis- ni con la penetración de otras tecnologías –en especial, las EERR- en el mix de generación eléctrico, lo que puede reducir el hueco térmico para la energía nuclear.
CAPACIDADES EN CIENCIA, TECNOLOGÍA E INNOVACIÓN	◐	Las infraestructuras de I+D+i españolas no son acordes con la relevancia del sector en nuestro país.	El desarrollo tecnológico en esta área requerirá de la combinación de las capacidades de I+D+i nacionales y extranjeras.
POSICIONAMIENTO TECNOLÓGICO	◐	La posición tecnológica de España es destacable. Hay un fabricante español de bienes de equipo que se encuentra entre los 10 primeros de la UE y se dispone de una fábrica de elementos combustibles.	España tiene un potencial de desarrollo de proyectos de I+D+i en esta tecnología que, si se explota adecuadamente, redundará en una mejora del posicionamiento tecnológico de las empresas del sector a nivel internacional.
CAPACIDADES DE INFR. DE I+D+i, HOMOLOG. Y CERTIFICACIÓN	INS	INS	INS
CONTRIBUCIÓN A LOS OBJETIVOS ENERGÉTICOS Y MEDIOAMBIENT.	◐	La fisión nuclear es una tecnología que contribuye a la consecución de los objetivos energéticos y medioambientales en la medida en que reduce la necesidad de importaciones de energía primaria y no emite CO_2.	Es una tecnología con baja, aunque variable en el tiempo, aceptación social, debido a los accidentes que se han producido en el pasado, como Three Mile Island, Chernobil y Fukushima. También se tiene el problema de la percepción social al tratamiento de los residuos radiactivos, posiblemente por el desconocimiento social de las soluciones contrastadas por la comunidad científica internacional

SÍNTESIS DE POSICIÓN EN CRITERIOS ESTRATÉGICOS (ENERGÍA NUCLEAR DE FISIÓN)

CRITERIO	POSICIÓN GENERAL	ASPECTOS POSITIVOS DESTACABLES	ASPECTOS QUE REQUIEREN ESPECIAL ATENCIÓN
COHERENCIA TECNOLÓGICA	◐	Los retos a los que se enfrenta esta tecnología están claramente identificados y existen líneas de trabajo a nivel internacional.	Los retos del sector en España son los mismos que a nivel mundial, por lo que la hoja de ruta en España se puede beneficiar y participar en los desarrollos que se están haciendo a nivel internacional.
DISPOSICIÓN RECURSOS FINANCIEROS Y OTROS INSTRUM.	INS	La mayor parte de la inversión en I+D+i proviene de recursos propios de empresas e instituciones del sector con poca proporción de ayudas públicas.	INS

	POSICIÓN GENERAL
●	Muy buena
◐	Buena, con algún aspecto puntual que requiere atención
◐	Mejorable
◐	Desfavorable, con algún aspecto puntual destacable
●	Desfavorable
INS	Información insuficiente / no disponible

Figure 8. Results of the Exercise "Analysis of the Potential Development of Energy Technologies in Spain" for the nuclear industry.

aid for R&D through national, European or international programs. Such aid would represent a significant support to the sector, which would increase its international presence and its competitiveness against other countries.

The aim of the technology platform CEIDEN is a greater involvement of the Spanish institutions in the definition and coordination of the European and international R&D. To achieve this, the sector needs more support from the Administration and the national institutions involved in this issue.

Figure 9. Participation of CEIDEN in the TRANSFIERE forum in 2015 in Málaga, 15 of February 2015.

THE RESULTS OF THE EXERCISE

Once completed the complex process of the ALINNE exercise, including the presentation of each technology platform to the evaluation group and the shared subjectivity ratings, and after the final report was issued, the main findings relating to the nuclear fission energy sector can be summarized as follows:

- The nuclear energy is an important technology market, at national and global level
- A system of R&D at national level is necessary to cope with the challenges identified in the sector
- Sector entities have developed technological capabilities, with exportation capacity (fuel fabrication, nuclear-grade components, engineering and services, etc.)
- There is a consolidated R&D network in the nuclear sector, but there are gaps in infrastructure research that makes necessary the international cooperation
- Funding for the R&D activivites comes mainly from own resources of the companies
- The sector has an active technology platform, which has defined a strategic plan, identifying the technological challenges of the sector, and promoting collaborative developments

Figure 7 summarizes the assessment of the nuclear sector from the perspective of the seven criteria established.

The main recommendations relating to the nuclear fission energy sector, as reflected in the ALINNE report, are:

- Support for this sector must be developed by means of public-private cooperation projects focused in the response to the technological challenges
- It should promote an unbiased social perception of nuclear energy, laying the groundwork for a serene and objective social debate
- It should facilitate the use of large European and international scientific facilities, following the existing collaborative scheme
- It should facilitate the participation of Spanish companies in the European H2020 Euratom program, with the aim of leading activities
- It should take advantage of the opportunity of the construction of the technology center associated to the Centralized Temporary Storage (ATC) for R&D infrastructure development
- Subsidies for the development of new aspects associated to technological challenges should be provided, allowing to launch pilot projects on those who are at an early stage of development
- The activities of nuclear fuel and equipment and components manufacturing companies should be supported
- International collaboration with European technology centers should be supported to optimize their use

It is important to emphasize the subjectivity of the exercise. Representatives of CEIDEN in the study do not share all the conclusions about the nuclear sector, as does some of those obtained in relation with other sectors (a significant fact is that among the nearly fifty experts that have participated in the evaluation process, only one -who did not even participate in the full exercise- comes from the nuclear sector).

