

01

Annual Report 2011

**ABENGOA**

Activities 2011

Innovative technology solutions  
for sustainability

# 01

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# 01

## Glossary

Operating terms	
A	Ampere
bar	Bar
bsh	Bushel
BTU	British thermal unit
CO <sub>2</sub>	Carbon dioxide
DGS	Distilled Grains and Solubles
EPC	Engineering, Procurement and Construction
ETBE	Ethyl Tertiary Butyl Ether
g	Gram
gal	Gallon
GHG	Greenhouse Gas
h	Hour
ha	Hectare
Hz	Hertz
ISCC	Integrated Solar Combined Cycle
J	Joule
km/h	Kilometer per hour
kW	Kilowatt
L	Liter
m	Meter
m/s	Meter per second
m <sup>2</sup>	Square meter
m <sup>3</sup>	Cubic meter
N	Newton
Pa	Pascal
ppm	Parts-per-million
s	Second
t	Metric ton
V	Volt
VA	Volt-ampere
VAr	Volt-ampere reactive
W	Watt
We	Electric watt
Wh	Watt hour
Wth	Thermal watt

Financial terms	
€	Euro
\$	US Dollar
BRL	Brazilian Real
CAGR	Compound Annual Growth Rate
EBITDA	Earnings Before Interest, Tax, Depreciation and Amortization
GDP	Gross Domestic Product
PCAOB	Public Company Accounting Oversight Board
ROE	Return On Equity
SOX	Sarbanes Oxley

# 01 |

## Glossary

Prefixes according to the International Metric System		
m	Mili	$10^{-3}$
c	Centi	$10^{-2}$
d	Deci	$10^{-1}$
h	Hecto	$10^2$
k	Kilo	$10^3$
M	Mega	$10^6$
G	Giga	$10^9$
T	Tera	$10^{12}$

02

Annual Report 2011 | Main figures

# 02

## Main figures

During the period 2001-2011 Abengoa's revenues have been growing at a compound annual rate of 18 %, the ebitda by 21 % and net income by 20 %.

	2011	% Var 2010-11	2010 <sup>(1)</sup>	2001	% CAGR <sup>(2)</sup> (2001-11)
<b>Income statement (M€)</b>					
Revenues	7,089	45.9	4,860	1,380	17.8
Ebitda <sup>(3)</sup>	1,103	35.7	812	166	20.8
Net income	257	24.3	207	42	20.0
<b>Balance sheet (M€)</b>					
Total assets	18,794	10.7	16,974	2,101	24.5
Shareholders' equity	1,726	5.9	1,630	317	18.5
Net corporate debt (cash)	120	(89.7)	1,166	174	(3.7)
<b>Significant ratios (%)</b>					
Operating margin (Ebitda / Revenues)	15.6	-	16.7	12.1	-
ROE (Return on Equity) <sup>(4)</sup>	15.9	-	16.1	13.1	-
<b>Data per share (€)</b>					
Earnings per share	2.39	4.5	2.29	0.46	18.0
Dividend per share	0.35	75.0	0.20	0.14	9.6
Last quotation	16.40	(10.7)	18.38	6.91	9.0
Capitalization (M€)	1,765	6.2	1,662	625	10.9
Daily avge. trading volume (M€)	12.3	15.0	10.7	0.8	31.0

(1)

For comparative purposes, Telvent appears in 2010 as a discontinued activity.

(2)

Compound Annual Growth Rate.

(3)

Earnings before interest, tax, depreciation and amortization.

(4)

Net income/Shareholders' equity.

## Types of activities & geographies

Areas of activity (%)	2011		2001	
	Revenues	Ebitda	Revenues	Ebitda
Engineering and construction	49.7	39.7	65.6	54.1
Concession-type infrastructures	6.0	27.1	4.6	7.0
Industrial production	44.3	33.2	29.8	38.9
<b>Consolidated total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

<b>Geographies (%)</b>				
Spain	27.3	29.3	63.7	70.5
Brazil	20.7	32.8	5.8	6.5
USA	19.0	12.6	0.4	1.3
Europe (ex. Spain)	15.3	13.0	9.1	13.2
Latin America (ex. Brazil)	10.9	7.8	18.6	7.4
Asia	5.7	3.2	1.7	0.6
Africa	1.1	1.3	0.7	0.5
<b>Consolidated total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

03

Annual Report 2011 | Our commitment



# 03

Our  
commitment

At Abengoa, we believe that the world needs solutions to pave the way for more sustainable development. Scientists tell us that **climate change** is a reality and at Abengoa we believe that now is the time to seek out solutions and put them into practice.

Over ten years ago, Abengoa made the strategic decision to focus its growth on the creation of new technologies geared towards sustainable development:

- Generating **energy** from renewable resources.
- Recycling industrial **waste**.
- Generating and managing **water**.
- Creating **infrastructures** that eliminate the need for new investments in assets that generate emissions.
- Creating **new horizons** for development and innovation.

To this end, we invest in Research, Development and Innovation, R&D&I, **globally** expand those technologies with the greatest potential, and attract and develop the necessary **talent**.

In a similar vein, we channel human and financial resources into the **Focus-Abengoa Foundation** to promote social action policies that champion social and human progress.

By following this approach, we create **long-term value** for our shareholders, ensure the growth of the companies through which we operate and help to make the world a better and more sustainable place for future generations.

# 04

Report from the chairman

# 04

## Report from the chairman

2011 was a good year for Abengoa. Our innovative technology solutions for sustainability enabled us to once again report double-digit growth in spite of the adverse conditions plaguing current financial markets. We continue to reinforce our commitment to technology, the key driver of the company's business today, in order to continue contributing to the enhancement of quality of life for all.

We are executing our strategic plan, making investments and closing financing on the corresponding projects. This, in conjunction with asset rotation and positive cash-flow generation from both engineering projects and industrial plants and concessions, helped us bring down our net debt and generate a total of 1,353 M€ in cash flow from operations.

Our revenues increased by 46 % over 2010, totaling 7,089 M€; ebitda totaled 1,103 M€, climbing by 36 %, and net income rose by 24 % from last year's figure for a total of 257 M€.

Our objective in 2012 is to keep growing and strengthen our financial structure, while taking into consideration today's complicated global context. It was for this reason that, in 2011 we welcomed First Reserve as a shareholder. As one of the major international investment funds specializing in the energy industry, their investment of 300 M€ reflects unequivocal support of our strategy. We also secured a significant strategic alliance with the Companhia Energética de Minas Gerais (CEMIG), one of Brazil's largest electrical power companies, which will enable us to develop new projects together. This alliance generated 479 M€ in cash proceeds for Abengoa and a reduction in net consolidated debt of 642 M€. Finally, the sale of our stake in Telvent allowed us to decrease net debt by 725 M€ and this move also marked the successful culmination of our presence in the systems integration sector.

As an overall result of the above, at year-end 2011, net corporate debt dropped to 0.1 times our corporate ebitda, for a total of 120 M€, and total net debt, including non-recourse financing associated fundamentally with our concessions, was lowered to 5,510 M€, representing 5.0 times our consolidated ebitda. We ended the year with a cash position of 4,752 M€, which will allow us to meet our anticipated investment and debt commitments in 2012 with confidence.

The innovative spirit that inspired our founders more than 70 years ago is still alive today at Abengoa. We ended the year with a total of 190 patents, 43 granted and the others pending, thanks to the team of 682 people devoted to R&D+i under the direction of Abengoa Research.

The technological foundation for our products gives us our leadership position in the energy and environmental sectors where we operate in three business segments: engineering and construction, concession-type infrastructure, and industrial production.

### Engineering and construction

Our solid geographical diversification, coupled with the rise in demand for our solutions, contributed to our 53 % growth in revenue, totaling 3,526 M€. New project orders over the past twelve months helped us to end the year with a backlog worth 7,779 M€.

Such projects include the Zapotillo aqueduct in Mexico, two new CSP plants in South Africa (one of which employs tower technology): new high-voltage lines in Latin America and Southeast Asia, and new desalination facilities in Africa.

In the meantime, construction is progressing well on the two largest CSP plants in the world, located in Arizona and California (USA).

# 04

Report from  
the chairman

## Concession-type infrastructures

Over the course of 2011, we produced more than 2,500 GWh of power through our solar, hybrid and cogeneration plants, including bringing 3 new plants online with an installed power output capacity of 250 MW. In addition, we generated 82,405 ML of desalinated water with the start-up of our new plant in Algeria.

The total power output capacity of our power plants, installed and under construction, is 2,405 MW, and we have plants, located in the US, Mexico, Brazil, Uruguay, Spain, South Africa, India and Holland. Additionally, we are currently building new desalination plants in China, Algeria, and Ghana, as well as various power transmission lines in Brazil and Peru.

## Industrial production

Our industrial recycling and biofuel businesses continue to grow, bringing in revenues of 3,136 M€, a 39 % increase over last year. This is the result of producing 2,758 ML of biofuel, recycling 1.24 Mt of steel and aluminum, and managing more than 0.93 Mt of industrial waste.

Our future options include: Abengoa Water, Abengoa Hydrogen, Abengoa Seapower, and Abengoa Energy Crops.

## Diversification and growth

The company's growth model is based on simultaneous management of our three horizons, or short, medium and long term objectives.

We maintain steady cash flow in our conventional Horizon 1 businesses, we invest in the growth of emerging Horizon 2 businesses, and we support numerous options for the future along Horizon 3 that will transition to Horizons 1 and 2 in the coming years.

Our international business accounts for 73 % of our total revenues, with Brazil standing out at 21 %, as well as the US, representing 19 % of the total figure.

## Human capital, innovation, and employment

We have always said that the future depends on the creativity of the present. An the present, in turn, depends on the training and dedication of the people who make up Abengoa, which today totals more than 22,000 professionals, up by 9 % over last year.

In 2011, we invested in more than of 1.4 M hours in training, and we introduced joint programs with renowned universities in various locations where we operate around the world.

We also unveiled the Loyola-Abengoa Research Center for the purpose of promoting the development of research activities and teaching focused on renewable energies and sustainable development.

## Auditing

Once again this year, our internal control system underwent an independent evaluation process in accordance with the PCAOB auditing standards. Our Annual Report incorporates five independently verified reports covering the following areas: annual accounts, the SOX (Sarbanes Oxley)-based internal control system, Corporate Social Responsibility, Corporate Governance, and design and application of the company's risk management system in compliance with ISO 31000 specifications.

## 04

Report from  
the chairman

## Sustainable development

Abengoa's commitment to sustainability is a priority in all of our actions. We strive to reduce the environmental impact of our business with the help of an integrated sustainability management system that makes it possible for us to measure and compare our activities footprint and set improvement targets.

