# CEIDEN TECHNOLOGY PLATFORM: FUTURE TECHNOLOGICAL CHALLENGES


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The purpose of the CEIDEN Technology Platform is to coordinate and support R&D&I activities in the field of Nuclear Fission Energy in Spain. The platform is a channel for proposing and jointly undertaking projects between companies, research centers and universities. All the sectors related to R&D&I are represented in CEIDEN. In the European arena, there is a close relationship between the CEIDEN platform and its European counterpart, the Sustainable Nuclear Energy Technology Platform, SNE-TP.

The Platform functions on the basis of the disinterested work of many collaborators who, with their efforts, contribute content to the CEIDEN activities. The coordinators of the different CEIDEN programs, the members of the Platform Management Council, the people from the Administration who support and help convey messages all of them have helped the platform become, in recent years, the leading reference for Nuclear Fission R&D&I in our country and the coordinator and driver of R&D&I in the Spanish nuclear sector.


## BRIEF HISTORY OF THE CEIDEN PLATFORM

The Nuclear Energy R&D Strategic Committee – CEIDEN – was created in 1999. This Committee was sponsored by the Ministry of Industry and Energy and was chaired by the Deputy Director General for Nuclear Energy at that time, Javier Arana. In 2007, the CEIDEN was set up as a Technology Platform. Since 2009, the Platform Presidency is held by a member of the CSN plenary council. Since 2013, the Vice President of the CSN, Rosario Velasco, is President of the CEIDEN. The Platform is part of the network of platforms maintained by the Ministry of Economy and Competitiveness (MINECO), which are coordinated by the General Directorate for Research, Development and Innovation Policy, whose director is currently Maria Luisa Castaño and which reports to the Secretary of State, who at present is Carmen Vela.

## ORGANIZATION OF THE CEIDEN PLATFORM

The CEIDEN Platform is a non-legal entity without its own budget. The CEIDEN mission is *to undertake R&D&I activities that focus on the safe, reliable, efficient operation of the current nuclear facilities and the nuclear fuel cycle and the development of possible new nuclear projects.*

The CEIDEN executive body is the Management Council (Consejo Gestor - CG), which meets three or four times a year. The CG is structured by subsectors, which ensures that all the agents of Spanish nucle-

ar R&D&I are fully represented on the governing body. The composition of the CG has been evolving and growing, with the basic objective of optimizing its operations and making it more open and participative. The 11 subsectors at present are:

- electric utilities
- fuel cycle businesses
- R&D&I institutes / technology centers.
- universities
- engineering and construction firms
- equipment manufacturers
- service firms
- SMEs
- regulatory body (CSN)
- ministry responsible for nuclear energy (MINETUR)
- ministry responsible for R&D&I (MINECO)

In recent years, apart from performing its primary function of directing, following up and managing the platform, efforts have been make to turn the CG into a true participative forum for information, exchange and discussion of new proposals.

In addition, the CEIDEN General Assembly (GA) is held every year. The main purpose of this meeting, which is open to all interested parties, is to review the main activities and results obtained, but it is also a forum for proposing and discussing the members' ideas and initiatives. At present, there are more than 100 members of the CEIDEN, and this year the 10th General Assembly and the 30th Management Council meeting are to be held.


**Figure 1.** Technological Challenges of the Spanish Nuclear Sector.

The **Technical Program** of the Platform is divided into different activities, each with a different scope and operating mode: the *CEIDEN Programs* which address a wide range of topics (e.g. Irradiated fuel dry storage and transport program), *CEIDEN Projects* (ZIRP (Zorita Internal Research Project) and Zorita Concrete, JHR, ESNII, etc.), *CEIDEN Standing Groups* (e.g. Training "F+", Knowledge Management "KEEP", Neutron Standards Laboratory Users Groups "GULP"), *CEIDEN ad hoc groups* (e.g. Work group on material degradation "GTDM"), *Horizontal follow-up activities* (e.g. Euratom-H2020 program, SNE-TP activities), CEIDEN Studies (e.g. Nuclear sector capabilities project Phases I and II), the so-called CEIDEN Tasks (e.g. Analysis of nuclear R&D&I investments in Spain, drafting of a Simulation Capabilities Catalogue, drafting of a CEIDEN Activities Map, drafting of a Infrastructures Catalogue, etc.), *Socio-technical Projects* (e.g. History of Nuclear Energy and Society "Honest"), etc.

