



03. Management of capitals

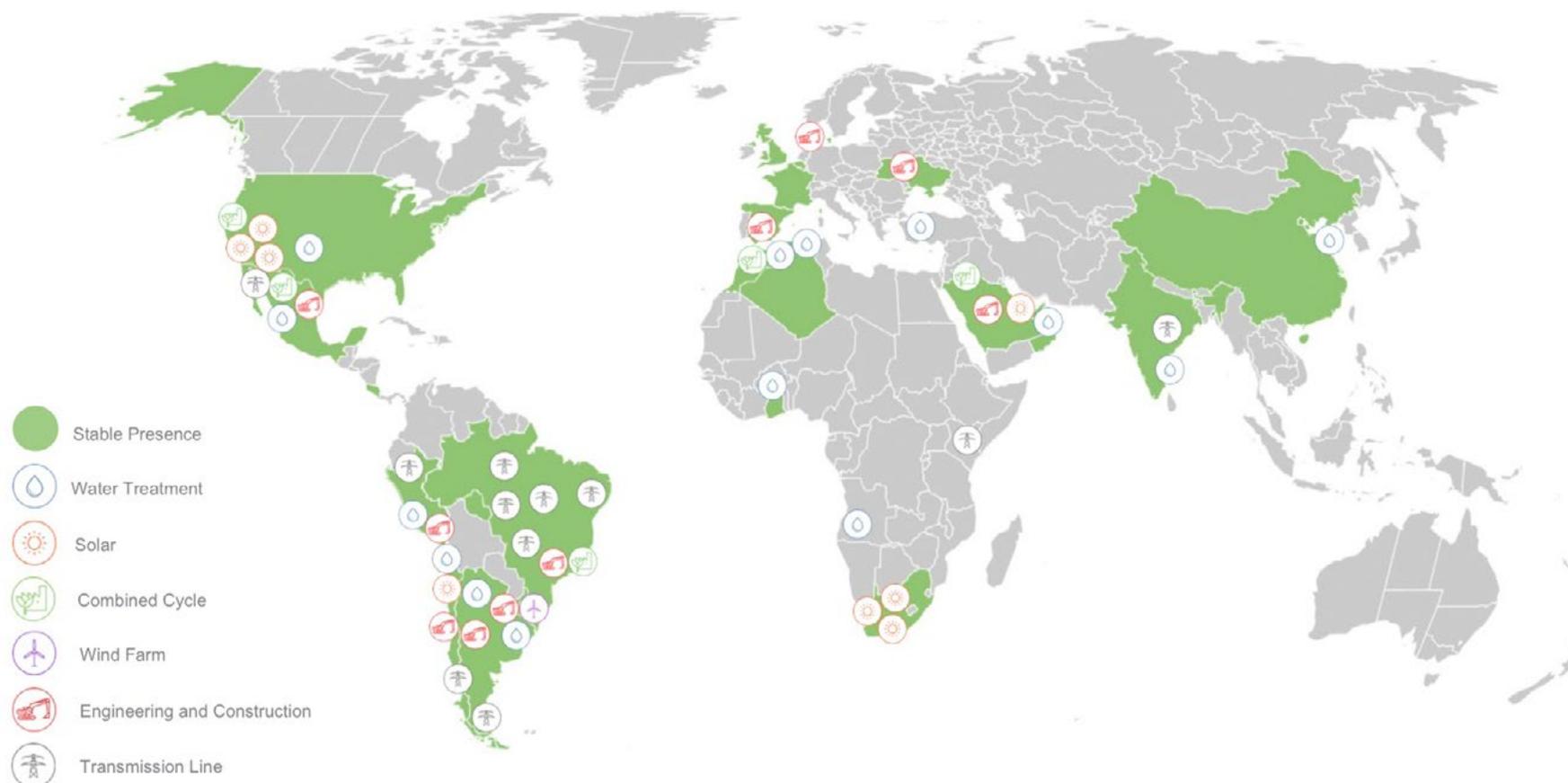
03.2 Industrial capital

Projects in which the company works

Abengoa performs its activities based on a vertical functional composition as well as a geographical criterion.

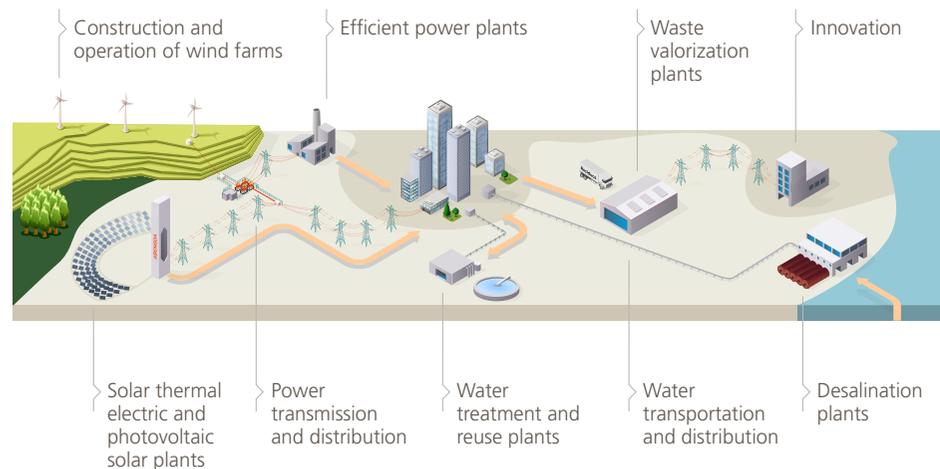
From the point of view of the products and services, these appear grouped in vertical sectorial areas, pooling, respectively, the activities of Energy, Water, Transmission and Infrastructure, and those of Services.

Geographically, there are countries and geographical regions that have a marked strategic nature for Abengoa -defined in its feasibility plan- and where the company is focusing its activity at this time. In these areas we must include South America (Argentina, Brazil, Chile, Peru and Uruguay), North America (United States and Mexico), Europe (Belgium, Denmark, France and United Kingdom), Africa (Algeria, Ghana, Kenya, Morocco and South Africa) and the Middle East (Saudi Arabia, United Arab Emirates, Oman and Qatar). In these countries, the company focuses its activity on both new EPC operations and management of remaining assets.



Projects by activity

Abengoa, having completed its financial restructuring process and faithful to what is established in its feasibility plan, performs its activity as a specialist in engineering and construction projects, in the energy, water, transmission and infrastructure sectors, and services.



 Energy	 Water	 Transmission and infrastructures	 Services
<ul style="list-style-type: none"> > Conventional generation > Solar power > Waste to energy > Eolic > Biomass 	<ul style="list-style-type: none"> > Desalination > Water treatment > Hydraulic infrastructures > Industrial water 	<ul style="list-style-type: none"> > Transmission and distribution > Railway > Installations and infrastructures > Auxiliary manufacturing > Engineering 	<ul style="list-style-type: none"> > Operation and maintenance > Manufacture of metal structures > Engineering and plant optimisation services

Despite what has happened in recent years, **the company continues to be a benchmark in the global EPC** (Engineering, Procurement and Construction) market. Proof of this can be seen in the new contracts obtained and the successful completion of reference projects as a result of the know-how acquired through more than seventy years' experience.

By areas of activity, these are the main milestones achieved by the company in 2017.

Energy



Image of the works that Abengoa is developing in Saudi Arabia in Waad Al Shamal plant.

Through its Energy business, Abengoa integrates the activities of business development, promotion, bids, engineering, technology and project performance, referring to the generation business, more specifically through combined-cycle plants, cogeneration, solar thermal plants, photovoltaic plants, windfarms, biomass and Waste To Energy (W2E). It covers the entire value chain of turnkey projects or EPC, from the commercial phase, design and basic and detail engineering through to construction and start-up.