Moreover, a number of technology platforms participating in the exercise have not seen themselves adequately "reflected" in it, considering the comments made in the meeting to present the results mentioned below. In the process of preparing the final report there has been the possibility of expressing opinions and discrepancies on the preliminary results of the evaluation group. From this exchange of views, several changes have been made in the text of the report, but some points of discrepancy still persist. In any case, it is estimated to be very useful the participation in the exercise as well as the results obtained, which have allowed to identify valuable lessons and areas for improvement.

DIFFUSION

Once the exercise has been finished, the final report was made and presented at the "Workshop of Presentation of the Analysis of the Potential of Energy Technologies in Spain", in the MINECO offices, on January 29, 2015, by the Secretary of State of Research,

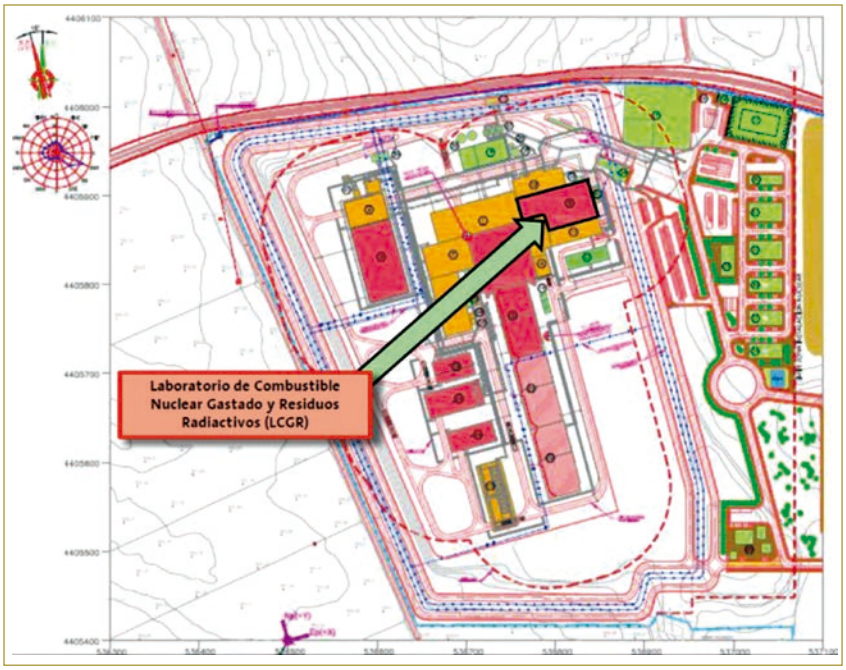

Figure 10. Laboratory of Nuclear Spent Fuel and Radioactive Waste (LCGR) associated to the ATC facility.

Development and Innovation, Carmen Vela, and Cayetano Lopez, the General Director of CIEMAT [8].

In the latest edition of TRANSFIERE, the European Forum for Science, Technology and Innovation, held in February 2015 in Malaga, where technology platforms play an important role, there was a monographic session where 13 energy platforms presented the results of the exercise, in line with the results obtained by each of them, followed by a discussion of the ALINNE exercise and its results.

In the field of the nuclear energy sector, CEIDEN has analyzed the results of this experience, trying to extract lessons learned from it, and giving publicity to the ALINNE exercise, first internally within CEIDEN, and later to all nuclear sector.

CONCLUSIONS

CEIDEN has partcipated with other 12 energy technology platforms, in the exercise called "Analysis of the potential development of energy technologies in Spain", promoted by the Ministry of Economy and Competitiveness and conducted by the ALINNE alliance.

Regarding to the field of nuclear fission, the most significant conclusions and recommendations of the exercise can be summarized as follows:

- The sector entities have developed technology capabilities and export capacity.
- There is ground of R & D in the sector, but there are gaps in the research infrastructure.
- An objective public perception of nuclear energy has to be promoted, laying the bases for a serene and objective social debate.
- A coordinated support system of nuclear R & D at national level is necessary to meet the challenges identified in the sector.
- The sector has an active Technology Platform, which has defined a strategic plan, identified the technological challenges of the sector, and promoted collaborative developments.
- Funding for the R & D sector comes mainly from own resources companies.
- Support for this sector must be specified in public-private projects focused on cooperation and on responding to the technological challenges.
- The participation of Spanish companies in the European program H2020 should be encouraged.
- The use of large European and international scientific facilities and the support collaboration in European technology centers to optimize their use needs should be encouraged.
- There is a good opportunity for infrastructure development of nuclear R&D in the construction of the Technology Associate Center (CTA) to the Centralized Temporary Storage (ATC).

It is expected that the participation of nuclear energy sector in the exercise, through CEIDEN, results in a better understanding of the strengths and weaknesses in terms of technological development of the sector, both internally, and, above all, in regard to instances of the Administration with competences in the subject, and, therefore, can become a tool to facilitate dialogue and support to the sector by these institutions.

From the conclusions and recommendations of the study important lessons arise that should be used to improve the performance of CEIDEN, and in general, all the industry organizations committed to technological developments. All this assuming that some of the results reported in the study are not shared by the participants of CEIDEN, or at least are considered questionable, due to the subjective nature of the exercise.

Participation in the ALINNE exercise has allowed the confrontation of CEIDEN with other energy technology platforms, with the undoubted benefit of mutual knowledge and learning and the possibility of future collaborations.

Finally, participation in this exercise and its diffusion is leading to an increase in visibility and positioning of CEIDEN and of the nuclear sector in the national panorama of energy technologies, which is considered highly beneficial.

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