Another expression of Abengoa's corporate social responsibility is the Focus-Abengoa Foundation which contributes to the cultural and social enrichment of the communities where we are present.

Our stakeholders and all interested parties can learn more about our activities and performance, including our accomplishments, areas for improvement, future challenges, and 2012 goals in the Corporate Social Responsibility Report, which was prepared applying the principles of the Global Reporting Initiative (GRI) and the AA1000 Sustainability Assurance Standard.

We welcome all ideas or opinions that may help us improve and meet our objectives in upholding the commitment to sustainability we have undertaken. Feedback is welcome through the corporate social responsibility mailbox ([csr@abengoa.com](mailto:csr@abengoa.com)), our website ([www.abengoa.com](http://www.abengoa.com)) and our corporate blog ([blog.abengoa.com](http://blog.abengoa.com)).

In summary, 2011 was a year of growth and accomplishments, which is a particularly significant given today's adverse economic environment. We are confident that 2012 will be a year of opportunities. We shall continue investing to solidify our businesses in high-growth sectors, contributing to the expansion of future options, and exploring new opportunities that allow us to create sustainable value.



# 05

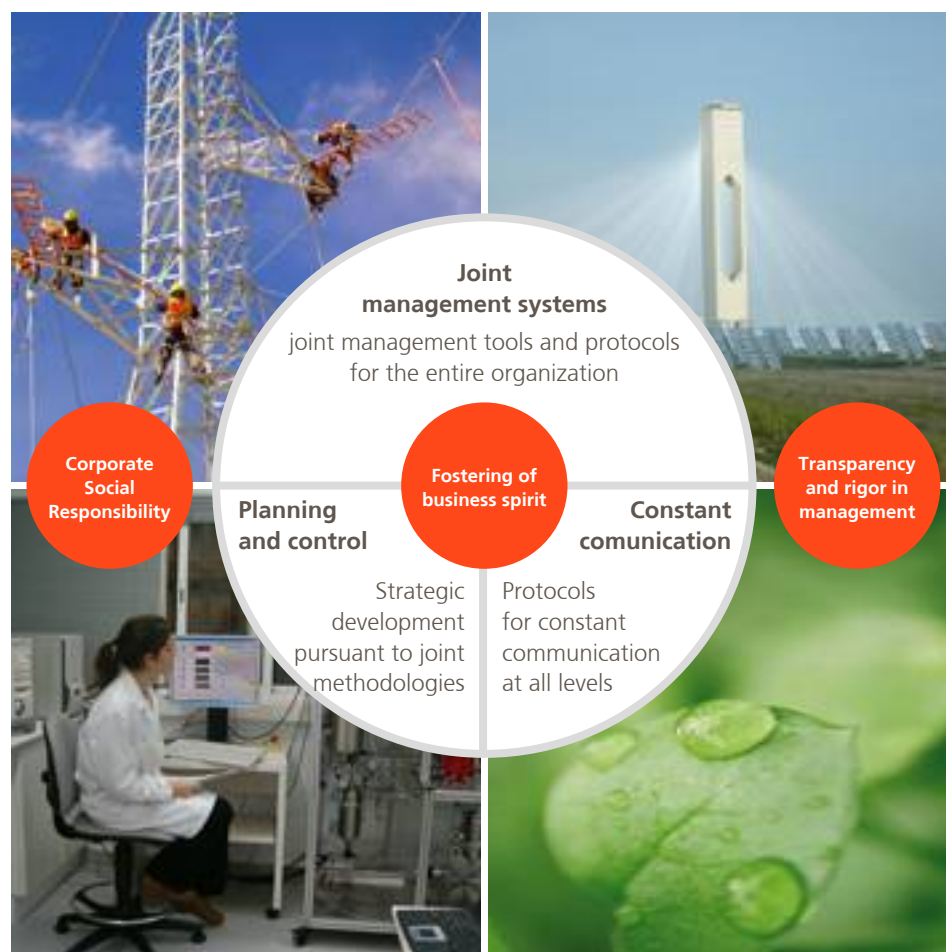
## Our management model

Growth at Abengoa is founded on five strategic cornerstones:

- Creation of **new businesses** that help combat climate change and foster sustainable development.
- A dedicated and highly competitive **human team**.
- Permanent strategy of creating value by generating new options and defining current **and future businesses** through a structured process.
- **Geographic diversification** in the markets offering the greatest potential.
- Heavy investment in **research, development and innovation**.

These cornerstones are shaped through a management model based on three core concepts:

- Corporate social responsibility.
- Transparency and rigor in management.
- Fostering of business spirit.



# 05

## Our management model

Our management model is reflected in our three horizons described below:

### A balanced set of activities

#### H1

- > Engineering and construction
- > Transmission lines
- > Solar (tower and trough in Spain)
- > Bioenergy (1<sup>st</sup> generation)
- > Industrial waste recycling (zinc, aluminum and salt recycling)
- > Desalination and water reuse

#### H2

- > Solar (trough international and storage)
- > Bioenergy (2<sup>nd</sup> Generation)
- > New transmission concessions (Direct Current)
- > Cogeneration
- > Industrial waste recycling in new geographical locations
- > Desalination and water reuse in new geographical locations

#### H3

- > Solar (new technologies and geographies)
- > Bioenergy (Biorefinery, Algae)
- > Energy Efficiency
- > Hydrogen
- > Ocean energy
- > Energy crops
- > Treatment and reuse of municipal solid waste





## 06.1

Annual Report 2011 | Engineering and construction

Abengoa, with over seventy years of experience in the energy and water engineering and construction market, boasts a long track record in performing complex turnkey projects: CSP plants, hybrid solar-gas plants, conventional power plants and biofuel facilities; hydro infrastructures, including large-scale desalination plants; and power transmission lines, to name but a few fields of expertise.

# 06.1

## Engineering and construction

Key figures	2009	2010	2011	Var. 11-10 (%)
Revenue (€M)	1,683	2,302	3,526	53.2
Ebitda (M€)	227	259	438	68.9
Ebitda margin (%)	13.5	11.3	12.4	9.7
Backlog (€M)	6,311	7,546	5,127	-32.1
Intake (€M)	3,464	3,033	5,293	74.5

## Our business

The fallout of the lingering economic gloom both in Spain and abroad is that banks are continuing to tighten their purse strings when it comes to lending and are demanding more for their money. The crisis has therefore restricted project start-ups and led to a slump in business, reflected by the widespread drop in viable opportunities.

Despite this widespread market instability, Abengoa's Engineering and Construction Division has once again responded superbly on course with company strategy, closing the year with a total of €3,526 M in projects underway, €5,293 M in order intake and €5,127 M on the order book, marking a 53.2 % increase in sales despite the precarious economic and financial climate, largely on the back of the company's efforts to diversify business and territories and its promotional drive.

CSP tower plant at Sanlúcar la Mayor (Seville)



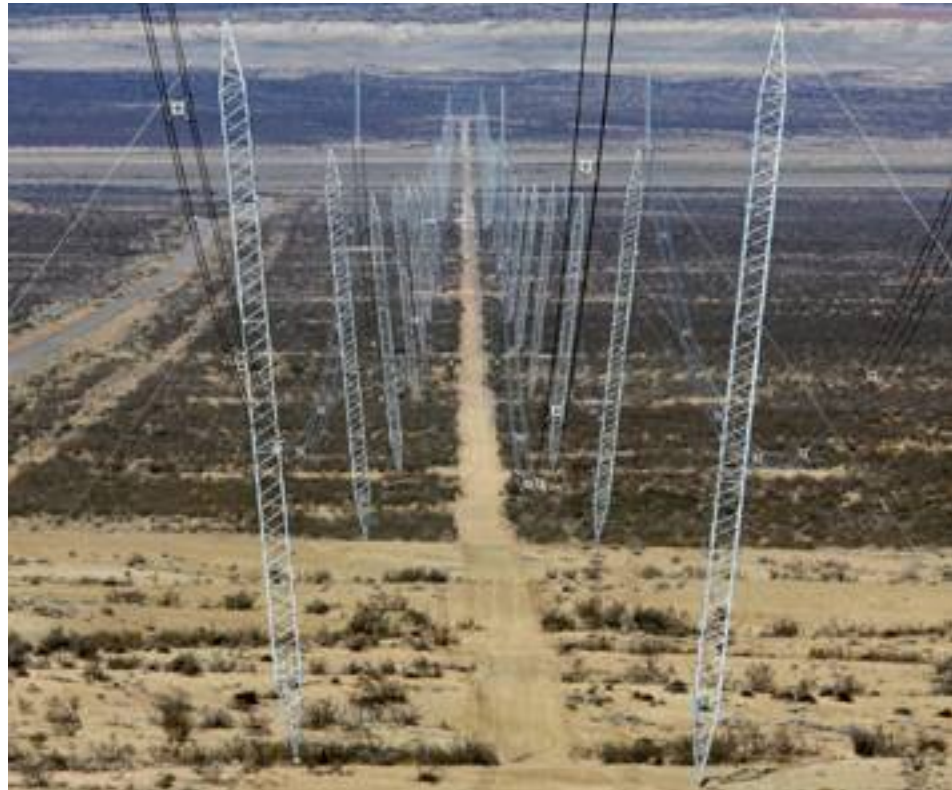
Abengoa offers its engineering and constructions customers a wide range of solutions relating to energy, transportation, telecommunications, industry, services and the environment. It provides groundbreaking solutions in clean energies and champions sustainable development by applying its considerable technological know-how to the following areas:

- Design and construction of electrical power plants based on renewable energies, capable of generating thousands of MWh (megawatts hour) of clean energy.
- Design and construction of biofuel plants to help combat climate change.
- Design and construction of cleaner and more efficient power plants.
- Design and construction of energy efficient power lines to help curb energy consumption.

# 06.1

## Engineering and construction

**Comahue-Cuyo interconnection**  
Section of power line heading south



**Transmission towers on the ATE IV line**  
Towers for the ATE IV Curitiba-Bateias power line



With engineering and construction being the cornerstone of Abengoa business, the company's mission in this field could essentially be defined as the design, engineering and construction of:

- Transmission systems and power generation plants.
- Water treatment and desalination plants, hydro power facilities and waste treatment.
- Industrial infrastructures and installations associated with conventional and high-speed railway.
- Telecommunication systems.

Abengoa aims to become an international market leader in the engineering and construction of power and environmental infrastructures and industrial installations on the path towards sustainable development.

Engineering and Construction embraces activities in which the division has over seventy years of experience in the market. It specializes in the performance of complex turnkey projects (EPC: Engineering, Procurement and Construction): CSP plants, hybrid solar-gas plants, conventional power plants and biofuel facilities; hydro infrastructures, including large-scale desalination plants; power transmission lines and critical infrastructure control systems, among others.

