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02 Innovative technology solutions for sustainability

Society is facing major challenges such as natural resource scarcity, rising energy demand and climate change. By 2050, world population is estimated to reach 9.6 billion people [1], which will entail, among other things, unfair competition in gaining access to limited resources, including water and fossil fuels, as well as a significant rise in the amount of waste generated.

The current change in paradigm is therefore compelling companies to adapt their business model towards a more sustainable model to ensure lower consumption of resources and efficient resource management by applying new technologies that do not compromise our future generations.

Abengoa applies **innovative technological solutions** for sustainability in the **energy and environment sectors**, bringing value to its stakeholders through a management system based on advancing enterprise, social responsibility, transparency and rigor.

Abengoa mission, vision and values

Mission: Abengoa is a technology company that applies innovative solutions for sustainability in the energy and environment sectors, bringing long-term value to its shareholders through management characterized by fostering the entrepreneurial spirit, social responsibility, and transparency and rigor in management.

Vision: to be a global benchmark in the development of innovative technology-based solutions for sustainable development.

Management at Abengoa is based on a set of **values** that govern the corporation's relations with all its companies:

Integrity: Abengoa conducts its affairs in an honest fashion in every endeavor, both within the company itself and in the communities in which it operates.

Legality: each action carried out by the company is compliant with applicable law so as to ensure legal security in undertakings and reduce risks.

Professional rigor: involvement and commitment to service in all activities conducted by the company are essential to its ongoing success.

Confidentiality: discretion and prudence govern each of Abengoa's relations with its stakeholders, which is a key aspect in forging trust and improving communication and rapport between the company and its environment.

Quality: excellence is realized in all of the products and services the company offers.

Note 1 UN Study: World Population Prospects: The 2012 Revision.

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Business model and areas of activity

Abengoa focuses its business on three core areas of activity:

Engineering and construction

With over 70 years of experience in the market, this area encompasses the company's traditional engineering business dedicated to executing complex turnkey projects in the energy and water sectors: solar thermal, solar-gas hybrid, conventional power generation and biofuel production plants; hydraulic infrastructure, including major desalination plants and transmission lines, among others.

Infrastructures under concession

Abengoa boasts an extensive portfolio of proprietary assets under concession, all of which generate income through long-term sale agreements, guaranteed purchase (take or pay) agreements and power purchase agreements. This business line encompasses the operation of electrical power plants (solar, cogeneration and wind power), desalination facilities and transmission lines.

Industrial production

This includes technology-heavy businesses such as biofuels and the development of solar technology, being areas in which Abengoa enjoys a strong position of leadership in the geographic markets in which it operates.

Organizational chart

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As part of Abengoa's commitment to sustainable development, the company addresses present and future needs

Innovative technology solutions

Abengoa, in its unwavering commitment to **sustainable development** and the **struggle against climate change**, has been able to recognize today's needs in the energy and environment sectors and address these needs through technological innovation to generate energy from renewable sources, produce drinking water from sea water and turn biomass into biofuels.

To tackle the issue of **energy sustainability**, Abengoa develops solutions in response to the challenge of **energy challenge through solar power and hydrogen**. The company, which has been researching and developing technologies for producing energy from renewable sources since the 80s, has become a global leader in the two main concentrating solar power technologies: parabolic trough and tower.

At present, more than 80 % of the company's energy resources come from **fossil fuels**. To address the challenge of replacing fossil fuels with fuels of vegetable or organic origin, Abengoa is **developing second-generation biofuels and energy crops**.

With the aim of tackling the **problem of water resource scarcity**, Abengoa has developed technology featuring innovative designs for **generating drinking water from sea water**, water treatment and the creation of processes for reusing water for industrial and domestic purposes.

The **generation of municipal waste** is already a problem for the world's major cities. Abengoa has been working on the development of **new Municipal Solid Waste (MSW) management models** for producing ethanol through a process involving treatment via fermentation and enzymatic hydrolysis, as well as recycling of materials that can be reused, minimizing the environmental footprint, and reducing both dependence on fossil fuels and greenhouse gas emissions into the atmosphere.

