

**UNA ORGANIZACIÓN
INNOVADORA**

2014

AN INNOVATIVE FIRM



EMPRESARIOS AGRUPADOS

Magallanes 3, 28015 Madrid, Spain
Tel.: (+34) 91 309 80 00. Fax: (+34) 91 591 26 55
www.empre.es



Empresarios Agrupados (EA) is an architect-engineering organisation founded in 1971 to support the launching of an ambitious nuclear power generation programme in Spain.

It was established as an operationally independent joint venture of three engineering companies which would provide human and financial resources, as required, for designing and managing the nuclear power plants to be built.

Today, a group of four companies are partners in EA: Técnicas Reunidas, S.A, GHESA Ingeniería y Tecnología, S.A., Iberdrola Ingeniería y Construcción, S.A.U., and Gas Natural Fenosa Engineering, S.L.U.

Overall management of EA's activities is entrusted to an economic interest grouping, Empresarios Agrupados AIE. For work on projects in countries other than Spain, a public limited company was set up, Empresarios Agrupados Internacional, S.A. (EAI). Diversification into aerospace technology led to the creation of the firm Ibérica del Espacio, S.A. (IE).

EA makes use of the human and financial resources of its partner companies depending on the needs of each project. The overall EA Group of Companies has around 9,000 employees, of whom 1,000 are integrated into EA on a permanent basis.

EA is ranked among the top 200 largest international design companies by the American trade magazine *Engineering News-Record*.

QUALIFICATION IN THE FIELD OF NUCLEAR POWER

EA's primary mission in the beginning was to gain initial qualification to work in the field of nuclear power generation, coinciding with the launch of the design and construction of the Almaraz Nuclear Power Plant in Spain in 1971. The process was organised based on the partners' extensive experience in fossil-fired power plant, large civil infrastructure and petrochemical plant projects, and a long-term collaboration agreement with an American engineering and design company from New York, Gibbs & Hill, Inc. (GHI).



Almaraz NPP (PWR-W 2x980 MWe)

Several nuclear projects were undertaken by EA in Spain, and by the end of a 10-year period, the technology transfer process had concluded. The complete plant design, equipment supply procurement, overall construction management and plant testing and startup were all now within the scope of EA. This was the case in the Trillo NPP project, for which EA was the Architect-Engineer and

which required some 10 million man-hours, employing a peak workforce of 1,400 employees, 65% of whom were university graduates.

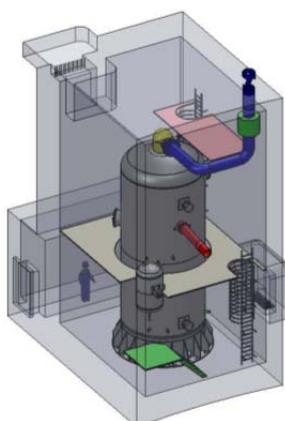
SUPPORT TO SPANISH NUCLEAR POWER PLANTS IN OPERATION

Nuclear power plants require ongoing external technical support for resolving incidents, adapting to new safety criteria, updating the technology, monitoring material ageing and performing special operations such as uprating, useful life extension, and so forth.



Trillo NPP (PWR-KWU 1050 MWe)

Empresarios Agrupados has kept pace with new technologies so as to be able to provide this support both to the plants it designed itself as well as to other nuclear power plants in Spain and abroad.



After Fukushima in 2011, EA has played an important role in engineering and designing improvement actions resulting from the stress tests performed on Spanish NPPs. As regards measures implemented as a result of the stress tests, and in addition to the engineering activities it has carried out, EA, in consortium with the Swiss company CCI A.G., is now performing the turnkey engineering, supply, construction and testing of the Containment Vent System for Almaraz I & II and Trillo NPPs.

OPENING UP TO INTERNATIONAL MARKETS

EA has aggressively developed its technological and commercial approach, and as a result has been awarded contracts in the field of nuclear power in a number of foreign countries:

- Engineering work in the USA, including Comanche Peak 1 and 2 NPP, as well as other services in plants at LaSalle, Hope Creek, Haddam Neck and Calvert Cliffs, now in operation.
- EA has carried out work on improving the safety of nuclear power plants in several countries that were former republics of the Soviet Union, financed by the European Union's TACIS and PHARE programmes and by the European Bank for Reconstruction and Development (EBRD).
- EA has been contracted as the utility's in-house consultant (Owner's Engineer) in the contractor selection contests for the construction of new nuclear power plants in Turkey, Finland, the Czech Republic, Lithuania and Switzerland.