Conventional generation



Combined-cycle power plant in Centro Morelos, Mexico.

Abengoa has 9 GW of installed power in conventional generation plants, split between single and combined cycles, conversion of single to combined cycles, motor and cogeneration power plants.

During 2017, Abengoa continued with the construction of the third 220 MW cogeneration plant, together with the Nuevo Pemex Gas Processing Complex in Mexico.

It also received provisional acceptance of the Centro Morelos combined-cycle plant in Mexico, which will produce 640 MW.

At plants that produce electricity using motors, it obtained final acceptance of the Baja California Sur IV power plant, Mexico, in operation since 2014, and which has installed capacity of 42 MW.

As a step forward in its feasibility plan, Abengoa secured the sale in Mexico of the Norte III combined-cycle plant.

Solar power



Photovoltaic plant developed by Abengoa in California.

Abengoa develops solar power generation plants using solar thermal technology and photovoltaic technology.

Power-tower solar thermal technology allows the production of electricity by concentrating the solar energy captured, through a field of heliostats, into a receiver located at the top of a tower. Abengoa is a pioneer in the construction of tower plants for commercial operation, with more than 80 MW in operation and 110 MW under construction.

Solar thermal parabolic trough technology (STEP) bases its performance on the collection of solar energy through a parabolic trough that allows the heating of a heat transfer fluid for the use of heat in a conventional thermal cycle. Abengoa is a pioneer in the construction of these types of plants, with more than 1,600 MW in operation.

Thanks to its extensive experience in the solar energy sector, Abengoa was selected in 2017 in two solar thermal projects in China to provide technology and engineering development. Specifically, it is the 50 MW LuNeng Haixi power-tower solar thermal plant in Qinghai province, and the 50 MW Royal Tech Yumen parabolic trough plant located in Gansu.

In Saudi Arabia, Abengoa continued in 2017 with construction of the plant that will be the largest hybrid solar-gas plant in the world, Waad Al Shamal, comprising a 1,390 MW combined-cycle power plant and a 50 MW parabolic trough solar field, set to produce a total of 1,440 MW of energy, coming from the combined cycle and the solar field.



Image of the Waad Al Shamal works.

Moreover, work finalised on the 14 MW Agua Prieta II solar thermal power plant in Mexico. This will be the first solar-gas hybrid plant in this country to be integrated with a combined cycle.

In addition, Abengoa obtained provisional acceptance of its third solar thermal plant in South Africa, Xina Solar One, with 100 MW of power, which uses parabolic trough collector technology to generate renewable, sustainable and manageable energy from the sun. This plant incorporates a thermal energy storage system with molten salts, capable of accumulating the energy necessary to supply it for an additional 5.5 hours, which allows it to contribute to satisfy the peaks of electricity demand that are recorded in the afternoon.

Abengoa designs and builds photovoltaic generation plants, optimising the design according to the characteristics of the land, using high, low or non-concentrated panels, as well as thin-film panels. Currently, Abengoa has 400 MW built and 100 MW under construction.



Image of the works developed at the photovoltaic plant of the Cerro Dominador solar complex. Copyright Cerro Dominador.

In 2017, the first 100 MW of the photovoltaic plant of the Cerro Dominador solar complex, developed by Abengoa, were connected to the network. The Cerro Dominador platform will also comprise a 110 MW solar power tower, which will be the largest in Latin America. Both plants are complementary, with the possibility of generating energy 24 hours a day.

Waste to energy

Waste To Energy has gained vital importance in recent years given the large amount of waste generated each year. In this regard, Abengoa also develops innovative solutions that contribute to sustainable development.

In 2017, Abengoa started the EPC works of the first plant that will produce biofuels from municipal solid waste in the USA. This plant will have the capacity to produce 10 million gallons of biofuels per year, which will be used in the aviation sector.

Water



Desalination plant in Almería (Spain).

Abengoa, through its Water business, acts as a global technological operator in this sector and integrates development, promotion, engineering, technology and project execution activities for industrial clients and public institutions. Moreover, it provides sustainable solutions to the full water cycle, both with regard to the scarcity of water resources, through large desalination and purification plants and hydraulic infrastructures, as well as protecting the environment, with the construction of plants to treat urban and industrial discharges. It covers the entire value chain of turnkey projects or EPC, from the commercial phase, design and basic and detail engineering through to construction and start-up.

Desalination



Image of the desalination plant developed by Abengoa in Almería.

Abengoa is one of the world leaders in the design and construction of this type of plant, with more than 20 large desalination plants in Spain, Africa, Latin America, the Middle East and Asia, for the production of drinking water or industrial water from seawater or brackish water, using conventional and advanced membrane processes. This allows the company to exceed 1.5 M m³/day of installed desalination capacity and close to 690,000 m³/day under construction. In addition, it is developing some of these plants under a concession model, offering customised solutions and guaranteeing the client an optimal result.

Thanks to its extensive experience in the desalination sector, in 2017 Abengoa obtained major achievements such as the award of the contract for the development of a desalination plant in the region of Agadir, Morocco, which will be the first one awarded in that country. In this contract, Abengoa will be responsible for the financing, development, engineering and construction, operation and maintenance of the same for 27 years.



Recreation of the desalination plant that Abengoa is developing in Morocco.

The plant will be able to produce 275,000 m³ of desalinated water per day and is considered the largest one designed for the combined use of drinking water and irrigation water. The contract contemplates the possibility of extending the capacity to 450,000 m³/day. It is a unique project that came about from the pooling of two projects. Firstly, the 50 % increase in the production capacity of the drinking water plant that Abengoa had been developing at 150,000 m³/day. And, secondly, the additional production of 125,000 m³/day of water for irrigation, as well as construction of the corresponding irrigation network for an area of 13,600 ha.



Image of the works that Abengoa is developing in Saudi Arabia.

In Saudi Arabia, the reverse osmosis desalination plant of the Shuaiba III complex, with daily capacity of 250,000 m³ was awarded. This project will guarantee the stable and quality supply for the cities of Mecca, Jeddah, Taif and Al-Baha.

In 2017, it also won the contract for the Susa desalination plant, capable of producing 50,000 m³ per day, which is our company's first project in Tunisia. Thus, Abengoa and the Tunisian Engineering Procurement & Project Management (EPPM) company will be responsible for the design, construction, commissioning and operation for a period of three months of this desalination plant, which has been designed for possible expansion up to 100,000 m³/day. This plant will produce drinking water from seawater that will be taken from the cooling water channel of the Sidi Abdelhamid power plant in Susa, belonging to the Tunisian Electricity and Gas Company.

In addition, in Oman, Abengoa was selected, as part of a consortium with Fisia Italimpianti, for construction of the Salalah desalination plant in the Dhofar region, with a capacity of 113,650 m³/day.

During this past year, Abengoa obtained final acceptance of a Ténès desalination plant in Algeria, the third one developed by the company in this country and which has the capacity to produce 200,000 m³ of desalinated water per day. Abengoa will continue to carry out the operation and maintenance of this plant, under a concession regime, initially planned for the next 25 years.

Water treatment



Detail of water treatment plant carried out by Abengoa.

Abengoa has an extensive track record with more than 90 plants built in Spain, Africa and Latin America, for the potabilization of water and also for treatment and reuse of wastewater of urban or industrial origin, through physical-chemical and biological processes, including treatments for digestion and recovery of sludge.

In 2017, the final acceptance of two water treatment projects was obtained, the improvement and expansion of the drinking water and sewerage systems of Boaco, in Nicaragua, and the supply to Ames and Brión, in Spain.