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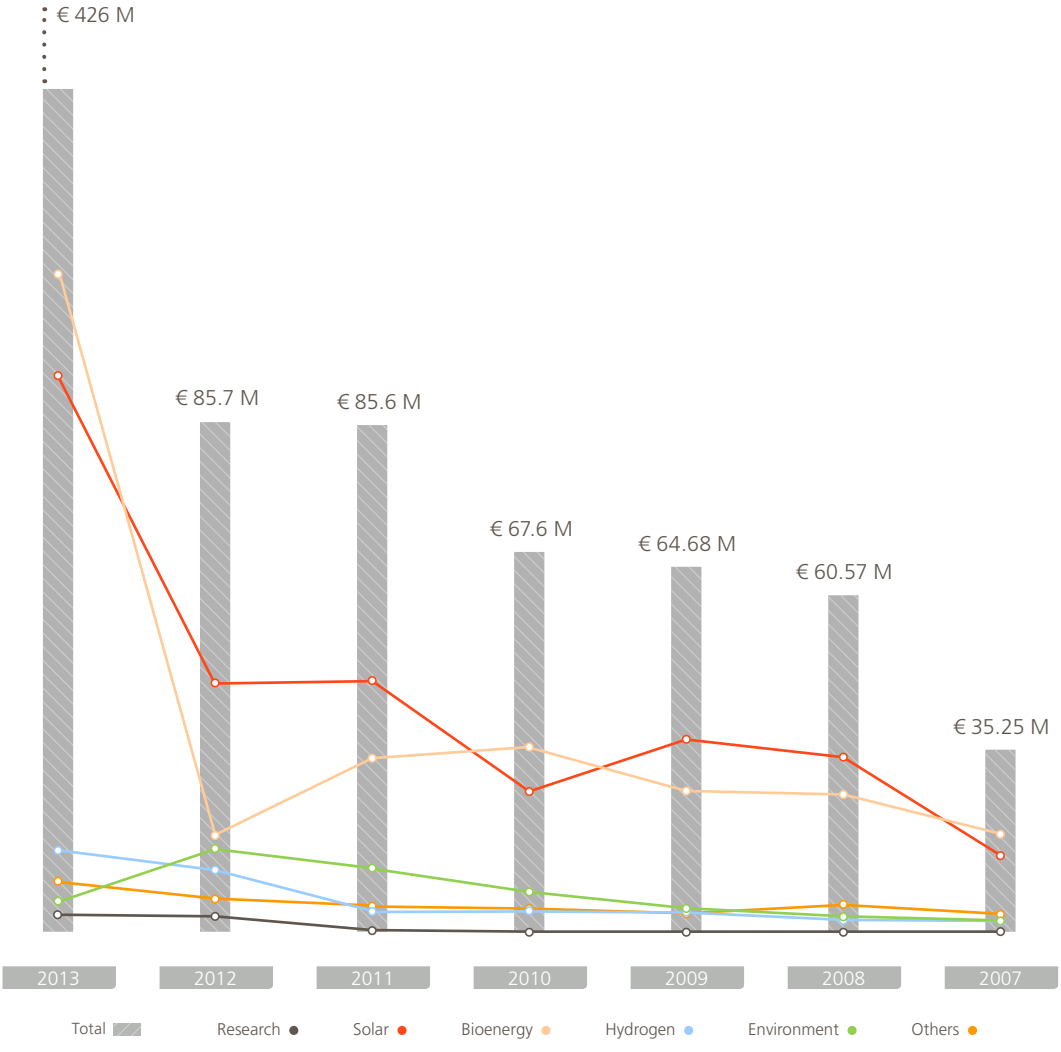
In 2013, the company invested over € 426 M in R&D and innovation. This figure represents aproximately 5.79 % of overall sales

Innovation for sustainable development

Abengoa believes in and backs technological innovation as a driver of company growth. In 2013 the company's R&D and innovation investment totaled € 426 M. This figure represents approximately 5.79 % of overall sales and a significative increased from 2012.