Angra II NPP (PWR, Siemens 1300 MWe) Brasil

- EA has done engineering work for the Laguna Verde 1 & 2 nuclear power plants (Mexico) as well as for the nuclear plants of Atucha 2 (Argentina), Angra 1 (Brazil), Angra 2 (Brazil), Montalto di Castro (Italy), Enrico Fermi 1 & 2 (Italy), Leibstadt (Switzerland) and Mochovce (Slovakia).
- As contractor to General Electric (GE), EA has carried out important engineering work over the past 10 years for Lungmen NPP (Taiwan).
- EA has been working for more than 4 years on the design of the Pebble Bed Modular Reactor (PBMR), an advanced Generation IV (Gen-IV) nuclear power plant in the Republic of South Africa based on 165 MWe modules using high temperature gas technology. Equipos Nucleares, S.A.

(ENSA) has been awarded the supply of the Main Power System Pressure Boundary of the prototype of this plant, designed by EA.

DECOMMISSIONING AND WASTE MANAGEMENT

EA is carrying out projects in radioactive waste management, covering everything from its generation in nuclear power plants and other nuclear facilities up to its final storage.

- In consortium with Westinghouse, two of EA's partners (TRSA and GHESA) have been selected by ENRESA to design the Centralized Interim Storage Facility (CISF). The facility will be constructed in Spain and will temporarily store all of the spent nuclear fuel generated by the nuclear power plants now operating in the country until a final repository is designed and built. The consortium has also been awarded the contract for the overall engineering services and detail design, as well as the documentation necessary to contract the civil works, equipment purchasing and final safety study for the spent fuel and radioactive wastes laboratory.
- EA is also participating in a consortium with Iberdrola and Indra that has been entrusted with project management of the decommissioning of units 1 and 2 of Bohunice NPP (VVER 230) in Slovakia, contracted by JAVYS, the Slovak national waste management company. The contract is funded by EBRD.
- Also with EBRD funding, SERAW (Staten Enterprise Radwaste) has awarded the consortium formed by EA and the British company NUVA, of which EA is the lead, the consulting and project management services contract for the decommissioning of units 1 and 4 of Kozluduy NPP (VVER 230) and for the construction of the national low- and medium-activity radioactive waste storage facility in Bulgaria.

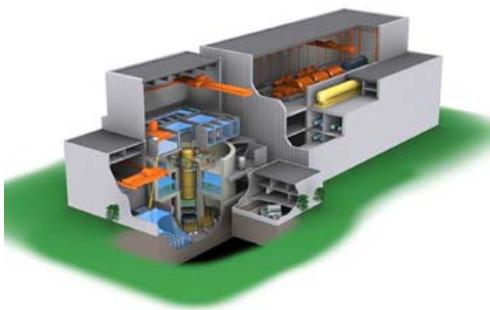


Bohunice V-3 NPP (JESS-Slovakia)

PARTICIPATION IN R&D PROGRAMMES

EA is participating actively in a number of R&D programmes in the field of nuclear power:

- EA participated in the development of the Generation III and III+ reactors, Westinghouse's APWR and AP1000 reactors, and GE's ABWR and SBWR within the American programme for the US Nuclear Regulatory Commission (NRC) certification of Advanced Nuclear Power Plants.
- EA's participation in the development of the ABWR (Gen-III) led to important engineering contracts from GE for services to be executed in Taiwan.



ESBWR (GE, 1600 MWe)

- Since 1997, EA has been participating in the development of a new type of reactor for GE - the passive ESBWR (Gen-III+). Its deployment in the USA under the Nuclear Power Program 2010 of the United States Department of Energy (DOE) is envisioned for 2015. EA and the DOE have financed this participation 50-50.
- EA plays an active role in a variety of European Union R&D programmes in the nuclear field. These include the gas-cooled reactor programmes, the Very High Temperature Reactor (RAPHAEL) and Gas-Cooled Fast Reactor (GCFR), and liquid-metal cooled reactors in the EISOFRAR, ELSY, EUROTRANS and CDT projects, all of which involve the new technologies for the future Gen-IV systems being designed for power generation, transmutation and other applications.
- EA is currently carrying out the FEED engineering of the Myrrha project, in collaboration with Areva and Ansaldo. This is a fast-breeder reactor equipped with a proton accelerator designed to demonstrate future technologies and produce radioactive sources and which will be built in Döel (Belgium).
- EA is also participating in European Union R&D programmes on energy in general, and specifically in the hydrogen generation programmes.