These activities have been described in previous SNE articles and papers and therefore this article will focus more on future aspects of the Platform.

Source: Enresa. José Cabrera NPP dismantling, cutting of concrete.

## NUCLEAR SECTOR CHALLENGES. PLATFORM STRATEGIC AGENDA

The nuclear sector in our country currently faces a series of challenges, which are similar to those identified in the international arena:

– The nuclear fleet is approaching 40 years in operation (already exceeded by Santa Maria de Garoña NPP). Long-Term Operation (LTO) is a goal of the Spanish nuclear sector, with safe, reliable, efficient plant operation.
– Spent fuel and waste management is another sector challenge. The characterization of the fuel in the NPP pools, its transfer to Intermediate Temporary Storage Facilities (ATIs), its management in the future Centralized Temporary Stor-

SNE Annual Meeting Plenary Session. President of the CEIDEN Platform, President of the SNE-TP Platform, Director of the JRC IET, and representatives of EPRI and IRSN.

CEIDEN 9th General Assembly. ETSIIM (UPM).

age Facility (ATC) and its final management in the Deep Geological Storage Facility (AGP) all pose a series of technological challenges to which R&D&I can offer solutions.
- Because of the country's current situation, no new nuclear projects in the short-medium term are likely. However, the new technological developments that are taking place in other countries can be applied to our operating plants. One example of these new technological developments is the digitization of instrumentation and control systems. On the other hand, the entities of the Spanish nuclear sector are very active internationally, including participation in the construction of new nuclear projects around the world.

In 2013, the CEIDEN Platform defined a new Strategic Agenda that identifies these three technological challenges. The objective of the platform is to group together the existing programs/projects, and any new ones that may arise, under one of these identified challenges (Figure 1).

These challenges were detailed in the definition of the 2014-2015 Objectives, for which 18 courses of action were developed, and these in turn included 62 types of activities. Some significant results have been:
- Increased participation in the CEIDEN activities.
- More programs and projects.
- More national and European aid obtained.
- Increase in extent of international relations at the national, European, Latin American and international levels.
- More and better CEIDEN documentation, dissemination and communication.

After the 2014-2015 period, a detailed analysis and self-assessment of the results obtained were carried out to help define the objectives of the 2016-2017 two-year period, to be approved in the 10th General Assembly to be held this year 2016.

## PRIORITY TECHNOLOGICAL INITIATIVES (ITP) OF THE ALINNE ALLIANCE

The Alliance for Energy Research and Innovation – ALINNE – is a non-profit initiative that was founded to join forces and coordinate efforts among all the agents of the energy R&D&I value chain, in order to respond to the main challenges of R&D&I policy in the energy sector, thus contributing to the definition of national work guidelines and European positioning. ALINNE was formally established on June 30, 2011, promoted by the then Minister of Science and Technology, Cristina Garmendia, and it is supported by the current Secretary of State for Research, Development and Innovation, Carmen Vela. The position of Secretary of ALINNE is currently held by the CIEMAT.

The fundamental purpose of ALINNE is to propose actions to boost the efficiency and effectiveness of our research and innovation system in the field of energy, to thus contribute to the consolidation of existing strengths and to drive the internationalization of its capabilities and competencies. The initiative for "Analysis of the Development Potential of Energy Technologies in Spain" was launched in 2013, with the active participation of the Platform.