The division has cemented its presence in no less than 32 countries on all continents, adapting its structure to meet local social, cultural and economic conditions but without ever losing sight of its corporate social responsibility with the surrounding area. It is therefore able to understand and adapt to the different needs of each community in which it carries out its different lines of business.

Abengoa's growth model is rooted in its market credibility, its technical, financial and managerial prowess, its ability to seek out and secure strategic alliances, its social responsibility and its technological leadership.

# 06.1

## Engineering and construction

The company expects to report high growth from its projected investments for the coming years. Its growth is based on leadership and knowledge of the contracts it secures and the associated risks, and also on its financial structure and strategic alliances.



### Acceptance testing

Acceptance testing at the ABB factory (Asea Brown Boveri) in Ludvika (Sweden) on one of the seven 500 kV (HVDC) - 600 MW - 600 Tm converter transformers

The engineering and construction division bases its growth on a three-stage model that has proved hugely successful to date: the know-how acquired from third-party projects enables it to reduce the risks associated with new internal projects performed by the company itself (concessions), while the references obtained from these internal projects allow Abengoa to secure new third-party projects. This virtuous circle is one of the keys to Abengoa's success.



# 06.1

## Engineering and construction

In line with this vision, the engineering and construction division aims to cement this position of international leadership and extend it to the other sectors flagged as strategic priorities. The division's strategy for 2012 therefore involves:

- Maintaining its position of international leadership in the engineering and construction of power transmission lines and electrical infrastructures.
- Cementing its position as an international benchmark in EPC projects for renewable power plants, particularly in the fields of solar energy and biofuels.
- Honing its skills in the environment sector, focusing on both water and waste.
- Continuing to grow in the industrial installations sector, where it already boasts a solid international presence.

The engineering and construction division also has a heavy international slant, with Abengoa targeting markets from across the globe:

- Latin America, where the sharp growth forecast for the coming years offers clear opportunities, especially given the company's excellent positioning within the region, with Abengoa being the region's fourth largest international contractor according to the ENR ranking.
- North America. Huge opportunity in the USA and Canada. This is in fact a key region where the company is currently expanding its presence: at present, more than ten Abengoa companies already have a permanent base in the region.
- Eastern Europe. Abengoa is firmly committed to this region, which promises much for the future.
- Middle East and Asia. Although Abengoa has less experience in these regions than in others, it expects to report heavy growth thanks to its know-how and prior experience in other territories.
- Other regions such as Australia, South Africa, Turkey, etc.

## 2011 in review

Abengoa's Engineering and Construction Division remains upbeat about its future growth, seeing as though the company's results have witnessed constant growth year after year and consistently outstrip the company's own expectations. It is continuing with its recent drive towards international expansion and growth, while cementing its leadership in those markets where it operates.

Ranked in 2011 as one of the world's leading construction firms in energy infrastructures according to the ENR (Engineering New Record) ranking, Abengoa is the world's largest international construction firm in power transmission and distribution, the largest for electrical infrastructures, and also the fourth largest contractor in Latin America. Moreover, it is already the sixth largest constructor of desalination plants according to the IDA Desalination Yearbook.

The talent and dedication displayed by the division's human team is one of the driving forces behind the company's success in executing its projects. Highlight projects for 2011 include:

- Ongoing construction of the Solana plant, which is set to become the world's largest solar power plant with 280 MW of installed capacity. The facility is located in Arizona and utilizes parabolic trough technology with thermal storage from molten salts, thus enabling the plant to increase the number of hours over which it can operate in daytime and also at night.
- Ongoing construction of the 100 MW Shams 1 CSP plant, the largest of its kind in the Middle East and located in the desert surrounding Abu Dhabi. Spanning 300 ha, the facility will curb annual CO<sub>2</sub> emissions by 175,000 t thanks to its nearly 600,000 m<sup>2</sup> of parabolic troughs.



Overhead shot of ongoing construction work on the Solana plant

# 06.1

## Engineering and construction

150 MW Hassi R'Mel hybrid ISCC plant in Algeria

- Work continuing on the El Carpio Solar Complex in Andalusia, the Castilla-La Mancha Solar Complex and the Extremadura Solar Complex. Each complex features two 50 MW power plants employing parabolic-trough technology.
- Completion and unveiling of the 150 MW hybrid solar-gas power plant in Hassi R'Mel (Algeria), one of the world's largest hybrid power plants. This groundbreaking facility is already exporting power to the national Algerian grid. With construction now completed, Abengoa has been tasked with the operation and maintenance of the plant for the coming 25 years.



- Another major milestone was the completion and commercial start-up of the 220 kV Carhuamayo-Cajamarca power line and associated substations in Peru. The project includes 670 km of line, two new substations and upgrades to five existing substations.
- Ongoing construction on the 600 kV direct current Porto Velho-Araraquara power line in Brazil. This is a truly groundbreaking milestone in that it is one of the world's longest direct current transmission lines at 2,350 km. Work is also continuing on the 230 kV Jauru-Porto Velho alternating current line as part of the Pre-Madeira project, which spans 987 km in total. Over the last ten years, Abengoa has constructed over 2,000 km of HV power lines and 21 substations. Abengoa currently has 4,000 km of lines (2,400 km being 600 kV direct current) and 16 substations under construction for concessionaire companies in which it holds a controlling stake.

# 06.1

## Engineering and construction

- Start-up of the 500 kV EHV (extra high-voltage) power line in Argentina between the Agua del Cajón transformer substation and the Rio Diamante transformer substation, spanning a grand total of 518.6 km.



**Agua del Cajón**

Agua del Cajón transformer substation in Argentina.

The satisfaction of our customers following successful completion of their projects has enabled Abengoa to secure and start up various new contracts, of which we would highlight:

- Construction underway on the Mojave facility, a new 250 MW CSP plant sited in the Mojave Desert and utilizing parabolic-trough technology. The facility is set to become one of the world's largest solar power plants.
- Work has also started on the world's first second-generation bioethanol plant intended for commercial use. The facility, which will run on cereal straw instead of grain, will produce 26 Mgal of bioethanol a year and 20 MW of electricity in the United States.
- In Peru, Abengoa has started work on the 500 kV Chilca – Marcona – Ocoña – Montalvo power line and associated substations, which includes the installation of two series compensation capacitors at the Ocoña substation. The 800 MW line is 872 km in length and has 1,200 MVA of transformation capacity.
- Abengoa has been awarded a 25-year contract to supply drinking water, with the project including the engineering and construction, and also operation, management and maintenance of the El Zapotillo-Los Altos de Jalisco-León aqueduct in Guanajuato, Mexico.
- Contract awarded for a water supply system in the city of Dogubayazit, Turkey, further consolidating Abengoa's presence in the country.
- Contract awarded towards the end of the year for two solar power plants in South Africa: a 100 MW plant employing parabolic-trough technology and a 50 MW plant featuring power tower technology, one of the largest of its kind worldwide.
- Contract awarded to the Spanish-Saudi consortium Al Shoula Group (which includes Abengoa) to construct a high-speed railway line connecting the cities of Medina, Jeddah and Mecca in Saudi Arabia.

220 kV Carhumayo-Cajamarca transmission line





# 06.1

## Engineering and construction

- A further highlight for 2011 was Abengoa's new inroads in the wind energy sector, marking another bold step forward towards its objectives in this area. The company has been entrusted with the design, construction, operation and maintenance of a wind farm in Cuchilla de Peralta, Tacuarembó (Uruguay), with 50 MW of installed capacity. It has also secured contracts from Aneel (Brazilian Electrical Energy Agency) for three wind farms with a combined capacity of 64 MW, namely Santo Antonio Pádua, Sao Jorge and Sao Cristovão, all located in the municipality of Trairí in Ceará state (Brazil).

## Our activities

Abengoa's engineering and construction division is structured under the following five different lines of business:

### Energy

This business line is primarily engaged in the design, engineering and construction of power generation plants and transmission systems.

#### Spain

The main projects undertaken at home in 2011 were as follows:

- Abengoa has completed work on the Ecija Solar Complex (Seville), featuring two 50 MW CSP power plants, namely Helioenergy 1 and Helioenergy 2, which are already supplying the commercial grid.

Helioenergy parabolic-trough solar field, Ecija (Seville)



# 06.1

## Engineering and construction

Pilot high-voltage line stringing by helicopter in Spain



- Ongoing work on eight 50 MW CSP power plants in the municipalities of Ecija and El Carpio in Andalusia, Logrosan in Extremadura, and in Ciudad Real, all employing parabolic-trough technology. As a whole, the power plants will generate enough electricity to supply over 200,000 homes and will slash yearly CO<sub>2</sub> emissions by over 250,000 t.
- Abengoa has been heavily involved with a number of the leading power utilities in Spain, and is also helping to construct electricity evacuation and transmission infrastructures for the solar power plants being promoted by Abengoa.
- Abengoa has been awarded a contract for the design, civil engineering, supply and start-up of three 400 kV distribution substations in Cerrato (Palencia).

### Europe

Highlight projects for the rest of Europe include:

- Ongoing work on the 150 kV Riba de Ave-Oleiros high-voltage line for REN (the Portuguese Electricity Grid).
- In 2011, Abengoa continued to provide engineering services to the client RTE EDF Transport, involving studies and projects to reinforce, adjust, restructure, change conductors and make other modifications to high-voltage overhead lines.
- Completed work on the 400 kV Lescovak-Macedonia Border line for the Serbian electricity utility EMS, thus paving the way for future interconnection between Serbia and Macedonia.

### United States

Highlight projects for this particular region include the following:

- With an installed capacity of 280 MW, the Solana plant is set to become the world's largest solar power plant and features parabolic-trough technology with thermal storage based on molten salts, thereby enabling the facility to increase the number of hours over which it can operate in daytime and also at night. The facility will power 70,000 homes while curbing yearly CO<sub>2</sub> emissions by 475,000 t.



Construction of molten salt storage tanks at Solana, Arizona

- Construction is underway on the Mojave facility, a new CSP plant in the Mojave Desert (California). The facility will include two CSP plants, each with a net installed capacity of 140 MW for a combined useful power output of 250 MW. The Mojave project is also set to feature one of the world's largest parabolic-trough solar fields.

# 06.1

## Engineering and construction

- Start of construction on the world's first second generation biomass-to-bioethanol plant in Hugoton, Kansas. The plant, which will produce 26 Mgal of cellulosic bioethanol per year, will harness Abengoa's own enzymatic hydrolysis technology. The plant will run chiefly on agricultural waste, such as corn or sorghum stems, but can also use wheat straw, wild grass and even wood chippings. The facility will also generate 20 MW of electricity from biomass, enough power to meet its own energy needs and demand for ethanol production.
- Abengoa has strengthened ties and strategic alliances with North American engineering and construction companies interested in developing and promoting joint projects to meet the current demand for power transmission lines of certain North American utilities.