Hydraulic infrastructures



Power plant developed by Abengoa at the foot of the Itoiz dam.

Throughout its 70+ years of history, Abengoa has always been at the forefront of hydraulic initiatives, collaborating with public and private institutions in the implementation, improvement and operation of infrastructures for regulation, transportation (more than 40 pumping stations), distribution (more than 4 million people served), irrigation (more than 500,000 ha) and hydroelectric plants (350 MW installed in more than 30 activities —plant construction, improvement, upgrading, etc.).

During 2017, Abengoa obtained provisional acceptance of the smart network of water pipes of more than 400 km, located in the town of Denizli, in southwestern Turkey. This facility aims to provide supply and sanitation to the area, with a population of 600,000 inhabitants.

In India, the company continued with construction of the residual water pipe project in Roorkee (state of Uttarakhand), which connects the discharges from a population of more than 300,000 inhabitants. The provisional acceptance of this project is expected during 2018.

Industrial water



Industrial water treatment plant in Ence Pontevedra developed by Abengoa.

Abengoa has more than 25 years' experience in industrial water treatment, with more than 500,000 m³/day of treated water for different industrial sectors, such as power generation, steel production, paper industry, leachate, oil and gas, petrochemical, pharmaceutical, mining and food, among others. Abengoa brings a high level of specialisation, with the latest technological solutions to solve the current challenges in process water, reused water, wastewater, zero liquid discharge (ZLD), for industrial, private and municipal clients.

Thanks to the consolidation of its industrial water division, in process water treatment plants Abengoa was awarded the expansion of a plant for the production of demineralized water in the Norte Durango combined-cycle plant, and the water treatment and reuse plant in the Norte III combined-cycle plant, both in Mexico. The Norte Durango plant will have a daily treatment capacity of 1,000 m³ and will have the latest technology in desalination using CCRO (Closed Circuit Reverse Osmosis) and CDI (Capacitive De-ionization) modules. The Norte III plant will treat 1,700 m³/day.

Transmission and infrastructures



In Ukraine, Abengoa continues with construction of a 765 kV line along 187 km.

The Transmission and Infrastructure (T&I) business has been a leader in engineering and construction of infrastructure in the energy and industry sectors for more than 70 years. It currently integrates the areas of transmission and electrical distribution, railways, facilities and infrastructures and auxiliary manufacturing of electrical and electronic equipment.

Furthermore, the T&I business has an area specialised in engineering to support these activities, which also has the capacity to cover any technical need of the projects, regardless of the geographical region where they are located.

Transmission and distribution



In France, for the last 15 years, Abengoa has been working for the public French operator responsible for the transmission systems in France.

Abengoa is an international benchmark in the construction of transmission and distribution infrastructures, with more than 27,000 km of high and medium voltage power transmission lines in more than 20 different countries and with more than 330 high and medium voltage substations, both AIS (Air Insulated Switchgear) as well as GIS (Gas Insulated Switchgear), in 15 countries.

Regarding transmission lines, both aerial and underground, Abengoa carries out medium, high and ultra-high voltage projects, up to 800 kV worldwide. It has the capabilities to carry out works of all kinds, whether it be study, engineering, supply, assembly, live works, as well as the "turnkey" works which are analysed from their technical and economic viability, through to full completion of the same, and including the design and complete development of the project.

In substations, Abengoa covers the full range of high and medium voltage substations for different uses in electrical companies, evacuations of renewable plants, railways, etc. It has capacity and experience in all types of technologies: conventional AIS substations, GIS substations, hybrid systems (combination of AIS and GIS substations), as well as in all auxiliary services: fire protection, detection systems, air conditioning, telecommunications, control and protection, auxiliary electrical services, lighting, grounding, etc.

Projects and milestones achieved in 2017:

Spain

In Spain, Abengoa continues to develop several different and important projects in the transmission and distribution sector, and is one of the leading sector companies in Spain. Of particular note is the remodelling of a section of the Belesar-Mesón 200 kV line or the expansion of the Aldea Blanca substation in the Canary Islands.



Stretches of the Belesar – Mesón line.

France

In France, for the last 15 years, Abengoa has been working for the public French operator responsible for the transmission systems in France, carrying out construction, modification and dismantling of high-voltage lines, as well as works at substations. In 2017, the framework contract for high voltage lines was renewed for a further three years, for the 2018-2020 period.

Ukraine

In Ukraine, the construction of a 765 kV line along 187 km continues, and is expected to be completed for the second half of 2018.

Morocco

In Morocco, Abengoa continues to build 400 kV transmission lines in Oujda and a 225 kV transmission line in the Ouarzazate area for the country's electrical operator.

United Arab Emirates

During 2017, construction has been completed and the Faya-Shamkha electric transmission line has been commissioned.



Abengoa has carried out the construction of the Faya-Shamkha power line.

Oman

The 132/33 kV Al Dreez substation has been completed and put into service.

Construction work continues for the 132/33 kV substations in Samad and Sinaw, as well as associated high-voltage power lines, for the Omani power company.



Abengoa has put the 132/33 kV Al Dreez substation into service.

Railways



Abengoa carries out catenary works on different lines in the United Kingdom.

With more than 2,300 km of electrification of railway lines and 80 traction substations, Abengoa is an international reference in the development of railway projects for both conventional railways and high-speed rail, metro, tram and monorail.

It has capabilities to carry out turnkey projects for catenary, traction substations, communications, signalling, electrical installations in high voltage and low voltage, lighting, maintenance and ancillary services.

Abengoa has its own catenary technology: CAVE, designed for speeds of up to 350 km/h, and TkMk, design for speeds of up to 160 km/h, and it has one of the most advanced railway machinery ranges in the sector, highly sophisticated and with maximum functionality.

Projects and milestones achieved in 2017:

Spain

In the railway sector, it continues with the project of installation and maintenance of systems of protection, security and landlines along a stretch of 51 kilometres of railway between the provinces of León and Asturias, as well as the catenary and substations installation works for the administrator of railway infrastructures (ADIF) in Spain.

Work continues on the electrification of the Monforte-Murcia section corresponding to the Madrid-Levante High-Speed Line.

United Kingdom

As part of the 2014-2019 framework contracts for the English railway operator, engineering and installation work continues on both catenary and traction substations on different railway lines in and around London.



Works developed by Abengoa in the United Kingdom.

France

As in previous years, the company has also performed catenary and traction substation projects for the French railway company, in various parts of the country.

Saudi Arabia

Final phase of the construction of the Mecca-Medina high-speed line, in which the first test trip of the complete line has already been successfully completed.



Abengoa takes part in the construction of the high-speed line between the cities of Mecca and Medina.

Installations and infrastructures

Abengoa builds facilities and infrastructures for the development and construction of all kinds of plants (conventional and renewable generation, oil&gas, food and paper, etc.) and singular buildings (hospitals, prisons, cultural, educational and administrative centres) and equips them to make them habitable and efficient, incorporating the design, supply, manufacture, assembly and testing of systems as well as operation and maintenance.

The main activities are: electrical and mechanical installations, instrumentation and control, air conditioning, water and fire prevention, fixed and mobile communications, control systems for plants and buildings, installations for renewable plants, power systems for data processing centres, as well as the maintenance associated with this type of activities.



400/22kV substation that Abengoa is developing at ITER.