The total number of employees dedicated to R&D and innovation in 2013 was 781.



Abengoa remains committed to R&D and innovation, ramping up its investment year after year.

R&D and innovation indicators	2013	2012	2011
Number of R&D and innovation-dedicated employees	781	737	661
Patents applied for	261	200	151
Patents granted	106	74	35
Number of PhDs in R&D and innovation activities	85	49	36
Investment in R&D and innovation (M€)	426	85.7	85.6
Investment effort (%)	5.8	1.35	1.36

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261 patents applied for and 106 already granted

R&D and innovation principles and structure at Abengoa

The company's R&D and innovation strategy revolves around three key areas:

- Alignment with company strategy.
- Being a driver for growth.
- Constituting a competitive edge over other companies operating in the industry.

Abengoa has implemented a set of tools for systematizing and standardizing R&D and innovation management throughout the different stages and levels of development.

The following are among the primary mechanisms employed to this end:

- **TechValue**: a tool used to evaluate the contribution of R&D and innovation to generating competitive advantage based on measuring the effects on cost reduction in Abengoa products and services.
- **R&D Value**: economic assessment of research and technological development that takes markets and their evolution into account to obtain the value of each R&D and innovation program and the R&D and innovation portfolio as a whole.
- **Stage-Gate Methodology**: this procedure aids in managing all company R&D and innovation projects in a uniform fashion, facilitating their monitoring and understanding with a view to decision-making and lower risks.
- **Patents and Technology Watch Office (PTWO)**: body in charge of managing all activities involving intellectual property. As of year-end 2013, Abengoa had applied for **261 priority** patents, 106 of which have already been granted.

Doctoral candidate program

Training is one of the cornerstones of Abengoa's R&D and innovation division. The **PhD program** was therefore unveiled in 2012 for the purpose of training highly qualified personnel in scientific and technical fields.

In 2013, fifteen of the 21 students who began the program have continued with their research in collaboration with a variety of **universities around the world** under the direction and supervision of recognized PhD. As part of this program, the company, through the Focus-Abengoa Foundation, has signed an agreement to fund three two-year scholarships from the Fulbright Commission for young men and women residing in Andalusia to study their master's degree or doctorate programs in the area of renewable energy and the environment in the US.

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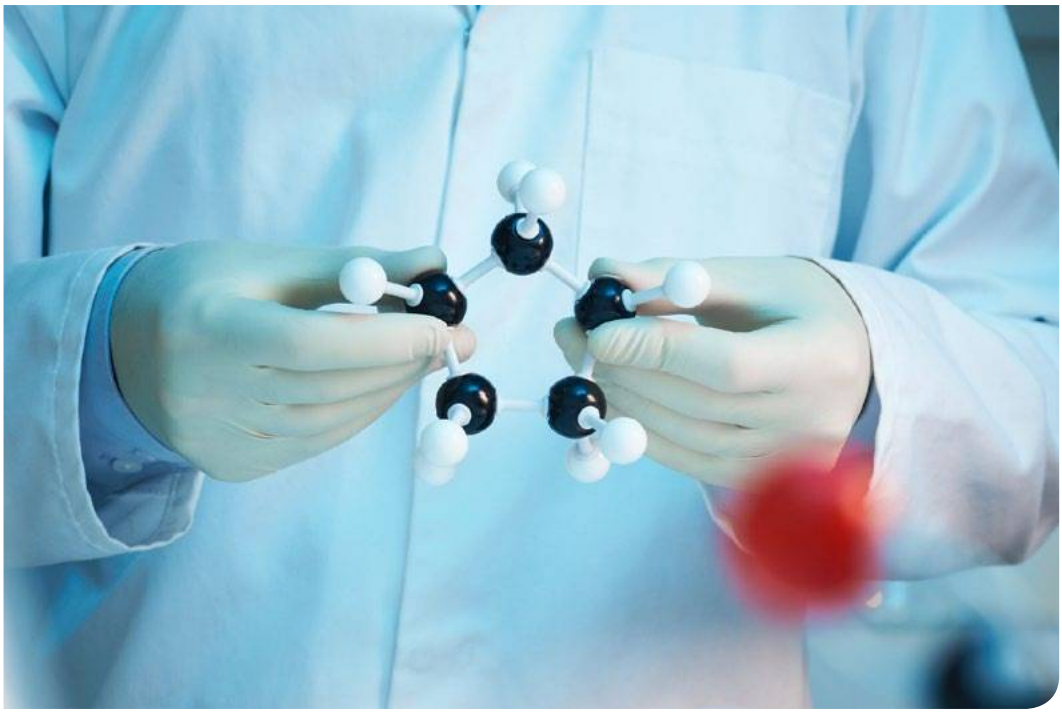
For the development of proprietary technology it is indispensable to have suitable means in place to enable the company to attain excellence in research. For this reason, the company has added **specialized facilities** to its existing infrastructure:

- **Soland Laboratory**: R&D and innovation facility located at the Soland Business Innovation Complex in Sanlúcar la Mayor, Seville, dedicated to concentrating solar power and high-concentration photovoltaic (HCPV) technology.
- **Abengoa Research Laboratory**: located at Campus Palmas Altas in Seville, the laboratory has experimental facilities for most of Abengoa's scientific areas:
  - Biological laboratory.
  - Electrical laboratory.
  - Materials laboratory.
  - Thermal fluids laboratory.
  - Chemical laboratory.
  - Biomolecular and biochemical laboratory.

The innovation model and managements tools have enabled Abengoa to **lead the ranking of Spanish companies** in European patent applications, and become the number-one Spanish company (eighth among European companies) in returns obtained from European research funds.



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Main projects in 2013

The current energy model based on fossil fuel sources poses problems that include depletion, supply security and high environmental impact. Coupled with accelerated population growth and a higher standard of living, this will lead to an ever-increasing cost of resources.

The solution lies in producing **new forms of clean and renewable energy** to gradually replace fossil-based energy sources. Abengoa continued to work in 2013 on developing technological solutions that will help attain a **sustainable future for all**.

Abengoa Solar

- Commercial operation startup in Arizona (US) of Solana, the **world's largest concentrating solar plant** with 280 MW of power and 6 hours of thermal energy storage capability. This plant yields an emissions **reduction of 475,000 tCO_2eq** per year and contributes **to direct employment by generating 1,069 jobs**.
- Construction of the Mojave Solar Plant, a parabolic trough plant with 280 MW gross power output located 150 km northeast of Los Angeles, near Barstow, California (US) that will curb CO_2 emissions by **350,000 tCO_2eq** per year, and will create **1,000 direct jobs**.
- Completion of construction on Khi Solar One, South Africa's first solar thermal superheated steam tower with 50 MW of power and two hours of storage capability, located close to Upington in the Northern Cape province (South Africa). This plant **curbs** CO_2 emissions by **183,000 tCO_2eq per year**. In addition, **600 jobs** were created during plant construction, and **35 more positions** will be created to handle plant operation and maintenance.
- Advancement in operating the Solugas pilot plants (combining solar energy with a Brayton Cycle) and Salt Tower, both of which are located at the Solúcar Complex in Sanlúcar la Mayor, Seville (Spain).

The Solana, Mojave Solar and Khi Solar One plants together yield emissions savings totaling over 1 Mt of CO_2 equivalent to the emissions from more than **250,000 passagers cars per year**[2].

Water

- Startup of commercial operation of the desalination plant in Qingdao, the second largest commercial port in northern China, in the province of Shandong (China). This plant generates 100,000 m^3/day of drinking water from sea water, a volume which is equivalent to 40 Olympic swimming pools, with the capacity to **meet the supply needs of half a million people**.