- EA is part of the group of European companies that has been developing the ITER Project design over the past 16 years to demonstrate nuclear fusion technology in a large-scale experiment.
- EA is currently participating in a relevant manner in the material execution phase of ITER at the Cadarache site (France), as part of the European consortium ENGAGE entrusted with designing the buildings, infrastructures and electrical system of the ITER project. EA has also been awarded, in consortium with Inabensa, the project for the design and supply of the main system of nuclear safety-related signals and cabinets for first plasma control of the plant.



ITER Project

DIVERSIFICATION

The 1983 decision to halt the nuclear power plant construction programme in Spain led to the need to find areas for diversification using existing technological capabilities. Identified among such areas were thermal power plants, the European space programme, and various one-off, singular projects.



Brazi Combined Cycle Power Plant, Romania
(2x2x1 multi-shaft, 865 MW)

Thermal Power Plants

In the late 1970s, EA began undertaking the complete design and engineering projects of coal-fired thermal power plants, of which 14 were built: 8 in Spain, 2 in Mexico, 1 in the Philippines, 2 in Chile and 1 in Argentina. EA also began performing consulting work in this field. To date, 31 coal-fired and fuel oil-fired power

plant projects have been completed or are under construction, with a combined power output of 17,325 MW.

EA is developing the engineering and design of the largest thermoelectric project now under way, Yanbu 3, in Saudi Arabia. This consists of five units with supercritical, dual fuel (heavy fuel and gas) boilers that will produce a total of 2708 MW, as well as export steam for a desalination facility producing 550,000 m³/day.

In the early 2000s, new power generation in many countries focused primarily on using natural gas as fuel, by way of combined cycle power plants featuring high thermodynamic performance and a lessened impact on the environment. EA entered this field decisively, participating in 47 projects with a combined power of 28,927 MW. Of these, 12, with an overall installed power of 6,986 MW, are currently under construction. More than 60% of these projects are located abroad.

CO₂ Capture

EA is participating in the OXY-CFB-300 project. This is an integral commercial demonstration project, including CO₂ capture, transport and storage. The project falls within the European framework to foster clean carbon technologies for the production of electrical power. It is based on a 330 MWe oxycombustion power plant with a supercritical Circulating Fluidised Bed (CFB) boiler, and featuring subsequent CO₂ storage in a saline aquifer.



OXYCFB300

European Space Programme

In the late 1980s, EA diversified its activities into the aerospace field.

The strategy materialised in the form of the company Ibérica del Espacio, S.A. (IberEspacio). IberEspacio's work initially centred on the Ariane 4 and Ariane 5 space launchers and included System Simulation, Advanced Structural Analysis, Reliability, Flight Data Analysis, etc.



Cryogenic Engine. Ariane 5

The skills for carrying out these activities came mainly from our experience in the nuclear field. In the area of System Simulation, even before IberEspacio was created, EA had an agreement with the European Space Agency (ESA) to develop a computer program, EcosimPro, specially designed to run dynamic simulations of life support systems in manned space vehicles. Later on, through co-financing with ESA, the computer program was equipped with new associated libraries and refocused towards dynamic simulation of more universal systems. EcosimPro is now ESA's space

propulsion simulation program, using the ESPSS library, currently being developed by EA. EA continues to develop and commercialise EcosimPro, now used, among others, by NASA, its Canadian counterpart CSA, CNES in France and India's ISRO.

IberEspacio is currently developing a new line of business involving the design and supply of heat transfer systems based on capillary fluid circulation with phase change between the cold and hot sources. These systems are aimed initially at cooling the electronic systems of satellites while in space, although other future applications of great interest are envisaged.

Singular Projects

EA has maintained a strategy of carrying out unique, singular projects that require special skills and capacities. The following are eight of these undertakings:

- Dynamic structural study of the in-flight behaviour of the nozzle throat of the Ariane 4 VIKING engine. The enormous number of nonlinearities in the behaviour of compound materials made it necessary to fine-tune a highly sophisticated complex analysis process. The results were used to analyse the causes of the problems detected in the equipment and to find solutions to improve its structural behaviour.

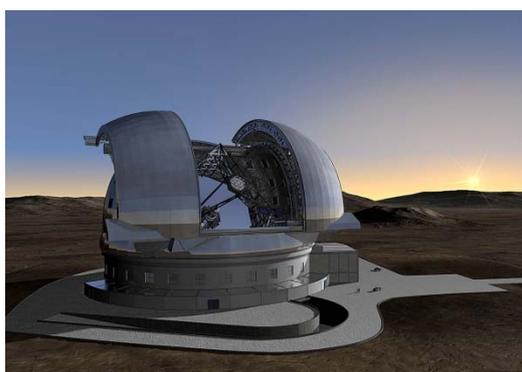


Motor Viking de Ariane 4

- Reliability study of the NASA space shuttle. A probabilistic safety analysis was carried out of the space shuttle main engine (SSME) and of the reusable solid rocket motor (RSRM).
- Making use of its capabilities in dynamic simulation, EA has worked on the VIVACE programme of the 6th EU Framework Programme, developing the computer program PROOSIS, an aircraft engine simulation tool to be shared by all European industry. The idea is to impose a standard that will facilitate joint participation by industry in the design of new motors. PROOSIS has already been purchased and implemented as design tool by several aircraft engine manufacturers.