The main projects and milestones achieved in 2017 were:

Spain

- › Abengoa has been awarded the installation project of medium voltage distribution centres of the Torrecárdenas Shopping Centre in Almería.
- › The project for the installation of power and lighting of the New School of Nursing of San Juan de Dios in Bormujos (Seville) is still in progress.
- › Abengoa has been awarded a project to adapt the low voltage installations of the Puerto Real Factory (Cádiz) to the regulations.
- › Work continues on voice and data installations corresponding to the maintenance and opening of stores and logistics centres in Spain.
- › Work continues on electrical maintenance and instrumentation in various industrial plants.
- › Deployments have been made of networks of mobile, radio and fibre-optic operators, as well as the installation of telecommunications structures or GSM-R installation.
- › Works continue in the project to repair feeder 1 of the US military base in Morón de la Frontera (Seville) for the US Air Force Department.

Belgium

Abengoa continues with the execution of the project for development of the mechanical facilities of the new building of the University Hospital Centre of Liege.

Denmark

In Denmark, Abengoa is continuing work on the electromechanical facilities of a new 56,000 m² hospital complex in the town of Herlev.



Abengoa develops the electromechanical facilities of a hospital in Herlev (Denmark).

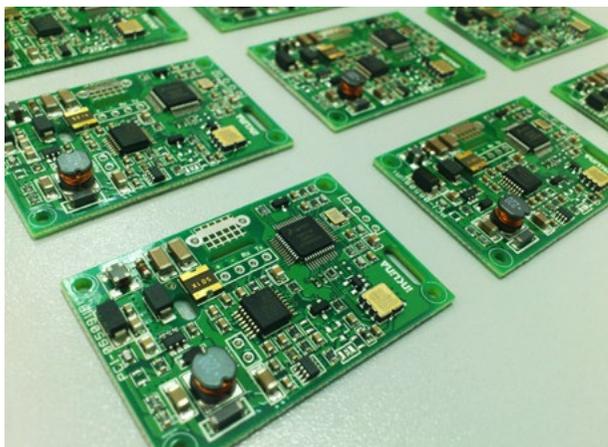
France

The company continues with construction of the TB06 package of the International Thermonuclear Experimental Reactor (ITER) project with the installation of the seven bays of two 400/22 kV substations.

Morocco

With the main telecommunication operators, it continues with the low and medium voltage electrification of the GSM stations, as well as with the deployment of the GSM network throughout Moroccan territory.

Auxiliary manufacturing



Detail of electronic cards for measuring the slope of solar collectors (inclinometers).

Abengoa has a production centre for electrical and electronic panels with more than 3,400 m², focused on the energy, oil&gas, aeronautics, renewable energy, defence, aerospace, traffic and rail transport sectors.

This centre specialises in the manufacture of low voltage switchboards, cabinets for telecommunications, video surveillance and access control, electronic cards, control equipment and integrated electronics, racks, ticketing equipment, power supplies, control and command consoles, test benches and test equipment, etc., as well as in the design of prototypes and first series, given its own design capacity, software and hardware.

Projects and milestones achieved in 2017:

Spain

- › The manufacture of electronics for the traffic, transport and defence sectors continues to make progress. Among them worth highlighting:
 - Manufacture of power distribution boxes (PDB) for armoured vehicles, AJAX programme.
 - Manufacture of ground test equipment and interconnection wiring for the aeronautical sector.
 - Manufacture of urban traffic control equipment and access control.
 - Manufacture of on-board command and control consoles for navy frigates.
 - Manufacturing of power converters.

Engineering



Detail of transmission line in France.

This area has a multidisciplinary engineering team, highly qualified and able to adapt to any environment. It specialises in the development of engineering applied to transmission works and infrastructures described in the previous sections.

The main engineering activities are: design of transmission lines, substations of any type (GIS or AIS), railway electrification systems (catenary and traction substations), civil works, as well as industrial, photovoltaic or wind installations. In addition to any type of design associated with the systems described above, such as electrical, mechanical, electrical simulation, electromagnetic compatibility studies, short circuit studies, RAMS studies (Reliability, Availability, Maintainability & Safety), protection and control systems, communication systems, protection and control, energy storage systems, maintenance plans, etc.

Projects and milestones achieved in 2017:

UK

- › In 2017, Abengoa completed the design work on GRIP3 phases of 44 km of double track type I catenary, between the sections of Southcote and Basingstoke.
- › Having completed the design and construction work and adaptation of the existing facilities for the construction of three new auto-transformation centres between the Gospel Oak to Barking Electrification zones, within the Southern Region. GOBE TP.
- › In 2017, Abengoa has completed the design in phases of GRIP2 and GRIP3 of the construction unit no. 17 of the Gospel Oak to Barking Electrification project. GOBE OLE-CU17.
- › During 2017, Abengoa completed the GRIP5 phase design of the GEML project, consisting of the design of a 400/55 kV auto-transformer centre for railway traction. It is currently in the phase of GRIP6-7.

Chile

- › In 2017 the design works and RAMS studies for line 6 of the Chile Metro were completed. Currently, work on line 3 of Metro is also underway.



Line 6 of the Chile Metro.

France

- › During 2017, the design of the Plaisir substation was finalized, consisting of the design of a 63/1500 Vdc traction substation for SNCF.
- › In 2017, Abengoa completed the design for the remodelling of the 1,500 Vcc catenary between the Paris-Bercy sections. These works have involved the calculation and design of support brackets, suspension hangers, structures, foundations, justificatory calculations of assembly, development of assembly cards, layout plans, cards for supplies and delivery of work materials list. In 2018, the As built works will be delivered.

Saudi Arabia

In 2017, the design work of the Mecca-Medina project has been completed. These works have involved the design and calculations of support brackets and suspension hangers of more than 235 km of high speed catenary, in addition to the development of construction designs for the construction of the two traction substations, 10 auto-transformation centres and more than 30 technical buildings of Abengoa distributed along the entire line.



Image of the Mecca - Medina project works in Saudi Arabia.

Services



Major inspection in the gas turbines of the ISCC Plant Ain Beni Mathar (Morocco).

One of Abengoa's highest priorities is to guarantee quality and compliance with environmental standards in the infrastructures it manages and in the services it offers, ensuring the performance of its activities with the strictest standards with regard to the prevention of occupational hazards. All this in harmony with our vision of safe, reliable, efficient and profitable work that is focused on sustainable development.

The Abengoa Services vertical focuses on the following business areas:

- › Operation and maintenance
- › Factories for metal structures
- › Engineering and plant optimisation services.

Operation and maintenance



Vehicle for cleaning the parabolic troughs.

Abengoa provides operation and maintenance (O&M) services in the energy, water and environment sectors. With more than 18 years' experience in O&M, it performs predictive, preventive and corrective maintenance, as well as computer-assisted maintenance at electricity, thermal, renewable and conventional plants, water treatment plants, waste treatment plants, hydraulic and environmental infrastructures.

Abengoa thus ensures the correct functioning of the asset during its useful life. In the design phase of the facility, the constructor and/or the owner of the future asset take into account the operator's point of view to optimise the life and performance of each facility.

Abengoa is a benchmark in the O&M of solar plants of which it has a commercial experience of 1,648 MW, of all commercial technologies (photovoltaic, solar thermal, hybrid with conventional cycles). Specifically, Abengoa is the company with the highest solar thermal capacity operated worldwide.

In 2017, Abengoa carried out the mobilisation phase and has started to operate and maintain the Cerro Dominador PV photovoltaic plant, located in the Atacama desert (Chile), with a total installed capacity of 100 MW. This is the photovoltaic plant with the highest power operated and maintained by Abengoa.

In August 2017, Abengoa started the O&M phase for the 100 MW Xina Solar One solar thermal plant, with parabolic trough technology. In addition, Xina incorporates a thermal energy storage system with molten salts, capable of accumulating the energy necessary to supply it for an additional 5.5 hours.

In the water sector, Abengoa supplies O&M services in desalination plants with a production capacity of more than 283 million m³/year.