### Mexico

The most significant projects in Mexico are detailed below:

- Turnkey contract, including one-stop engineering and construction, for a 640 MW combined cycle plant in the state of Morelos, Mexico. This electrical power plant of the Mexican Federal Electricity Commission will form part of the "Proyecto Integral Morelos" project, a key initiative in developing central Mexico.
- The Mexican CFE (Federal Electricity Commission) awarded an EPC contract to construct the 42.3 MW Baja California Sur IV internal combustion plant in the state of Baja California Sur.
- The CFE awarded Abengoa the Agua Prieta Phase III EPC contract to construct a 12 MW solar field in the state of Sonora (Mexico), which will be integrated with a combined cycle gas turbine (CCGT) to become Mexico's first hybrid solar-gas plant.
- Ongoing construction of the 300 MW cogeneration plant in Tabasco (Mexico) for the state-owned company Petróleos Mexicanos (PEMEX). The project encompasses both the construction and a 20-year operating concession for the plant. The new facility will be able to generate up to 800 t of steam to supply electricity to the New PEMEX Gas Processing Complex in Tabasco, while exporting surplus power into the Mexican national power grid.
- Abengoa secured the Agua Prieta II power line contract from the CFE, comprising three substations (including a total of nine feeders) and two power lines spanning 82.6 km and with voltages of 400 and 230 kV in the Mexican state of Sonora.
- Abengoa was awarded the substation 1116 "Transformación del Noreste" contract (phase 3), involving the construction of six 400 and 138 kV transmission lines for a total length of 85.6 km, and six substations with voltages of 400 and 138 kV, with a combined transformation capacity of 500 MVA and 14 feeders, all located in the Mexican state of Tamaulipas.

Substation constructed by  
Abengoa México



# 06.1

## Engineering and construction

- In the final quarter of the year, the company managed to secure the SE 1321 Distribución Noreste (phase 3) project, which includes the construction of a distribution substation with voltages of 115 kV and 13.8 kV, to be located in the Mexican state of Chihuahua.
- Continued work on the first phase of the substation and transmission line contract for the Baja California and North West areas, and also on the substation 1110 "Compensación capacitiva del Norte" project involving the construction and installation of three substations of 230, 115 and 69 kV.

### Central America

- Siepac project (Central American Electrical Interconnection System), involving the construction of 950 km of 230 kV power lines across Nicaragua, Costa Rica and Panama and has now completed all of the Nicaragua section.

### Peru

Detailed below are the main projects carried out in 2011 by Abengoa in Peru, Abengoa's engineering and construction company operating within the South American country:

- Start of work on the 220 kV Paragsha-Francoise power line and upgrade work on the Paragsha II substation and new Francoise substation, combined with a 30-year operation and maintenance agreement. The project embraces the engineering, study, procurement and construction of the roughly 55 km of high-voltage line, which will be strung at between 4,200 and 4,500 m above sea level within a timeframe of 540 days.
- Start of construction on the Chinalco project, which will involve the one-stop engineering, procurement and construction (civil and electromechanical work) of the 220 kV Pomacocha-Toromocho transmission line, the 23 kV Toromocho-Kingsmill distribution line and upgrades to the Pomacocha substation.
- Start of construction on the Cheves project, comprising the one-stop engineering, procurement and construction (civil and electromechanical work) of the 220 kV Cheves – Huacho transmission line (75 km) and upgrades to the Huacho substation.
- Construction continuing on the 500 kV Chilca – Marcona – Ocoña – Montalvo transmission line and three new substations in Peru, and upgrade work on a further three, including the installation of two series compensation capacitors at the Ocoña substation. The 872 km project encompasses the design, supply, construction and financing of the entire electricity system, and operation and maintenance for a 30-year term.
- Completion of work on the 200 kV high – voltage Carhuamayo – Carhuaquero power line and associated substations in Peru. The project includes 670 km of line, two new substations and upgrades to five existing substations.
- Completion of work on the Tía María project, encompassing the study, engineering, procurement and construction of the 220 kV Montalvo-Tía María power transmission line and upgrades to the 220 kV Montalvo substation. The project covers roughly 101 km along the coastline of two southern regions, namely Arequipa and Moquegua, and includes one of the longest spans to be found on the country's transmission line network at 1,700 m.

220 kV transmission line between Montalvo and Tía María, Peru



500 kV transmission tower, ATE III Itacaiúnas (Pará)-Colinas (Tocantins)



### Brazil

Listed below are the main projects performed over 2011 by Abengoa in Brazil:

- Completion of work on the ATE IV Canoinhas (Santa Catarina)-Sao Mateus (Pará) line.
- Completion of the ATE VI Doña Francisca (Rio Grande do Sul)-Santa Maria (Rio Grande do Sul) power line.
- Completion of the project to increase transformation capacity at the ATE VII Foz do Uguacú (Pará) substation.

# 06.1

## Engineering and construction

- Work continuing on the project to increase transformation capacity at the ATE III Itacaiúnas (Pará) substation.
- Completion of the turnkey EPC contract signed with Eletronorte to construct the Ribeiro Gonçalves (Piauí)-Balsas (Maranhão) transmission line, including the new Balsas substation and upgrades to the Ribeiro Gonçalves substation.
- Continuation of work on the turnkey EPC contract signed with Porto Velho Transmisora de Energía (subsidiary of Eletrosul) for Lot A of the Madeira project, involving the construction of a back-to-back station in Porto Velho (Rondônia).
- Work progressing on the turnkey EPC contract signed with Estação Transmisora de Energía (subsidiary of Eletronorte) for Lot C of the Madeira project, involving the construction of a rectifier station in Porto Velho (Rondônia) and the corresponding inverter station in Araraquara (Sao Paulo) at the two ends of one of the 600 kV direct current transmission lines forming part of the infrastructure in place to draw hydro power from the Madeira River.
- Work continuing on the turnkey EPC contract signed with Manaus Transmisora de Energía (consortium comprising Abengoa, Eletronorte and Chesf) for Lot C of the Manaus project, involving construction of the 500 kV Oriximiná (Pará)-Silva (Amazonas)-Lechuga (Amazonas) transmission line, and including the new Silves and Lechuga substations.
- Start of work on the turnkey EPC contract signed with Norte Brasil Transmisora de Energía (consortium comprising Abengoa, Eletronorte and Eletrosul) for Lot G of the Madeira project, involving construction of the 600 kV Porto Velho (Rondônia)-Araraquara (Sao Paulo) direct current line.
- Start of work on the turnkey EPC contract signed with Línea Verde Transmisora de Energía (consortium comprising Abengoa and Eletronorte) for the Pre-Madeira project, involving construction of the 230 kV Jauru (Mato Grosso)-Porto Velho (Rondônia) direct current line and including adaptation work on seven existing substations.
- Start-up of engineering and procurement for the 230 kV Itacaiúnas (Pará)-Carajás (Pará) power line. The corresponding contract was awarded at the last Aneel auction for transmission systems held in 2010, leading to the incorporation of the concessionaire company ATE VIII.
- EPC construction of wind farms to generate electricity for Abengoa concessionaire companies. Abengoa holds equity stakes in three future wind farms to be located in the state of Ceará as part of the Eólico Trairí II complex, which will boast a total installed capacity of 96.6 MW.

## Chile

Abengoa successfully completed the following projects in 2011 in Chile:

- Chacaya Maitenes transmission line for the customer Pacific Hydro. This project involved the construction of an interconnection substation and upgrades to the Maitenes and Sauzal substations and the 2x220 kV power transmission line between the Chacayes and interconnection substations. The work required the company to configure the switching substation as a SF6 gas insulated substation (GIS), modify and extend the Maitenes and Sauzal substations and construct a 2x220 kV line between the Chacayes and switching substations.
- New 220 kV Agua Santa line bay at the San Luis substation. The project included the installation of a 110 kV position with its respective switch, along with output switch, two bar switches, three current transformers, three potential transformers and three lightning conductors.
- Work underway on the Cardones substation-Punta Totoralillo substation power line project. The contract envisages construction of the first circuit of a 220 kV double circuit power transmission line spanning roughly 140 km. The ultimate aim of the project is to supply electricity to the Cerro Negro Norte mine and Totoralillo desalination plant from the Cardones substation.



Work in progress on the Chacaya-Maitenes transmission line



# 06.1

## Engineering and construction

- El Tesoro CSP plant: this particular project embraces the construction, procurement, supply, commissioning, start-up, operation, and training of Minera El Tesoro workers in relation to the one-stop operation and maintenance of a solar energy plant capable of supplying at least 60% of the annual thermal power needs of the SX-EW (solvent extraction and electrowinning) process of the Minera El Tesoro mining company for a minimum period of 10 years, extendable to 20.

### Uruguay

Highlight projects for this region include the following:

- Work underway on Abengoa's new wind power business line in Uruguay, with Abengoa securing a contract to design, construct, operate and maintain a 50 MW wind farm in Cuchilla de Peralta-Tacuarembó for the Uruguayan National Authority for Power Generation and Transmission (UTE).
- Abengoa is performing the 500 kV substations project for the Uruguayan state-owned UTE. The project encompasses the supply and turnkey installation of two 500 kV stations, which will effectively connect the Punta del Tigre power line with the existing Uruguayan 500 kV power transmission grid.
- In relation to the frequency converter station project for UTE, Abengoa has been sub-contracted by Areva to carry out all the civil engineering and electromechanical assembly work on a frequency converter station capable of transmitting up to 500 MW between Uruguay and Brazil.
- Contract awarded for a 18.5 Mgal bioethanol plant for the state-owned company Alcoholes de Uruguay (ALUR). The facility will process sorghum, corn, barley and wheat and will be located in Paysandú (Uruguay), producing 50,000 t of the DDGS (Distillers Dried Grains with Solubles) byproduct to be used in the production of animal feeds. The project also envisages the construction of an 8 MW cogeneration facility annexed to the parent plant, which will supply the latter with electricity and steam, using biomass as its raw material.

### Argentina

The main contracts in progress or completed in 2011 by Abengoa in Argentina, are as follows:

- Completion of the 500 kV Comahue – Cuyo interconnection. This project interconnects since September the Agua del Cajón substation in the province of Neuquén with the Gran Mendoza transformer substation located roughly 707 km away in the province of Mendoza, requiring a 500/220 kV substation called Rio Diamante midway between the points. It is also worth noting that this project also envisaged an associated emissions control process to track CO<sub>2</sub> emissions for each line and transformer station, with the resulting report detailing both emissions generated by third-party supplies and those stemming from the company's own work on the project.