- Design of the Dome and the Mechanics of the GRANTECAN Telescope in La Palma Island (Spain). It is one of the largest telescopes in the world (its primary mirror is 10.4 m in diameter). In collaboration with IberEspacio and GHESA, EA developed the basic structural design of the telescope and the detail design and supply of the complete dome and mobile structure with all associated mechanics and elements for telescope movement and positioning. EA is responsible for supervising the installation of these elements, as well as for their testing and fine-tuning.



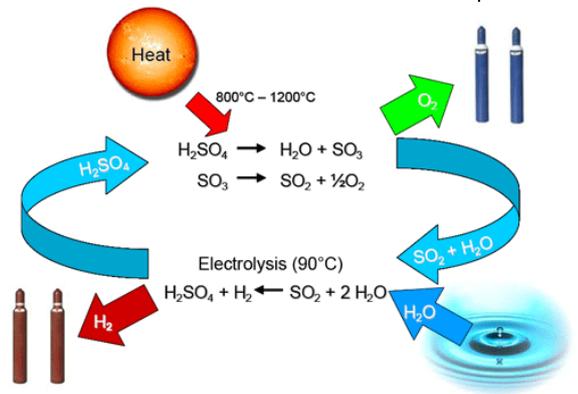
E-ELT Telescope – 39 m Primary Mirror

- Design (FEED) of the Mechanics of the next-generation European Extra Large Telescope (E-ELT), equipped with a 39 m diameter primary mirror. The main structure, with its corresponding azimuth and elevation drives, will weigh over 3,000 t but feature precision pointing and tracking. Ea has developed the design and submitted a binding proposal to ESO to be global supplier of the telescope mechanics.

- Structure and mechanisms of the Large Synoptic Survey Telescope (LSST) to be built in Atacama, Chile for the Association of Universities for Research in Astronomy (AURA). EA is responsible for the project

management, performance of the engineering and design, supply management and construction, and supervision of erection and testing.

- Participation in projects within the EU Framework Programme aimed at demonstrating the viability of generating hydrogen using high temperature processes: HYTHEC (Hydrogen Production by Thermochemical Cycles), INNOHYP-CA (Innovative high-temperature processes for Hydrogen Production) and HYCYCLES (Materials and Components for Hydrogen



Production by Sulphur Based Thermochemical Cycles). EA has been entrusted with coupling these thermochemical processes to the future high temperature reactors or solar furnaces. The projects continue in FP7 Gen-IV activities.

- Participation in the design of a pilot CO₂ capture and H₂ production plant in the Puertollano Integrated Coal Gasification Combined Cycle (IGCC) Power Plant in Puertollano (Spain)

ACRONYMS

ABWR	Advanced Boiling Water Reactor
AENA	Aeropuertos Españoles y Navegación Aérea
AP-1000	Advanced Pressurized Water Reactor ~ 1000 MW
APWR	Advanced Pressurized Water Reactor
CISF	Centralized Interim Storage Facility
EBRD	European Bank for Reconstruction and Development
BWR	Boiling Water Reactor
DOE	Department of Energy (USA)
EA	Empresarios Agrupados
EAI	Empresarios Agrupados Internacional, S.A.
E-ELT	European Extra Large Telescope
ENSA	Equipos Nucleares, S.A.
ESA	European Space Agency
ESBWR	Economic Simplified Boiling Water Reactor
ESO	European Southern Observatory
ESPSS	European Space Propulsion System Simulation (EcosimPro library)
FEED	Front-End Engineering and Design
GE	General Electric
GHI	Gibbs & Hill, Inc. (New York)
GRANTECAN	Gran Telescopio de Canarias
ITER	International Thermonuclear Experimental Reactor
NRC	Nuclear Regulatory Commission (USA)
PBMR	Pebble Bed Modular Reactor
PHARE	EU programme for technical assistance to countries of Central and Eastern Europe
PWR	Pressurized Water Reactor
SBWR	Simplified Boiling Water Reactor
TACIS	Technical Assistance for Commonwealth of Independent States (EU programme)
W	Westinghouse