Operation and maintenance work at the desalination plant in Accra, Ghana.

The company operates seawater desalination plants throughout the world, using different technologies. Abengoa has built desalination plants for production of more than 1.5 M m³/day and has its own technology for continuous monitoring of the plants it operates. This monitoring system allows it to operate and maintain the desalination plants in

an optimal and efficient way, which enables the company to take the most appropriate operation decisions at all times. It currently supplies O&M in seven plants located in Spain, Algeria, India and Ghana.

Abengoa currently operates more than 650 MW in cogeneration, hydroelectric power stations and conventional plants, and the company is a pioneer in the O&M of hybrid solar-gas plants.

At the end of 2017, Abengoa launched the mobilisation phase for the O&M of the high efficiency cogeneration A3T, a 220 MW combined-cycle plant in the state of Tabasco (Mexico).

Manufacture of metal structures

In 2017, Abengoa O&M, through the Eucomsa and Comemsa factories, produced a total of 22,420 t of metallic structures for a total of 16 and 17 projects in the world, respectively.

Engineering and plant optimisation services

Abengoa provides consulting and advisory services for the implementation of O&M in conventional and renewable electric power production plants and desalination plants. It also develops quality, environmental and health and safety programmes for O&M and conducts O&M consultancy at power generation and desalination plants for the purpose of optimising and improving its O&M processes and programmes.

See main references services in [Appendix](#).

Projects by geography

102-03, 102-04, 102-06

Abengoa's activity during 2017 was carried out mainly in the following geographical regions.

Latin America

Argentina



In 2017 Abengoa was awarded the construction of the '25 de Mayo' transformer station.

The company has been in the country for over 50 years, during which it has become a benchmark in works associated with the transport and transmission of electric power in high and ultra-high voltage.

In 2017, contracts were signed, among others, for carrying out works of special importance, which will be executed during 2018:

- › The new 500 kV '25 de mayo' transformer station
- › The new 345 kV Altiplano switching station
- › The adaptation in the electricity system of the Buenos Aires metro



Abengoa's works in the electricity system of the Buenos Aires metro.

Likewise, the company continues with the execution of the 500 kV transformer station of Vivotará, and with completion of the expansion of the Chaco 500/132 kV transformer station.

The main challenge for 2018 is to ensure that the Argentine market identifies the company as a benchmark in electric power generation works, both conventional and renewable, as well as in the construction of aqueducts, water treatment plants and sanitation. Another objective is to secure new projects, through the system of Public Private Participation (PPP).



In 2017 Abengoa was awarded the new Altiplano switching station.

Brazil



The company performs operation and maintenance tasks on more than 3,000 km of transmission lines.

Abengoa has been present in Brazil for more than 20 years, during which it has developed innovative technological solutions in the energy and environment sectors.

In 2017, the company reached a restructuring agreement, lawfully approved, with its creditors, from which a process of implementing a new business plan began. This plan, in line with the organisation's strategy, is based on the sale

of concession-type assets and focuses the business on the construction and operation and maintenance of infrastructure activities.

The main activities developed in 2017 were the following:

- › O&M of transmission assets: more than 3,200 km of transmission lines and substations.
- › O&M and management of the PPP of the North Zone Hospital of Manaus, with capacity for 350 beds.
- › Construction of reinforcements in 230/138 kV substations in Videira (SC) and Foz de Iguaçu (PA).
- › Rental of machinery for construction of transmission lines.



Abengoa is currently responsible for the operation and maintenance of the North Zone Hospital Manaus.

Brazil, despite its economic situation, continues to offer great business opportunities since it is one of the most attractive markets to invest in, being the prime economy in Latin America and the ninth in the world.

For 2018, the main objective, besides continuity of operation and maintenance and rental of machinery, is to increase the volume of construction contracts to re-position the organisation as one of the main benchmarks in the energy transmission sector.

Chile



Reforestation associated to the environs of the 220 kV Puente Negro electrical substation.

The company has been operating in the country for more than 30 years, focusing its activities on electricity transmission and infrastructures. In addition, it has extensive experience in engineering and construction activities in electromechanical and renewable energy works, satisfying the needs of the mining and energy sectors. In the same way, the company performs O&M tasks at renewable energy plants and in the electricity transmission sector.

During 2017, the following projects were carried out:

- › Supply of the electricity system for the project of lines 6 and 3 of the Santiago Metro.
- › Construction, assembly and electricity supply of the 23 kV line - Oxido - Encuentro (OXE) project, Minera Centinela.
- › Engineering, supply, construction, assembly, testing and commissioning of the 220 kV Puente Negro substation, in Colbún (SA).
- › Construction of the 2x220 kV line Los Cóndores - Ancoa, and the electrical substation.
- › Relocation of the transmission line under the OHL project, and of the ZEAL project for Chilquinta Energía.

- › Replacement of 110/12 kV transformer no. 1 at the San Felipe substation.
- › Increased capacity of the 110/23 - 12 kV Las Vegas substation.
- › Increased capacity of the San Antonio substation.
- › Increased capacity of the 1x220 kV line Cardones - Carrera Pinto - Diego de Almagro.
- › Construction of the 100 MW Atacama I photovoltaic plant, of the Cerro Dominador solar complex.
- › Installation of the V55 fan for the El Teniente mine, the largest underground copper mine in the world.



Switching station of the Atacama I project, of the Cerro Dominador solar complex.

For 2018, Abengoa aims to consolidate management of excellence with the new structure and business strategy, as well as adapt management systems to the single certificate model.

Peru



In 2017, Abengoa was awarded the electromechanical assembly of the Rubí - Montalvo transmission line.

The activity of Abengoa Peru has a trajectory of more than two decades through engineering and construction for the development of projects in the mining, energy, water, industry, oil & gas and infrastructure sectors.

The company offers integral solutions to customers, with special attention to civil, hydraulic and electromechanical projects, as well as the operation and maintenance of transmission systems.

Throughout the last decade, the Peruvian economy has presented the fastest exponential growth in Latin America, in a country that will continue to allow our participation in all sectors of interest to us.

In 2017 the company has been awarded several projects.

- › **Transmission & distribution:** Abengoa was awarded the relocation of the 138 kV and 69 kV transmission line at the Botiflaca and Pushback substations, owned by Southern Copper Peru Corporation, in the Moquegua

region. Likewise, the electromechanical assembly of a section of the 220 kV Rubí - Montalvo transmission line was awarded, through which the Rubí solar power plant, owned by Enel Green Power, would discharge power. Moreover, we were awarded completion of the works in the Shahuindo electric substation owned by Tahoe Resources.



In 2017, Abengoa was awarded the relocation of the 138 kV transmission line.

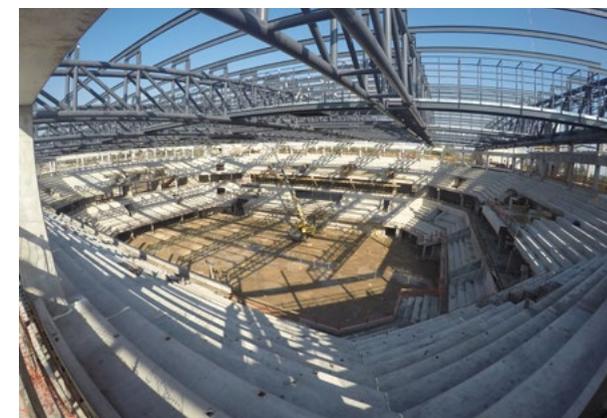
- › **Engineering:** in this sector, the design of the electric transmission system for the Minas Justa de Marcobre project was awarded, at 220 kV, and engineering work was also carried out for the company Engie Perú, at 500/220 kV.
- › **Hydraulic projects:** during the past year, the company was awarded the civil works of the Santa Lorenza I hydroelectric plant, owned by Generación Eléctrica Santa Lorenza. The generation project obtained a 20 MW concession through a renewable energy auction with the Peruvian government, through its policy of being committed to the generation of energy from renewable resources. The company was also awarded the energy rating works at 13.8/4.16 kV at a new desalination plant

with capacity of 30,000 m³/day, as well as civil works in complementary areas of the expansion of the mining project owned by Shougang Iron Peru.