Agua del Cajón  
substation, Argentina



# 06.1

## Engineering and construction

- 132 kV single-circuit high-voltage line between Estanislao del Campo and the Las Lomitas transformer station (Formosa province). The project is currently in progress and is expected to be completed and brought on line over the second half of 2012.

### Africa

- Completion, unveiling and start-up of the 150 MW Hassi R'Mel hybrid solar/gas plant where Abengoa was tasked with the engineering, design and start-up of the hybrid plant, which combines a natural gas combined cycle (NGCC) and a solar field featuring 224 parabolic troughs, with enough capacity to generate up to 25 MW of energy.

Hassi R'Mel ISCC plant in Algeria



HV lines for the Moroccan motorway administrator



- In the energy sector Abengoa continues working on high-voltage transmission lines for Autoroutes du Maroc (ADM).
- Award of the KaXu Solar One plant, a 100 MW parabolic-trough solar plant with a storage capacity of 3 hours and to rest on 1,100 ha of land. The facility will be sited near the city of Pofadder, to the north of the Northern Cape province in South Africa.
- Abengoa also secured a contract to construct the 50 MW Khi Solar One power tower solar plant in South Africa, one of the largest of its kind in the world. The facility, with two hours of thermal storage, will sit on 600 ha of land close to Upington, also in the province of Northern Cape.

### Middle East

- Abengoa continues to work on Shams 1, the largest CSP plant in the Middle East located in the desert on the outskirts of Abu Dhabi. The facility has an installed capacity of 100 MW and employs parabolic-trough technology. It features more than 700 troughs, comprising 12 mirror modules covering a total area of 300 ha. Thanks to the nearly 600,000 m<sup>2</sup> of parabolic troughs, the plant generates enough electricity to power 62,000 homes, while curbing yearly CO<sub>2</sub> emissions by 175,000 t.
- Also in the United Arab Emirates, Abengoa remains involved in the project to install the 132 kV Fujairah-Tawyeen and Fujairah-Dibba power lines for Transco, with work expected to culminate in 2012.
- Continued construction work on the 132 kV high-voltage power line in Qurayyat for the SEC (Saudi Electricity Company). The company is also constructing the Jeddah and Riyadh GIS (Gas Insulated Substations), both 380 MW and 132/13.8 kV, again for the SEC.



100 MW CSP plant in Abu Dhabi.

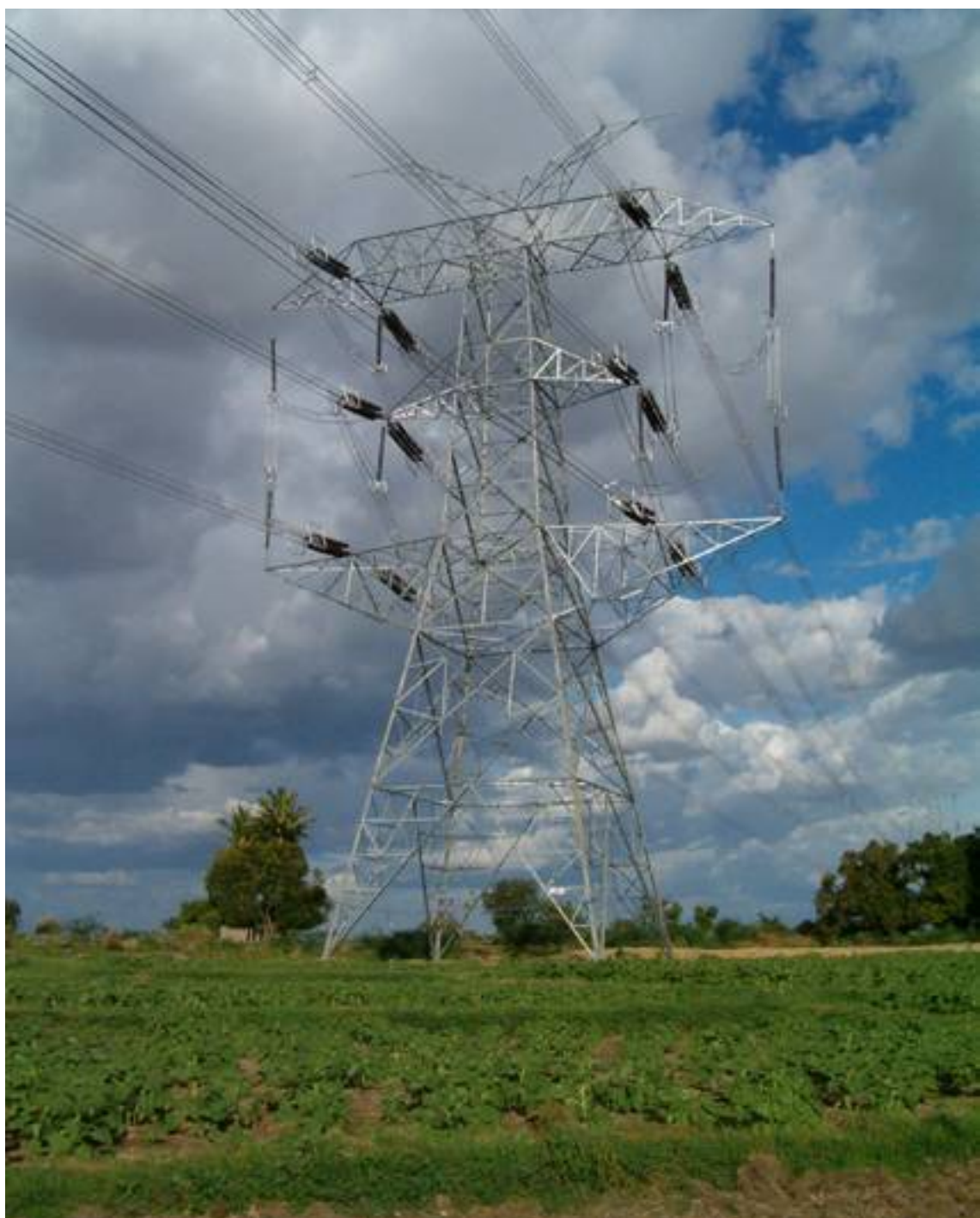
# 06.1

## Engineering and construction

### India

- Abengoa has completed work on the 3 MW solar field for the Indian Institute of Technology Bombay (IITB). The start-up of this facility will enable the IITB to act as a base and platform for future technological research and development.
- Over 2011, Abengoa continued work on the two 400 km stretches of the 765 kV Biswanath Chariyali-Agra direct current line. Moreover, and with a view to expanding operations in the power transmission line sector, the company has been striving to gain direct entry into other state-owned electrical utilities, thus allowing it to eliminate its dependence on other tower manufacturers by creating its own production plant.
- Ongoing construction of a 20 kW photovoltaic plant.

Transmission tower for the line between Biswanath Chariyali and Agra.





# 06.1

## Engineering and construction

### Environment

Environmental business encompasses the design, engineering and construction of water treatment and desalination plants, hydro projects and waste treatment facilities.

#### Spain

The main projects undertaken over the year within Spain were as follows:

- Completed construction of the Bajo Almanzora desalination plant in Almeria. The facility will be capable of producing up to 60,000 m<sup>3</sup> of water per day. It employs reverse osmosis technology, with capacity to supply up to 20 h<sup>3</sup> per year, 15 of which will be used for irrigating the local area, with the rest intended for human consumption.
- Construction underway on the waste treatment plant in the Port of Bilbao (Spain). The facility will be able to treat 120,000 t of sulfur while producing 350,000 t of sulfuric acid and oleum, effectively meaning it will be able to generate roughly 90,000 MW per year of electricity.
- Ongoing work to improve the water supply to the city of Caceres from the Portaje dam, the aim of the project being to meet the water supply needs of 150,000 inhabitants. The project envisages three pumping stations and over 65 km of water pipes with diameters ranging from 1,000 to 1,200 mm. Once completed, the piping will be able to transport a maximum of 1,500 L/s.

#### Turkey

The following key project was a particular highlight in Turkey:

- The Turkish Ministry for the Environment and Urban Planning entrusted Abengoa with the development of the water supply system for the city of Dogubayazit in eastern Turkey, very close to the border with Iran, with total project investment topping €22.5 M. The project includes the construction of a drinking water plant featuring a physicochemical process, which will boast a treatment capacity approaching 35,000 m<sup>3</sup> per day, enough to supply water to 175,000 people, along with two reservoirs with a combined volume of 7,000 m<sup>3</sup> and 400 km of piping. The contract will help to develop the area, which will now enjoy a guaranteed supply of drinking water all year round.

#### Mexico

The company has been awarded the following key project in Mexico:

- Abengoa has secured the contract to construct the El Zapotillo aqueduct, which will provide an efficient, sustainable and safe means of supplying drinking water to just shy of one and a half million inhabitants. The engineering work includes the construction of 139 km of large diameter piping; pumping stations with a total installed capacity of 24,000 kW; a drinking water treatment plant of 3,800 L/s; a 100,000 m<sup>3</sup> capacity storage tank; and a 40 km distribution circuit within the municipality of León.



Drinking water and sewerage systems commissioned by Sedapal for the areas of Pariachi, La Gloria, San Juan, Horacio Zevallos and annexed territories.

#### Peru

Detailed below are the main projects to have been performed in Peru:

- Award and start-up of engineering work to extend and improve the drinking water and sewerage system for the Pachacútec macro-project. The project encompasses the design, supply, land preparation and construction of the entire water and sewerage system, including a 430 L/s wastewater treatment plant. It is the largest water and sewerage project currently underway in Peru and will benefit an estimated 200,000 people.

# 06.1

## Engineering and construction

- Start of construction to expand and improve the drinking water and sewerage system of the Pariachi area for Sedapal. The project embraces the design, supply, land preparation and construction of the entire water and sewerage system, including drilling, boreholes and the installation of pressurized pipelines. The initiative also envisages the construction and outfitting of a 420 L/s activated sludge treatment plant in the area of Santa Clara, the water from which will be reused to irrigate short-stemmed plants.
- Completion of construction work to improve the drinking water and sewerage systems for Piura-Castilla Contract 3 A. The project involved the construction of a sewage treatment plant with an average flow rate of 200 L/s, a perimeter enclosure for the El Indio lagoon and a wastewater analysis laboratory. It also required the company to restore primary and secondary drinking water and sewerage networks, including household connection points for the area, and to install 23,500 household meters with meter boxes and accessories.
- Abengoa, through a consortium with Graña y Montero, are continuing work on the La Tomilla II water treatment plant in the city of Arequipa for Sociedad Minera Cerro (Contract Lots 1 and 2). The project includes a water intake for the Chili river, an 11 km pipe, 2 tunnels spanning 1,270 and 190 m, a 167 m vertical shaft, and a water treatment plant capable of treating 1,575 L/s.