ALINNE has recently launched the proposal to define and develop the so-called "Priority Technological Initiatives" (ITP) that target each technology sector. ALINNE defines an ITP as:

*A large scale technological development that enables Spanish technology to develop an industrial fabric and cover a significant technological market share (national and international), both in terms of its economic return and other tangibles and intangibles of high intrinsic value (employment, sustainability, etc.) in a not-so-distant future. Therefore, the development of an ITP justifies a focused, sustained commitment of economic resources and human capital, as well as the establishment of a favorable framework for implementation.*

The CEIDEN platform has received this proposal with great interest, considering that it could be an important element to contribute to the development of cutting-edge technologies in our country. Consequently, the CEIDEN has developed three ITPs, **which are perfectly aligned with the technological challenges defined in the Platform's strategic agenda**:

1. Long-term operation
2. Spent fuel and high-level waste management
3. New technological capabilities

The very process of developing the CEIDEN ITPs is turning out to be very

28th CEIDEN Management Council meeting in ENDESA.

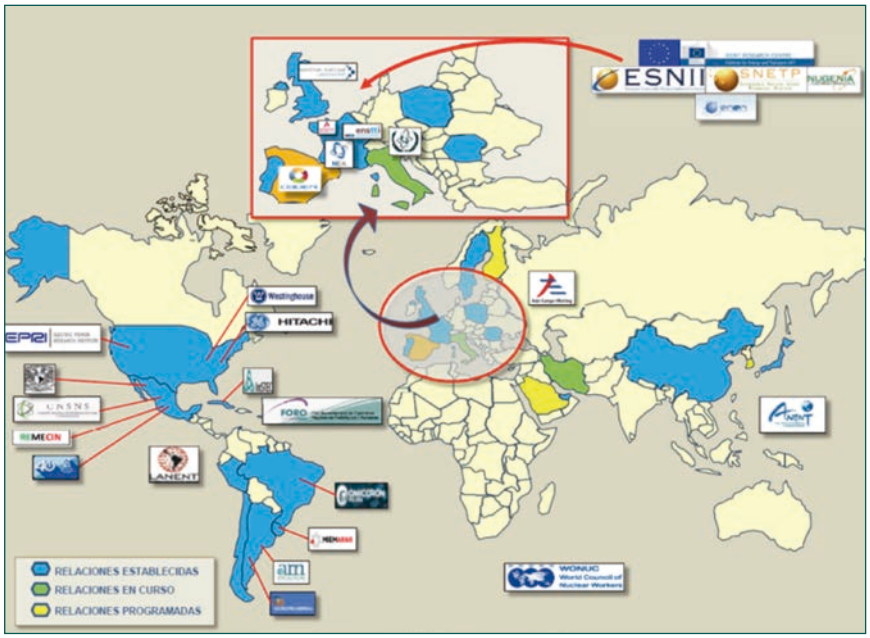
enriching and enlightening for the entities that are directly participating in it. As a result, regardless of the final impact that this exercise will have, we can affirm that for CEIDEN it is a milestone in the development of its strategy to deploy technology policies.

## Long-term operation

Nuclear development in Spain began in the late 1950s with the construction of the Jose Cabrera NPP. Since that time and up to the present day, a major business fabric has been created around this industry, in all the links of the value chain, with more than 200 companies that operate not only in Spain but also in another 40 countries, where they have been gaining a well-deserved prestige.

The average age of the world's nuclear power plants is around 30 years; 250 of the 440 existing reactors are more than 30 years old and the situation is very similar on our continent and in the European Union countries. The average age of the Spanish plants also exceeds 30 years.

As the end of the design life for which these plants were designed (40 years, as in the case of the Spanish nuclear power plants, is a typical period) draws near, their owners consider the possibility of applying for an extension of operation (to 60 years or more), supported by adequate management of the ageing of structures, systems and components, as well as by technological upgrading, safety levels and high reliability.




Map of CEIDEN International Relations.

The paradigmatic case of Long-Term Operation (LTO) is the United States, which is the source of the technology of most of the operating nuclear power plants in Spain. In that country, there are 38 units operating for more than 40 years, 84 nuclear units have a license to operate until 60 years, and there are joint R&D studies by the American regulator and the industry to analyze the possibility of operating the plants to up until 80 years. In Europe, countries such as Switzerland, Belgium, Sweden, United Kingdom and Holland are operating plants beyond 40 years. LTO is thus an international reality of the nuclear sector.