Conveyor belt.

Uruguay



Abengoa is working on the new entertainment complex in Montevideo, the Uruguay Antel Arena.

The company was established in the country almost 40 years ago. Since then it has taken part in the main infrastructure projects in Uruguay and has become a benchmark in construction and a key element in the performance of large investment projects, both public and private, with solid experience in the execution of EPC contracts.

Specifically, Abengoa has performed more than 400 projects, including approximately 450,000 m² built, more than 100 hydraulic works, numerous industrial projects and 70 electrical projects, and is the country's main private developer of wind farms.

Its business is divided into four main areas: construction, environment, forestry and O&M.

Among other smaller projects, in 2017 work continued on the rehabilitation of two railway stretches. A section of 133 km in length between the towns of Piedra Sola and Algorta, and another one of 194 km in length between Algorta and Salto Grande.



Abengoa's railway rehabilitation works in Uruguay.

In addition, progress was made in construction of the first multifunctional complex in Uruguay, the Antel Arena complex, in Montevideo, a building designed to house sports, cultural and social events.

The contract, signed with the National Telecommunications Administration (Antel), involves the construction of a five-story building with a total area of approximately 40,000 m², its front

and rear esplanade (logistics area), as well as the construction of an independent open amphitheatre.

A milestone during the year of the project was the assembly of the eight main beams weighing 70 tonnes and almost 80 metres each in length, a complex manoeuvre that is rare in Uruguay.

Likewise, the completion of the work and commissioning of a wind farm in Campo Palomas (Salto) took place. The park has 35 wind turbines of 2 MW each and provides 70 MW to the national energy matrix.



In 2017 Abengoa finalised construction of the Campo Palomas wind farm.

2017 also saw completion of the work and the beginning of the start-up of the prison in Punta de Rieles (Montevideo). This is the first project in Uruguay contracted within the framework of the Public Private Participation (PPP) law, which also represents a new prison management model in the country. The project involved the design, financing—with an initial investment of approximately 120 million US dollars—, construction and fitting out of a state-of-the-art prison with a capacity of 1,960 places.

In the operation phase, which will begin in 2018, the feeding, cleaning and pest control service, laundry, infrastructure maintenance and equipment maintenance will be provided for a 25-year period.



Image of the Punta Rieles prison, built by Abengoa in Uruguay.

North America

United States



View of Solana, a solar thermal plant developed by Abengoa in Arizona, owned by Atlantica Yield.

Investments in energy and water infrastructure continue to grow in North America, where the company is focused on the key markets for power generation, such as photovoltaic energy, energy storage, bioenergy and waste management, transmission lines and substations, power plants, treatment and desalination, and in the area of services, management, operation and maintenance of facilities.

In 2017, the company began construction of a bio-refinery to obtain biofuel from municipal solid waste (MSW) in Nevada. This plant will have the capacity to produce 10 million gallons of biofuels per year, which will be used in the aviation sector.



Recreation of the W2E plant developed by Abengoa in the United States.

In the United States, Abengoa continues to provide O&M services at two of the largest solar power plants in the country: Solana, in Arizona, and Mojave, in California. Both have been developed by Abengoa and are owned by Atlantica Yield.

In addition, we continue to provide programmes and project management services for the [Keck Centre for Science and Engineering](#), measuring 13,000 m², a high-technology research and teaching laboratory at Chapman University.

Mexico

Abengoa has been present in Mexico for more than 35 years, during which time it has carried out various projects of conventional and renewable energy generation, transmission and distribution of energy, electromechanical installations and hydraulic infrastructures, among others.

Mexico represents a priority market for the company as a consequence of, inter alia, the liberation of the energy sector, the size of the market and the company's experience and knowledge of it. Accordingly, Abengoa has its own structure in Mexico aimed at achieving the targets set out in the strategic plan. However, in 2017 the activity was affected by the continuance, throughout the year, of the competitive situation in which had been immersed since December 2016, but which it managed to extricate itself from at the beginning of 2018.



Aerial view of the A3T efficient cogeneration plant, which is being developed by Abengoa in Mexico.

In 2017, some projects could be carried out:

- › **Centro Morelos combined cycle (640 MW):** received provisional acceptance (PA) of the first combined-cycle carried out entirely by the company.
- › **Agua Prieta parabolic solar thermal plant (14 MW):** received provisional acceptance of the country's only solar thermal complex, which will be integrated into a combined-cycle plant, thus representing the first solar-gas hybrid plant in Mexico and Latin America.
- › **Efficient A3T cogeneration (220 MW):** continuation of the project works, with a global advance of more than 95 %.
- › **Divestiture of the Norte III combined cycle (906 MW).**



Parabolic trough collectors of the Agua Prieta II solar-gas hybrid plant, of which Abengoa has been responsible for the 14 MW of solar power.

Thus, for 2018, and extricated itself from the insolvency situation, Abengoa considers the main targets to be recommencement of the activity, finalisation of negotiations arising from the waiver without liability presented in 2017 of the Zapotillo aqueduct project, and to sign the power purchase agreements (PPA) for 100% of the capacity of the A3T plant, achieving the start-up and divestiture of the asset.

Africa

Morocco

In Morocco, through its subsidiaries, Abengoa offers public and private clients all products and services in the areas of water, energy, transmission and services, with the transmission and distribution branch having the greatest presence historically in procurement, following more than three decades in the country.

The company is also present in the telecommunications sector with framework contracts with the main operators, both in fibre optics and GSM, with Orange and INWI, the Moroccan operator. These framework contracts consist of maintenance works or expansion of existing telecommunications infrastructures.

Morocco has been a market with sustained growth for a decade, which has developed energy and water policies equipped with the appropriate regulatory frameworks to encourage investment and competition from international operators.

In 2017, the activity focused mainly on the development of transmission line works, particularly the evacuation line for renewable plants in the Ouarzazate area, more specifically the Noor plant, promoted by Acwa. Another significant work due to its strategic nature is the Meloussa line associated with the construction of the high-speed line that will connect Tangier with Kenitra.

Furthermore, Abengoa signed agreements in mid-2017 for the development of the Chtouka-Agadir desalination plant with capacity of 175,000 m³/day. This strategic project for Morocco is also a milestone for the company because of its characteristics, given that it will provide desalinated water for urban use and for irrigation of 16,000 ha.



Image of the works developed by Abengoa in Morocco for Orange.

Abengoa's main challenge in 2018 is the launch of the works of the Chtouka-Agadir desalination plant, although the company is faced with other challenges, both in water - Dakhla project - and in energy, the Mildet CSP project, which will be the largest project that Abengoa will undertake in this region in the medium term in the country.

South Africa



Khi Solar One has a capacity of 50 MW and two hours of storage.

The company started its activity in South Africa in 2009. It was in November 2011 when Abengoa was awarded the first two solar thermal projects in the country's first round of the "Renewable Energy Independent Power Producer Procurement Programme (REIPPP)". These projects were developed and jointly financed by the company and its local partner Industrial Development Corporation (IDC).