Construction of a liquid industrial waste treatment facility at the Quilicura plant in Chile

### Chile

Highlight projects in the country include:

- Execution of the Gran Alimentadora Valparaíso pipe laying project, which required the company to relay 700 mm piping along the section between km 2,850 and km 5,528.
- Construction also got underway in 2011 on the liquid industrial waste treatment facility at Quilicura plant, requiring civil engineering work and assembly of the industrial water treatment facility. The project also envisages the Santa Cruz reservoir, which will involve the construction of a 1,100 m<sup>3</sup> reservoir capable of supplying water to 35,000 local residents.

### Uruguay

Highlight projects performed by Abengoa in Uruguay include:

- Completion of pumping line six for the State Department of Sanitary Works, including the design, supply and laying of 47 km of ductile cast piping with diameters of between 800 and 1,200 mm and 40 km of piping with diameters of between 350 and 800 mm.
- Abengoa continues to provide Montevideo City Hall with urban waste collection and cleaning services, which are carried out through the Cap consortium (Consortio Ambiental del Plata).

### Argentina

Key projects performed in 2011 by Abengoa in Argentina include:

- Extension of the sewage system in San Vicente (Buenos Aires) to cover over 20 km of sewage network and 1,000 household connection points, and extension of the drinking water network in the localities of Pehuajó and 9 de Julio (both in Buenos Aires), requiring over 19 km of drinking water infrastructure, 1 pumping station, 20 collecting wells and 21 connections to existing infrastructure.

# 06.1

## Engineering and construction

### China

Detailed below is a hugely important project currently in progress in China:

- Ongoing work on the Qingdao seawater desalination plant, at which Abengoa have successfully completed the outfitting and assembly work. The facility will be capable of desalinating 100,000 m<sup>3</sup> of water per day and will supply drinking water to 500,000 people. The plant utilizes reverse osmosis technology and includes innovative design features, both during pretreatment (ultrafiltration membranes) and in terms of its centralized pumping system, rendering the facility more energy-efficient.

### Outfitting

This particular line of business encompasses industrial and infrastructure engineering, construction and maintenance relating to:

- Industrial plants.
- Electrical and mechanical installations.
- Custom construction work.

Detailed below are the most significant contracts secured and/or performed in this particular field:

### Spain

Highlight projects for 2011 in Spain include:

- Maintenance of the HV installations at the new Heineken brewery and also with the restoration of Hotel Alfonso XIII (both in Seville). It has also been commissioned by Adif (Spanish national railway administrator) to carry out work on various stations due to the remodeling of the Camas-Salteras stretch of the Seville-Huelva commuter railway line.
- Remodeling of the El Algar pumping station in Alicante, and is now starting to reroute the overhead lines affected by the new high-speed AVE railway network. It is also working on the Font de la Figuera stretch of the A33 highway for Acciona.
- Abengoa has been awarded the contract for HV lines in north Catalonia, which envisages repair, construction and replacement work and voltage changes, among others. In the field of transport communications, the department is helping to maintain line 9 of Barcelona Subway through a consortium with five other leading companies from the sector.
- Ongoing work on the framework substation agreement for Iberdrola. Similarly, the department has successfully completed the links for the 13.2 kV high/medium voltage line from Billabona-Aia and from Lesaka-Bera under the framework distribution agreement for the province of Gipuzkoa.
- Key contracts awarded include electrical installations at five stations on Line 6 of the Madrid Subway, fire protection work, energy control for the Mutua Madrileña building at 50 Paseo de la Castellana, Madrid, and electrical installation work for the Helios 1 and 2 concentrating solar power plants in Ciudad Real.
- Development and construction of new vehicles projects for the PSA Peugeot Citroen factory in Vigo, installation work at plants operating in the power, wood, and metal processing and integrator sectors and construction of custom buildings, industrial estates, road lighting and video surveillance systems.



Osmosis racks at the Qingdao desalination plant in China



Ducting of high-voltage cables in Puigreig street, Barcelona

Work to widen the La Cabada – Cantabria road



# 06.1

## Engineering and construction

Mutua Madrileña building on Paseo de la Castellana, Madrid



Moving of VOR regulator rooms at Ibiza Airport



- Civil engineering work on the project to move VOR regulator rooms at Ibiza Airport.

### Mexico

The most significant projects undertaken by Abengoa in México are detailed below:

- Project to construct four three-phase separators at the Bellota-Jujo Integrated Asset on PEMEX facilities occupied by the prospecting and production division in the municipalities of Cárdenas and Cunduacan (state of Tabasco).
- Construction, integration, appraisal, testing, training and start-up of a 34.5 kV synchronization bus at Thermal Power Plant 1 of the Francisco I Madero refinery in Tamaulipas.



# 06.1

## Engineering and construction

- Contract for the part supply, installation and start-up of a 143 kW electrical power generation facility property of ABB at its San Luis Potosí plant.
- Construction of the Centro Cultural Mexiquense Bicentenario (cultural center). The complex occupies 17 ha and boasts 35,000 m<sup>2</sup> of museums, libraries, workshop modules with over 60 classrooms intended for a range of different art-related subjects, an administrative building, halls, open-air theater, concert hall with seating for 1,200 people, cafeteria, restaurant and parking for over 1,000 vehicles. The impressive facility will welcome more than six million local inhabitants. Coaben is now to operate the center under a concession for the coming 20 years.

### Brazil

Focusing on outfitting, the following projects are worthy of particular note in Brazil:

- Turnkey construction of an office building located in Barra de Tijuca, with a floor area of 8,070 m<sup>2</sup> structured in four levels. All phases of the building (design, construction, operation and maintenance) were originally conceived with sustainability firmly in mind with the aim of securing the LEED (Leadership in Energy and Environmental Design) "Green Building" certificate.
- Currently constructing the valve rooms and service areas of the Araraquara II substation, including foundations (7,500 m<sup>3</sup>), assembly of metal structures (670 t), assembly of precast structures (1,400 m<sup>3</sup>) and the masonry and finishes for the buildings.

### Chile

In outfitting, Abengoa started work on the following project in Chile:

- Design and construction of the infrastructure for the new TK04 electric mining loop to power the drilling and excavation machines that are to extract ore from the future pit of the Minera Quadra Chile mining company facing the settlement of Sierra Gorda. The project also includes the design, construction, assembly and start-up of infrastructure for the 220 kV system of the Sierra Gorda substation.

Operators constructing a power transmission line



# 06.1

## Engineering and construction

### Uruguay

Listed below are the main projects to have been undertaken in this particular field:

- Construction of a diesel oil desulfurization plant, gasoline desulfurization plant and sulfur recovery plant for the National Department of Fuel, Alcohol and Portland Cement (Ancap). Abengoa has been tasked with the corresponding civil engineering and electromechanical assembly work within the La Teja refinery in Montevideo.



Desulfurization plant at  
La Teja Refinery

- Start of construction on the Montes del Plata cellulose pulp plant, including civil engineering and mechanical and electrical assembly of both the processing and water treatment facilities.
- Abengoa is currently expanding the Sanatorio Americano hospital. The work has required the company to erect a new building of nearly 8,000 m<sup>2</sup> to house an ER area, surgical blocks and admission halls.
- On a final note, we would highlight the construction of two new bridges over the Yaguarí and Santa Lucía rivers, spanning 148 m and 650 m, respectively, as part of the national road network.

### North Africa

Abengoa has been the key player in this region:

- In the industrial sector, Abengoa has continued to cement its position in the Moroccan market by assisting with the industrial assembly of the new Renault factory in Tangier, and carrying out installation work on the new steelworks of Maghreb Steel.

# 06.1

## Engineering and construction

### Middle East

We would highlight the following projects in this region:

- Abengoa has signed a number of contracts relating to the Shams 1 CSP plant, with the commissioned work including electrical installation, laying of 220 kV and 11 kV cable and telecommunications.

### Transportation

This line of business embraces the design, supply, assembly and maintenance of conventional and high-speed railway installations.

#### Spain

In the field of transportation, the following projects are worthy of particular note at home:

- The Spanish administrator of railway infrastructure (Adif) has continued to place its trust in Abengoa's railway department by commissioning it with various new projects, including rail voltage work, extending the reach of the Camas-Salteras stretch of the Seville to Benacazon commuter railway, eliminating critical points and serious defects on the Seville commuter railway network and renovating Castejon station. Similarly, Abengoa has continued to play a prominent role in maintaining most of the high-speed lines through contracts for the Madrid-East Coast, Madrid-Barcelona and Madrid-Valladolid links.
- In addition, thanks to the unrivalled performance and quality of Abengoa's cutting-edge machinery, particularly its line stringing train, the company was called into action to string the catenary system on the new high-speed Vigo-A Coruña line.



Catenary line installed by Abengoa



Automatic gate at the high-speed train station on the Beijing – Shanghai line

#### International market

- Towards the end of the year, Abengoa accomplished one of its most impressive milestones for the year by entering the consortium of Spanish companies entrusted with the Mecca-Medina high-speed railway line, which will connect the cities of Medina, Jeddah and Mecca in Saudi Arabia. The contract includes the construction and assembly of the railroad line, spanning roughly 450 km of electrified double track designed for trains to travel at speeds of up to 350 km/h, along with installation of the signaling and telecommunications systems, rail electrification, the operations and control center, and full maintenance for twelve years.
- A further milestone was its penetration of the French rail electrification market, having secured from Société Nationale des Chemins de Fer Français (SNCF) a contract to upgrade the catenary systems at Lourches and Cambrai stations and to remodel the catenary system for the railway stations in Lille.
- First rail electrification contract for Central Organisation for Railway Electrification (CORE).
- Lastly, manufacturing of 1,200 automatic gate machines (AGMs) for the high-speed Beijing-Shanghai train stations and X-ray scanners to be installed at a number of different Chinese airports and stations.



# 06.1

## Engineering and construction

### Services

This business line brings together EPC projects for telecommunications and the production and supply of auxiliary and insulation equipment and materials.

#### Spain

At home, highlight projects for 2011 included:

- Abengoa has continued work on the 2007-2012 Global Customer Loop Contract with Telefónica de España S.A.U., with implantation ongoing in the provinces of Alicante, Badajoz, Barcelona, Cadiz, Jaen, Madrid, Seville, Tenerife and Valencia. Over the year, the company carried out the associated installation work for 292,000 new customer subscriptions and repaired over 410,000 faults for Telefónica.

The contract envisages the ongoing implementation of FTTH (Fiber To The Home) networks. Infrastructure installation for 2011 extended to 138,500 properties in Madrid and Barcelona, which are fed by 212 km of fiber optic cable (between 64 and 256 fibers) on the trunk network and nearly 242 km of 32-fiber or less cables on the access network towards the end user. Over 11,000 customers have signed up for voice, data and, in certain cases, video services provided directly through fiber optic cables.