A necessary condition for this is that the plant must meet the regulatory requirements, which should be supervised by the corresponding National Regulator.

Long-Term Operation is a technical decision, but it is always a more economically appealing option for countries that have NPPs than the construction of new plants. Furthermore, it makes a very significant contribution to emission-free generation. For instance, the Spanish nuclear fleet prevents the emission of 55 million tons of $CO_2$/year to the atmosphere; these emissions are equivalent to all those produced by the fleet of vehicles in circulation. Therefore, long-term operation of the nuclear fleet ensures compliance with the commitments demanded by society to reduce emissions.

In the European Commission's Staff Working Document (2016) 102, it is estimated that Long-Term Operation will require investments of more than 38,000 million EUR in the European Union over the next 15 years.

The purpose of the activities carried out for Long-Term Operation is to ensure that the structures, systems and components will maintain their capacity to perform their safety functions, in the event that the operating period is extended, in spite of the ageing process that they will experience.

Spanish companies and their human resources are technically qualified to confront this challenge in Spain and abroad, as demonstrated by the execution of a multitude

Construction of the Jules Horowitz Research Reactor in Cadarache (France).

of projects in the far-reaching field of ageing management and life extension in our plants and in other countries. It can be safely said that, in Spain, there are proven capabilities to take on Long-Term Operation projects that constantly pose technological challenges to be overcome.

### Spent Fuel and High-Level Waste Management

The greatest challenge faced by technicians, authorities and policy-makers in the nuclear field is to assure the safety of people and the environment.

The use of nuclear in the industrial, medical, electricity generation, agro-food and environmental sectors results in the production of different categories of radioactive wastes that should be safely and sustainably managed in an environmentally friendly way for the present and future generations. Thus there is a need for research – with considerable intellectual and financial resources – into techniques aimed at minimizing the effects of these wastes and reducing their volume, and for this purpose it is advisable to join forces at several levels and to share expenses and results.

In this respect, some decades ago several pioneering countries in the nuclear field, including Spain, jointly allotted resources to fostering R&D applied to spent fuel (SF) and radioactive wastes. This is making it possible, through know-how and tools, to further the development of safe, suitable, acceptable and reliable management mechanisms and to explore options for a better understanding, handling and transformation thereof.

Spain originally opted for reprocessing the SF from the Vandellós I, Jose Cabrera and Santa Maria de Garoña NPPs. This practice was interrupted in 1982, except for the first of these 3 plants which ceased operation in 1989 and whose fuel, which was a different type than that of the light-water plants, had to be fully reprocessed due to technical reasons.

Since 1982, all the light-water plant SF that has been produced in the Spanish nuclear fleet has been stored in the plant pools. In view of the anticipated saturation of the capacity of these pools, in the decade of the 1990s the original racks were progressively replaced with other more compact ones, which in most cases has made it possible to postpone the need to provide the Spanish system with SF storage capacity other than that of the pools themselves.

The basic strategy considered by Spain currently focuses on the operation of a **centralized temporary storage facility (ATC)** for spent fuel and high- and medium-level wastes. It is expected that part of this infrastructure can start operating soon. This facility will be part of a technology park that would have an associated technology center and infrastructures to help companies set up business in the region.

This temporary facility is a prior step to the final disposal of the SF and high-level waste in a Deep Geological Repository (DGR), a project that Spain must undertake in the coming years in accordance with European Directive 70/2011.

In Spain, the open fuel cycle is applied, i.e., the option of reprocessing the spent nuclear fuel is not currently considered. However, the recycling of actinides in advanced reactors (e.g. Generation IV), which is considered in other countries, could maximize the energy use of uranium already refined in mining and reduce the inventories of long-lived radioactive wastes and the demands for final storage; therefore it is advisable to acquire and develop the knowledge of these techniques and their implication in the inventory to be stored in the DGR through international collaboration projects.