Specifically, they consisted of the promotion, engineering, construction and subsequent operation of two solar thermal power plants:

- › **Kaxu Solar One:** a solar thermal plant with parabolic trough technology, with a generating capacity of 100 MW and 4.5 hours of storage.
- › **Khi Solar One:** a cutting edge plant that uses power tower solar thermal technology with a capacity of 50 MW of electricity production and two hours of storage.

Both plants produce clean electricity for the distribution grid of South Africa and contribute to the local economic development established in the REIPPP programme.

In 2017, the commercial operation of the third solar thermal power plant in the country took place: XiNa Solar One, with a generating capacity of 100 MW and six hours of storage using molten salts.



XiNa is the third solar thermal plant in South Africa and has been developed by Abengoa and its local partner Industrial Development Corporation.

Together, the three plants in operation contribute to the local economic development and with 250 MW of energy to the national grid. They cover almost all the electricity consumption of the Northern Cape province, of almost one million inhabitants.

2018 will be a key year for the company in this country, since the main objective has been to reactivate the investment in renewable energies, resuming the energy projects that were suspended.

In addition, due to the major droughts that have plagued the country in recent years, South Africa has launched an ambitious infrastructure and water project plan, so the construction of four large desalination plants supported by the

World Bank is expected in the short/medium term, as well as construction of new wastewater treatment plants at municipal level.

Middle East

Abengoa is present in the Middle East in countries such as Saudi Arabia, Kuwait, United Arab Emirates (UAE), Oman, Qatar, Bahrain and Egypt. These are high growth markets in which the company has a large portfolio of projects and opportunities.

Over the last year, Abengoa has been awarded new and interesting projects such as a desalination plant in Oman, 40 km from the town of Salalah, with reverse osmosis technology that it will develop together with Fisia Italmipianti; as well as another desalination plant with a supply capacity of 250,000 m³/day through reverse osmosis to be located in the Shuaibah III complex in Saudi Arabia, also in partnership with Fisia Italmipianti.

The company also continued with the development of Waad Al-Shamal, the largest hybrid solar-gas plant in the world, comprising a combined cycle of 1,390 MW of power and a solar field of 50 MW parabolic trough collectors, also in Saudi Arabia. This project is being developed together with General Electric.

Innovation

ID1, ID2, ID3_4

The Innovation area allows Abengoa to improve the performance of its current products and develop both new products and businesses.



100 MW electric motor converter.

Main figures	2017	2016	2015
Investment in R&D and innovation (€ thousands)	621	4,762	345,200
Personnel	25	232	797
Cumulative patents granted since 2008	395	294	394

This area encompasses three major sectors: aerospace, electric power systems and hydrogen, executing both commercial and technological development projects, focusing its activity on European countries.

- › **Aerospace:** this line has the design, manufacturing and testing capabilities of power distribution, monitoring and control systems for the aerospace, defence and scientific sectors. One of the main milestones in 2017 was the obtaining of new contracts such as those signed with ELV and Airbus DS.



Abengoa is in charge of designing, manufacturing and validating the automatic testing equipment of the European VEGA launcher. Image © ESA-David Ducros.

ELV is the first main contractor of the European VEGA launcher, designed to launch small satellites in low orbits and which has been operating successfully since 2012. Currently, ELV is developing a new version of the launcher, in which Abengoa is in charge of designing, manufacturing and validating the automatic test equipment (ATE) that will be used in the launcher's qualification campaign during the Electro-Magnetic Compatibility (EMC) tests, which will be carried out on the Upper Composite (UC).

In addition, in 2017 Abengoa conducted the manufacturing and validation of the automatic test equipment for two of the critical units of the new European launcher Ariane 6: the CMFU (Centralised Multi-Functional Unit), a unit that performs the functions of a mainframe computer, management of telemetry and remote controls, and power control and distribution; and the PFU (Pyro Functional Unit), which manages all the pyrotechnics of the future launcher.

- › **Power electrical systems:** focused on the design and development of electrochemical storage and control solutions (lithium-ion batteries, flow batteries, supercapacitors, etc.) with the aim of improving the quality of the electrical network and favouring the integration and manageability of renewable energies. The main milestones in 2017 were participation in projects such as Pegasus and Flexitranstore.
 - i. **Pegasus** is an EU-funded project within the first call of the Interreg MED Programme, the aim of which is to boost the introduction of microgrids (micro-networks). It is a project carried out in partnership with energy agencies, local public authorities,

SMEs, large companies, research centres and universities in nine countries in the Mediterranean area.

- ii. **Flexitranstore**, a project whose main objective is to increase the flexibility of the European electricity system and increase the penetration of renewable energies, focusing not only on infrastructures, but also on the demand, generation and integration capacities of energy storage. As a result, eight demonstrators will be set up in different areas of the electrical system. Abengoa is responsible for one of these demonstrators, designing, installing and remotely operating a storage system in an electrical substation, acting as an active distribution node.
- › **Hydrogen**: development of technology for the production of hydrogen, as well as its use in industrial, energy, transport, aerospace or naval sectors.



Hydrogen service station.

The company has extensive experience in the design, construction, integration and testing of different technologies in the area of hydrogen and fuel cells, developing power generation plants with fuel cells, hydrogen production systems, service stations and offering assistance and advisory services for customised systems that meet the client's needs.

One of the main challenges that remains to be tackled in this sector is the optimisation of costs so that the technology can be more competitive. This is why Abengoa participates in the Grasshopper project, funded by the JTI (European Commission) with the aim of creating the next generation of fuel cell power systems, at the MW level and with investment costs estimated at around € 1,500/kWe. The project, presented in consortium with such major players as NedStack, Johnson Matthey, Zentrum and the Politecnico di Milano, was approved at the end of 2017 with a launch scheduled for 2018, and in which Abengoa is chiefly responsible for carrying out all the plant's BoP (Balance of Plant).

Main lines of technological development

R&D and innovation in the solar thermal area



XiNa Solar One, parabolic trough collector plant with storage developed by Abengoa in South Africa.

In the sector of solar thermal energy, Abengoa continues to be a technological reference thanks to its ongoing effort to promote the innovation of its products. To this end, it continues to develop R&D and innovation projects in this area. This will help it identify new lines of business and acquire new skills that will keep it positioned in the market as a consolidated brand.

Among its major achievements is the portfolio of technological solutions adapted to the manageability of energy demand that Abengoa maintains. Thanks to its know-how, it has been able to design a new generation of renewable energy plants that satisfy at a single facility the low cost of photovoltaic energy (PV) and the management capacity of thermal solar energy with thermal storage. In this latest period, Abengoa has developed and optimised the so-called "Smart Solar Plant", where a major saving of the prices of solar energy is expected thanks to the plan for development and optimisation of components implemented at Abengoa.

So, thanks to the work performed in the area of solar thermal technology, 2017 has been a year in which Abengoa achieved the following technological milestones:

- › **Parabolic trough collector technology** has reached a new milestone with the commissioning of the Xina Solar One plant, with 100 MW of power and 5.5 hours of energy storage. This plant has incorporated new advances in the development of solar components such as the commercial implementation of the large aperture collector structure designed

entirely by Abengoa, the implementation of a new receiver tube with a larger diameter and, finally, an optimised design of the tanks of molten salts where a significant reduction in the salt inventory has been achieved.



Large-aperture collector installed in Xina.