Note 2 Figures from the Department of Energy (DoE) from the US and the European Commission (EC).

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Biofuels

- Operational startup and inauguration of the first Waste to Biofuels (W2B) technology demonstration plant with the capacity to **process 25,000 t of Municipal Solid Waste (MSW)**, from which up to 1.5 ML of fuel-grade bioethanol can be obtained. The plant is located in Babilafuente, Salamanca (Spain) [3].
- Operational rollout of the Hugoton plant, the first commercial-scale plant to produce second-generation ethanol from biomass, located near Hugoton in Stephens County, Kansas (US), and which will **replace the use of over 60 ML of gasoline each year**, and **1,300 new positions will be created**.

Note 3 More information in this chapter.

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And what if we could use garbage as a fuel to run cars?

To solve the problems linked to waste management and the production of clean biofuels, Abengoa has developed a **solution** which simultaneously addresses efficient management of the organic fraction of municipal solid waste and sustainable energy production through **Waste to Biofuels (W2B) technology**.

In June, the company has been operating the Waste to Biofuels (W2B) technology demonstration plant in Babilafuente, located in the province of Salamanca (Spain). The plant has the capacity to process **25,000 t of Municipal Solid Waste (MSW)** and **produce up to 1.5 ML** of bioethanol for numerous applications: as a gasoline additive to increase octane levels; to fuel cars; as a product for use in the chemical and pharmaceutical industries (in solvents and cosmetics, for example) and even as an intermediate product in the production of jet fuel.

The plant comprises the infrastructure already in place for the second-generation plant which converts biomass into bioethanol, the operation of which, for more than **6,000 hours**, enables technical and economic viability validation of enzymatic hydrolysis technology for transformation of lignocellulosic material, an innovative treatment process representing a revolution in MSW management.

W2B technology decreases the time involved in landfill management, which contributes to **minimizing the environmental footprint** of waste management, in addition to significantly reducing the emission of particles and greenhouse gases per kilometer traveled by 70 %. It also maximizes the recovery of the organic fraction of municipal solid waste and prevents the dumping of more than 80 % of waste.

W2B technology demonstration plant in Babilafuente, Salamanca (Spain).

If we were to make use of the bioethanol obtained using W2B technology to treat the more than 24 Mt of MSW that are generated in Spain each year, meaning about 2,100 ML of bioethanol, **we could cut gasoline consumption by 1,900 ML**; in other words, 31 % of the total amount of gasoline consumed in Spain.

Turning garbage into **bioethanol** is an innovative way to manage waste that in turn generates a product that is beneficial to everyone. W2B technology therefore brings **technological innovation** and **social responsibility together**.

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Abengoa presence map

Headquartered in Seville (Spain), Abengoa operates in 50 countries on every continent through its, aproximately, 600 companies, subsidiaries, holding companies, facilities and office locations.

North America

United States of America
Mexico

Latin America

Argentina
Brazil
Chile
Colombia
Costa Rica
Ecuador
Guatemala
Nicaragua
Panama
Peru
Uruguay

Europe

Denmark
France
Germany
Holland
Ireland
Italy
Poland
Portugal
Romania
Russia
Spain
Sweden
Turkey
United Kingdom
Ucrania

Africa

Algeria
Angola
Egypt
Ghana
Kenya
Libya
Morocco
South Africa
Tunisia

Asia

China
India
Israel
Japan
Nepal
Oman
Saudi Arabia
Singapore
South Korea
Sri Lanka
Taiwan
United Arab Emirates

Oceania

Australia

In September 2013, Abengoa inaugurated its **new headquarters in Madrid**. Located at No. 43 on the Paseo de la Castellana, the **375-employee**-capacity building brings together the activities of the Abengoa companies in the nation's capital in order to combine company business and to apply the social model in place at Campus Palmas Altas, with activity focusing on advanced technologies, environmental excellence and sustainable development.