The objectives of the Technology Center associated with the ATC (CTA) respond to the need for R&D in Enresa, in compliance with the current Science Act as regards its provisions to "promote scientific and technical research, innovation and knowledge transfer that would materialize with the creation of infrastructures and structures to support research, as well as the promotion of technology centers".

Specifically, the CTA will help to implement the research, development and demonstration activities required to offer solutions both in the field of spent nuclear fuel and radioactive waste management and in the dismantling and decommissioning of nuclear facilities. For this purpose, it should develop R&D projects, execute technology development projects, improve the surrounding technology and manage knowledge, thus creating a relevant place for national and international scientists and researchers focused on the safe management of radioactive wastes.

### New Technological Capabilities

Whether or not the decision is made to extend operation of the Span-

CEIDEN-NNL meeting in Sellafield (UK).

Meeting to present the Analysis of the Energy Technology Development Potential in Spain, attended by the Secretary of State for Research, Development and Innovation, Carmen Vela, 29 January 2015.

ish reactors beyond 40 years (related to the first ITP), these plants are executing upgrade and modernization programs. The modifications are associated with the ongoing review of the plant safety standards and their subsequent improvement or the natural obsolescence of the equipment in any industrial facility. There is also a need to be more efficient in order to trade on a more competitive electric power market. These needs include the ability to regulate load or the development of new accident-tolerant fuels.

Last but not least, it only seems logical to apply the advantages of the new technologies (in particular the digital technologies) to the systems of our nuclear power plants, which were designed with older technologies. Migration to digital technology systems (basically I&C and information management systems) in nuclear power plants entails a technological challenge and also a regulatory challenge, because the applicable standards must be revised. Attention must also be paid to the opportunities provided by new materials (graphene, nanomaterials) for use in nuclear power plants.

In the international market, there are currently four reactors under construction in the European Union and 70 around the world, and the nuclear capacity in Europe is expected to increase by around 100 GW in the next 30 years with investments approaching 400,000 million EUR.

This is especially important if we remember that Spanish technology is present in the leading international projects.

Thus there is a considerable need for new products and services linked to the use of the new digital technologies in different operating areas of the plant, whether it be newly built or in operation.

Each of the ITPs defined above should cover the following aspects:

- Qualitative definition of the proposed ITP.
- SWOT analysis.
- Identification of the Total Addressable Market (TAM).
- Profile of the product obtained.
- Resources needed for development.
- Non-financial, legal and regulatory aspects.
- Job and knowledge creation.

Early work on the ITPs has begun. A detailed analysis of each of the proposed ITPs will enable the Platform to ascertain the status of R&D&I in each of the technological challenges, to analyze what has already been done, what is being done and what is left to be done, and the economic, employment and educational contribution in our country. This analysis will give rise to specific R&D&I projects that will be included in the CEIDEN project portfolio at the national, European and international levels.

## CONCLUSIONS

Since 2013, the CEIDEN Technology Platform has launched new initiatives that have broadened the Platform's aim and activities (international organizations such as NEA and IAEA, embassies, etc.), it has made its activities and objectives known in Spain and abroad, it has increased the number of collaborating entities and international contacts, it has signed more collaboration agreements (EPRI, Latin American entities, etc.) and held bilateral meetings with countries such as UK (visit to Sellafield with the Nuclear National Laboratory NNL, France, Japan, etc.), and it has taken part in international exercises such as the NEA's NI2050 (Nuclear Innovation Roadmap).

All these activities have helped the platform become the main contact point for National Nuclear Fission R&D&I activities.

The future plans for the Platform activities are based on its Strategic Agenda, where the Technology Challenges of the Sector and the Platform objectives for each two-year period (currently 2016-2017) are identified. Definition of the ALINNE ITP will allow the Platform to define the present situation of the sector in relation to these challenges and new activities to be undertaken in the framework of nuclear R&D&I, and to position the nuclear sector within the energy sector, emphasizing its advantages for the economy and competitiveness of our country. ■