- Deployment of state-of-the-art mobile telephony technologies for both technology firms (Huawei-NSN) and operators (Vodafone-Orange); third year of maintenance on Orange's fixed and mobile telephony network; final stage of GSM-R deployment for the Barcelona commuter railway network; and communications on the Opera – Principe Pio branch of the Madrid Subway system.
- Supplied the Spanish electricity grid operator (REE) with auxiliary services cabinets and protection relay frames, among other items. It has also been involved in the new Nuevo Pemex electrical cogeneration plant in Mexico, developing the main MV and LV switchboards. In the solar market, the necessary equipment has been supplied for the Solacor, Solaben and Helios solar power plants, while in the aerospace market, we would highlight the manufacture of earth-based satellite test benches for Crisa EADS – Astrium.
- Upgrades to the Repsol refinery in Cartagena (Murcia) through the supply of power cables and instrumentation, lighting, trays, conduits, junction boxes, compression glands, control stations, power outlets, panels, capacitor batteries and direct current supply boxes. In relation to the Fuel Oil Reduction Unit project for Petronor, Repsol's refinery in Bilbao, Abengoa was awarded a one-stop agreement to supply all the associated electrical materials and instrumentation assembly work.



Operator carrying out maintenance work

Repsol refinery in Bilbao





# 06.1

## Engineering and construction

- Contract by Navantia S.A. to supply the Vortex panels for the new S-80 submarine, which will be fitted on the first four S-80 type submarines Navantia is currently building for the Spanish Navy. Abengoa has also conducted a pilot test at a Madrid Subway station involving the installation of 75 LED tubes. So far, the results of the tests have been positive.
- Supply of the power transformers for the Helioenergy, Solacor, Solaben and Helios CSP plants, as well as many other plant components, such as uninterruptible power supply systems, sampling systems, cables and equipment. The company will also be responsible for overseeing the assembly work.
- Completed construction of the pedestrian and cycle path access route to the Campus Palmas Altas in Seville, Abengoa's headquarters, which were designed by the architect Richard Rogers and the Spanish firm Vidal y Asociados Arquitectos. The walkover connects Campus Palmas Altas to the district of Los Bermejales, without affecting the existing SE-30 ring road.

Solar field at the 50 MW Helioenergy Ecija CSP plant



### Europe

- Upgrade the Galp refinery in Sines, Portugal. The project will entail heat insulation work covering roughly 120 km of piping, and fireproofing of 15,000 m<sup>2</sup> of metallic structure and 10,000 m of cable trays.
- In relation to the project to restructure the Sines refinery (Portugal) of Galp Energia, Abengoa was awarded a contract to supply the power cables and instrumentation, grounding, lighting, compression glands, junction boxes, switching stations, power outlets, signaling and beacons, local panels and pressurizing material.

### United States

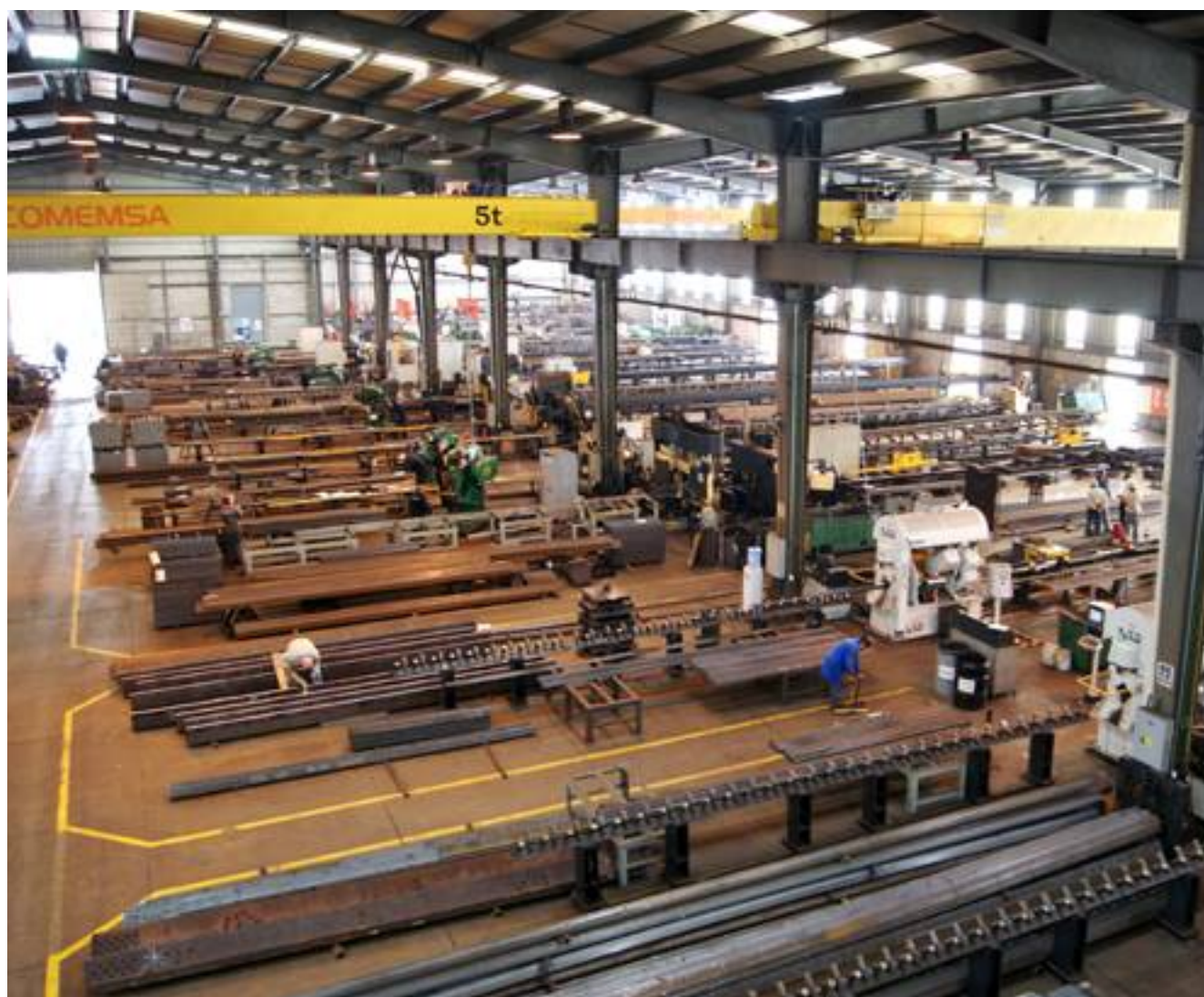
- Supply and start-up the main power transformers (200 MVA) and auxiliary transformers (58 MVA) for the Solana solar power plant in Arizona. Nicsa was also chosen under the same project as the one-stop supplier of cable and fiber optic, medium-voltage speed variators, busbar ducts and transformers.

# 06.1

## Engineering and construction

Construction factory for power transmission lines

- Supply of structures for the Solana plant in Arizona, which is scheduled for completion in 2012. The company has also completed a number of smaller projects in Mexico and structures are now being delivered under the 2010 contracts signed in North America with Southern California Edison (California) and Public Service Electric and Gas (New Jersey). Comemsa has also supplied the structures for the Shams 1 CSP plant in Abu Dhabi.
- The company was also awarded a contract by Sharyland Projects in Texas to supply the structures for five power transmission lines as part of the Competitive Renewable Energy Zones project. The contract includes design engineering and testing on five different types of structure.



### Mexico

- As an integral part of the project to upgrade the Manzanillo thermal power plant for the Mexican Federal Electricity Commission (CFE), Abengoa has been awarded a contract for the medium-voltage cables and instrumentation, cable trays, electrical assembly material, intercommunication system, public address system and telephony.
- For the Tabasco Cogeneration Project for Pemex, Abengoa has been commissioned to supply medium-voltage (MV) and low-voltage (LV) instrumentation cables, direct current systems, lightning conductors and electrical assembly material.



# 06.1

## Engineering and construction

Transportation of power transformers for the Pemex Cogeneration Plant.



Workshop for galvanized structures

- Abengoa's structures plant has been increased through an investment of over \$20 M so as to be able to supply the vast amount of structure required for the Solana CSP plant in Arizona, estimated at over 50,000 t, and also for the similarly sized plant to be constructed in Mojave, California. Thanks to these upgrades, Abengoa now has the necessary production capacity to tackle the large-scale transmission line projects currently materializing in the United States, along with the solar facilities that Abengoa intends to construct in the country.



# 06.1

## Engineering and construction

Midal coils for the Madeira project (Brazil)



GSM mobile telephony localization for Meditel

### Peru

- Supply and deliver current measurement transformers and lightning conductors for the Chilca – Montalvo – Caravelli project. It was also awarded a joint contract with Edelnor (Endesa's subsidiary in Peru) for the supply and local transportation in Peru of LV and MV power cables.

### Brazil

We would highlight the following key projects in Brazil:

- Supply and delivery to on-site warehouses in the Amazon region of 10,000 t of bare conductor costing approximately \$33 M as part of Abengoa's Madeira project.

### North Africa

- Continuing to construct GSM mobile telephony localizations and lay fiber optic cable for the country's second and third largest telephony operators (Meditel and Wana), thus further cementing its position as a benchmark company in the development of telecommunications infrastructures in Morocco.



## 06.2

Annual Report 2011

Concession-type infrastructures

Abengoa boasts an impressive and young portfolio of proprietary assets under concession, all generating income through long-term take or pay contracts and power purchase agreements.

# 06.2

## Concession-type infrastructures

Key financial figures	2009	2010	2011	Var. 11-10 (%)
Sales (€ M)	219	308	427	38.6
Ebitda (M€)	143	208	299	43.8
Ebitda margin (%)	65.3	67.5	70.0	3.7

Key figures Power transmission	2009	2010	2011	Var. 11-10 (%)
Km constructed (km)	4,041	3,717	3,903	5.0
Average availability ratio (%)	99.67	99.10	99.50	0.4

Key figures Solar	2009	2010	2011	Var. 11-10 (%)
Plants in operation (MW)	43	193	443	130
Plants under construction (MW)	450	930	1,060	14
Plants in pre-construction / advanced development (MW)	0	380	150	-61
Production (MWh)	66,132.9	179,972.3	390,860.8	117

Key figures Desalination	2009	2010	2011	Var. 11-10 (%)
Installed capacity (ML)	215,000	315,000	375,000	19
Annual production (ML)	35,881	60,745	82,405	36

Key figures Cogeneration	2009	2010	2011	Var. 11-10 (%)
Installed electricity capacity (MWe)	70.56	70.56	70.56	0
Installed thermal capacity (MWt)	142.91	142.91	142.91	0
Annual electricity generation (MWh)	373,882.6	392,455.4	396,664.3	1.1
Annual thermal power generation (MWh)	262,451.3	279,451.6	285,922.9	2.3

## Our business

### Transmission lines

When compared with electrical systems as a whole (generation, transmission and distribution), power transmission infrastructures account for only a small percentage of total costs, both in terms of the initial investment and subsequent operating and maintenance expenses. To provide an example, it is estimated that these infrastructures account for barely 14 % of total investment. They nevertheless remain a core element of the electricity system as a whole and promise much for the future.