› **The central receiver technology** remains the most promising in solar power generation. Among the different CSP technologies available, solar towers will dominate the market for solar thermal power plant projects thanks to the lower energy cost generated by higher efficiency and direct thermal energy storage capacity than the parabolic trough plants. In solar thermal tower plants, the ongoing improvement in the efficiency of thermal energy capture is critical, as is optimisation of the solar field cost. Therefore, in 2017 we worked on several lines simultaneously:

- I. Azimuthal and elevation positioning system with new high-precision sensors applied to both axes with an optimisation of their arrangement on the structure of the heliostat.
- II. The development of a closed-loop control of heliostats system, which will allow the calibration of a solar field focus of up to thousands of concentrators automatically, quickly and easily.
- III. Development of tools for receiver temperature control that improves control and allows work with greater incident flow.
- IV. Study of dynamic behaviour mechanisms of molten salts in the receiver.



Image of the tower and receiver of Khi Solar One, in South Africa.

- › Likewise, Abengoa continues to participate in European projects where it encourages the **creation of international partnerships** and focuses on new developments of high temperature technology. Firstly, Abengoa is a partner in the H2020-Solpart project, the aim of which is to demonstrate on a pilot scale the viability of the use of solar energy in cement production, one of the most energy-intensive industries today. Furthermore, Abengoa also participates in the H2020-Sun-to-liquid project, the aim of which is the complete validation of the production process of hydrocarbon fuels from water, CO₂ and solar energy.

Following this strategic line, Abengoa has proposed a **roadmap for 2018**, establishing continuance of the **works to optimise tower technology** with molten salts based on nitrates at a higher temperature. This entails optimisation of the components based on the new temperature and considering the transience of the energy received. In addition, it presents the challenge of optimising the working temperature, which requires the development of techniques to inhibit the degradation of salt at a temperature higher than 565 °C in the current state of the art. To this end, Abengoa has sought technological support from the main EU technologists within the proposal presented to the H2020-2018 programme.

In 2018, we will continue to **provide technological support to the development of commercial plants**, in the design phase as well as construction and operation. There are different working groups specialised in the most critical systems of each technology, providing technical support in the design, purchase and manufacture of the main equipment.

The optimisation of cost and precision of the solar field will remain a priority development. We will work on the optimisation of the wind loads with which the components of the solar field are designed. The control and monitoring works will be maintained, along with the study of other critical systems such as corrosion of materials and the degradation of storage and heat transfer fluids at advanced solar thermal plants.

Lastly, Abengoa continues to promote the **creation of a network of strategic collaborators, from national and European universities and research centres**, developing specific projects and medium- and long-term partnership agreements that facilitate the exchange of researchers and the transfer of knowledge. One example of this would be its participation in the European project (FP7) "STAGE-STE: Scientific and Technological Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal Energy", which will conclude in the first quarter of 2018.



Visit by members of the Sollpart project.

R&D and innovation in the water area

In 2017 Abengoa finalised its participation in the Life+ ZELDA (Zero Liquid Discharge Desalination) project. The aim of this project is the development and demonstration of a new process for the treatment of brines based on the use of electro-dialysis metathesis and on the recovery of valuable compounds, with the ultimate goal of achieving a zero liquid discharge (ZLD).

The project has been carried out within a consortium formed by the Fundació Centro Tecnològic de Manresa (CTM), the European Water Platform (WssTP), FujiFilm and Abengoa. During 2017, in compliance with the stipulated schedule, the experimentation campaign with seawater brine from the Almería desalination plant was successfully completed, and the project was completed in June 2017.

As the main results of the project, the consortium has been able to test the versatility of the process, since it has been possible to apply it to brines from the desalination of both brackish water and seawater, in both cases achieving a water recovery higher than 80 %. This implies a significant decrease in the volume of brines, extracting, in addition, valuable compounds such as magnesium hydroxide $Mg(OH)_2$ and sodium chloride (NaCl) from both types of brines, as well as sodium sulphate (Na_2SO_4) from the interior brines, compounds that are not normally recovered in conventional ZLD systems. In addition, the project showed that the process would reduce or eliminate the costs of brine management of interior brackish water.

As a consequence of the knowledge acquired during development of the Life+ ZELDA project, in the future Abengoa would be able to participate in the marketing of solutions for management of saline effluents that are more sustainable, efficient and aligned with the new paradigm of the circular economy.

R&D and innovation in the railway area



Image of the Mecca - Medina project in Saudi Arabia.

From the Technical Office Innovation area, Abengoa specialises in the development of projects related to the study of the behaviour of facilities under extreme conditions, as well as new materials; development of sensor systems for the monitoring and protection of infrastructures; energy storage systems; new catenary power systems; the development of railway simulation software, and studies for the implementation of Building Information Modelling (BIM) methodologies in the railway sector.

- › **The Railway Innovation Hub:** since 2016, Abengoa has been participating in the development of a railway cluster in Malaga to support the sector and stimulate aid in innovation at national and international level, thus becoming an international benchmark in innovation in the sector and a meeting or consultation point at international level.

Specifically, Abengoa plays the role of vice chairman of 'The Railway Innovation Hub Spain', officially constituted on 12 December 2017 by the following founding companies: Abengoa, Azvi, Comsa Corporación de Infraestructuras, Deimos Space, Ferrovial Agromán, MRI Internacional, Siemens, Telice, Thales and Vias, although it is open to all private enterprises that wish to join the initiative.

- › **Broken Track project.** Abengoa has developed a track break detection system capable of real-time monitoring of the breakage of any of the dual tracks and their location. Abengoa, together with Adif, is currently in the process of locating new stretches for testing and trials.



The broken track project allows rapid detection of track breaks.

- › **MICRail project:** at the end of 2017, Abengoa, together with the SME Apogea Consulting, S.L. and the Polytechnic University of Madrid, studied and presented the MICRail project to a call for launch aid. This would be undertaken between 2018 and 2020. The aim of this project is the development of an innovative tool for automatic catenary stakeout and system modelling, fully integrable in a workflow under BIM methodology, allowing not only the 3D vision of the complete project, but also the subsequent obtaining of cross sections per post or the extraction of material measurements from the overall project, as well as the automatic generation of stakeout logs.



The project will allow smart modelling in BIM for optimisation, decision-making and life-cycle analysis in catenary designs.

- › **HVDC (High Voltage Direct Current) project:** during 2017, Abengoa, in partnership with the University of Malaga, worked on a market analysis and study in reference to the implementation of HVDC (High Voltage Direct Current) technologies in railway systems, detecting that nothing relevant has yet been developed in this regard. The project will focus on the development of a direct current catenary (HVDC) power system for 25 kV high speed power systems.



The HVDC project will allow the development of HVDC rail electrification systems for high speed lines.

- › **SATRAIL project (“SmartStorage for Railway Infrastructure”)**: during 2017, Abengoa, in partnership with the University of Malaga, worked on a market analysis and study in reference to the implementation of storage systems within railway systems. With the SATRAIL project, Abengoa aims to develop a system to optimise the energy infrastructure in railway systems through the use of smart storage systems. The aim of this storage of energy is to cover demands of railway traction, as well as to standardise the existing problems related to under voltage allowed in catenary.
- › **Alis project**: the integral simulation tool that Abengoa began to develop in 2016 is in its final phase. Thanks to the development of this software, Abengoa will have a major competitive advantage in the international railway market, allowing smart designs of railway electrification systems, both in their electrical and mechanical aspects. This tool also allows studies of electromagnetic compatibility, induced voltages, short circuit studies, accessible voltages, stray currents or network imbalances. Finally, this software also has the capacity to conduct studies of energy efficiency in railway environments, optimisation of efficient running, optimal sizing of energy storage systems or studies of integration of renewable energies.



The Alis project allows smart designs of railway electrification systems.

- › **RAIN project - Railway Inspector**: in 2017, Abengoa started work on the launch of the RAIN project -Railway Inspector: an autonomous vehicle that will allow the auscultation of multiple elements along the railway line, thus guaranteeing the safety of the operation, and which will collect images, data or information from the existing infrastructures.