There are essentially two prevailing trends worldwide:

- Countries in which private companies are not only tasked with the engineering, procurement and construction (EPC) of power transmission lines, but actually retain possession of the finished assets. This model is most commonly seen in emerging economies.
- Countries in which private companies carry out solely the EPC on the lines, with the state retaining ownership of the assets. Despite being more typical of developed economies, this approach is in fact becoming more widespread and certain investment opportunities are beginning to materialize.

As a result, we are witnessing an increasing number of opportunities in power line concessions, and companies with a dominant international presence and proven track record in managing transmission assets, such as Abengoa, are now ideally positioned to tap the huge growth potential of this market.

Abengoa manages power transmission assets in Latin America in an efficient, effective and environmentally-friendly way and aspires to become an international leader in power transmission concessions that contribute towards sustainable development. At present, Abengoa has both public and private transmission line concessions in Peru, Chile and Brazil. Assets under management currently amount to 9,000 km, at various stages of maturity.

**Tía María concession, Peru**  
220 kV transmission line and upgrades to the Montalvo substation as part of the Tía María project





# 06.2

## Concession-type infrastructures

Abengoa's standing as the largest international contractor in transmission and distribution systems affords it a crucial advantage in harnessing the wealth of opportunities to be had in power transmission concessions. As the company is vertically integrated and boasts an undisputed track record in power line engineering and construction, it is fully capable of tapping the huge opportunities that are currently emerging across the globe. Abengoa therefore expects to see sharp growth in this line of business for the following reasons:

- The model whereby private companies retain ownership of power transmission assets is not only prevalent in emerging economies, but is also offering specific opportunities in more developed regions.
- The growing demand for electrical power is generating more demand for infrastructure.
- The increasing presence of renewable generation in the global energy mix requires more solid and flexible transmission systems.
- The ever-widening gap between generation at one end of the spectrum and consumption at the other is demanding increasingly larger power transmission systems.

Abengoa attempts to integrate, throughout all business lines, the company's strategy in relation to stakeholder expectations, which is geared towards seeking out new customers and exploring technical solutions based on specific needs. To such end, the company offers a full range of one-stop services using its own resources, meaning that when compared with the competition Abengoa concessions pose less risk and greater credibility.

300 MW Santa Bárbara  
Trupán TL, Chile



# 06.2

## Concession-type infrastructures

Solucar complex,  
Seville (Spain)

The company's strategy in power transmission concessions can be summarized as follows:

- Maintaining its position of leadership in Latin America, a region that continues to offer huge growth potential. In addition, and as certain assets approach their final years of operation, agreements are often reached to rotate them, thus allowing for new investments to be made to ensure further growth.
- United States. Obsolete transmission systems, coupled with the huge distance between power generation on the one hand and end consumption on the other and the increasing weight of renewable energy within the energy mix, have all made the United States one of Abengoa's key targets for the coming years.
- Asia. The huge demand for electrical infrastructure within the region also makes it a top priority for the company



### Solar power

Abengoa offers solar-based electrical power generation technologies, which are more efficient than competing technologies, allowing the company to cut the cost of solar energy on the path to matching fossil fuel prices by 2020, after factoring in CO<sub>2</sub> costs.

The company also constructs solar power plants with proprietary technology and then sells the resulting electrical power under concession agreements. Abengoa is therefore helping to meet the international objective of stemming environmental damage in the countries in which it operates.



# 06.2

## Concession-type infrastructures

Abengoa markets and sells electrical power while developing groundbreaking solar technologies within a global market offering huge growth potential. It also utilizes solar energy technologies to help combat climate change and push towards sustainable development.

In 2011, the electricity generation market experienced sharp growth worldwide, with a marked increase in the number of facilities and an improvement in the state of the art. The upshot of this is that solar energy remains a profitable, efficient and technically viable solution in both consolidated and emerging countries. Abengoa has also witnessed a sharp jump in the number of competitors, not only using solar energy sources but also other alternative energy sources.

Faced with this growing competition, Abengoa has been able to strengthen its leadership within the sector by offering the market a solution that fuses the benefits of conventional technologies (easy management, scalability, hybridization) with those of renewable energy sources (preventing tons of CO<sub>2</sub> emissions, use of clean and non-exhaustible energy sources).

Solar concessions at Abengoa are divided into the following lines of activity:

- Development of CSP and photovoltaic plants.
- Sale of power and plant operation.

Abengoa has power generation plants and offices in:

- Europe: Spain and Italy
- America: United States, Brazil, Mexico and Chile
- Africa: Morocco, Algeria and South Africa
- Asia: Abu Dhabi, China, India
- Oceania: Australia

Abengoa's solar business has acquired a wealth of experience along the different stages of the value chain for the CSP business. This vertical integration enables the company to harness synergies between development, operation and technology, such as designing optimal solutions, controlling and procuring key components and enhancing cost competitiveness.

PS10 and PS20,  
Seville (Spain)



# 06.2

## Concession-type infrastructures

Abengoa's experience in internationalization processes has enabled it to adapt to different regions with differing regulatory frameworks. This knowledge has been pivotal to its expansion into new markets with potential in concentrated solar or photovoltaic energy, enabling it to adapt more quickly than its competitors.

In 2012, Abengoa will continue to consolidate its leadership within the solar energy sector in which operates internationally with hugely efficient proprietary technology in both concentrating solar and photovoltaic energy. To achieve this, the company will rely on the following factors:

- Global presence, cementing its position in the United States and Spain while also expanding into new markets.
- Efficient operation and maintenance of CSP and photovoltaic plants, as well as construction oversight and start-up of new projects.
- Constant innovation in those technologies tagged as key. This will be achieved through the company's own teams and via agreements signed with leading R&D institutions.
- Risk control and efficient cash management.

## Desalination

Spiraling climate change and growing urbanization mean that the world is now faced with a huge water supply problem. This challenge has two component parts to it. Firstly, water scarcity is reaching alarming levels and currently affects millions of people, all the more worrying when we bear in mind that the population is constantly growing. This water scarcity is further exacerbated by a shortage of suitable water treatment facilities, leading to health problems and effectively meaning that the water cannot be reused. Secondly, it is worth noting that the industrial sector is a major water consumer and depends heavily on this natural resource for the proper functioning of boilers, cooling towers and production processes, therefore making water of critical importance for ongoing business.

There are three different markets capable of tackling this water challenge:

- The desalination market, whereby salt is extracted from seawater or brackish water to render it fit for human consumption or use within the agricultural sector.
- The reuse market, enabling wastewater to be reused through disinfection processes and removal of suspended solids via filtration technologies.
- The industrial market, which has massive potential to meet the needs of the mining, oil and gas industries, as these require a huge volume of water to ensure the proper functioning of their facilities.

In these markets, Abengoa specializes in the promotion, development and exploitation of water treatment plants and membrane technology, and it means to consolidate its position as an international market leader in desalination plants, managing proprietary assets while expanding its water treatment and reuse business and industrial outsourcing. It invests in and manages its own assets, while promoting and developing new products and operating proprietary and third-party plants.

Abengoa operates its water business on four continents. In addition to its headquarters in Seville and Madrid, the company has offices in Harlingen and Austin (Texas, United States) and in Beijing (China), as well as the offices of concessionaire companies and projects in Algeria (Skikda, Ténès and Honaine), India (Chennai) and China (Qingdao).

The keys to the success and leadership of Abengoa include a budding water market experiencing constant growth, a team of professionals with a truly international outlook, a global desalination market and sufficient resources to finance its own operations.



Production facility at the Skikda desalination plant (Algeria)

# 06.2

## Concession-type infrastructures

The water business brings together an international team of workers who are fully committed to the company and possess in-depth knowledge of their market and of the associated technologies. Abengoa attaches great importance to training and professional performance as it helps to drive employees forward within the company.



Employees of the Qingdao concessionaire company (China)

One of the company's overarching aims has been to fence off and optimize concession projects and meet operational targets and expectations for the Skikda and Chennai plants. The company has cemented its leadership within the desalination market by securing a project in Ghana, thus further extending its geographical reach, and starting to operate the desalination plants in Honaine (Algeria) and Bajo Almanzora (Spain).

## Cogeneration and other concessions

Although the economic crisis is continuing to plague both Spain and international markets, cogeneration business in Spain promises further growth. Specifically, the Spanish Energy Efficiency Action Plan for 2011-2020 (Plan de Acción de Eficiencia Energética) approved in June 2011 envisages the following cogeneration objectives for Spain:

- 71 % growth in production between 2011-2020 so as to ensure that cogeneration accounts for 14 % of domestic demand in 2020.
- Increase in power from 6,704 MW to 10,455 MW.
- Investment of €5,970 M€ over the period.
- Major upgrades to bring existing cogeneration facilities (Renove plan) to 3,925 MW by 2020 (1,723 MW by 2016).

# 06.2

## Concession-type infrastructures

The main barrier to external investment in cogeneration projects is the widespread lack of financing brought on by the crisis, mirroring the situation seen in most other sectors. There are also two other barriers typically associated with cogeneration:

- Customer risk (host industry).
- The disappearance of GHG (greenhouse gas) emission rights from 2013 onward, as cogeneration facilities will only receive allowances on account of the thermal savings they generate.

Focusing on the Latin American market, it is very likely to witness an increase over the coming years in large cogeneration facilities attached to refineries or chemical plants (heavy energy consumers).

The main barriers preventing entry into countries such as Mexico, Brazil and Argentina include the absence of specific legislation to champion cogeneration technologies, a situation that will likely change given that these technologies allow for substantial energy savings, an absolute must in times of crisis.

Large private companies, which boast a range of different industrial assets, are starting to invest heavily in cogeneration systems under concession, whereby other companies are entrusted with the construction work and operation of cogeneration systems under long-term power supply agreements. This situation is of great interest to Abengoa, in that it can harness its extensive experience in managing cogeneration assets, primarily in Spain, to secure an important part of the international market.

At present, Abengoa has 647 MW of installed capacity at Spanish and Mexican cogeneration plants. Abengoa's mission in this area is therefore the optimal management of cogeneration assets in Spain and Latin America.

Abengoa's vision is to become an international benchmark on how to manage cogeneration concessions safely, reliably and efficiently.

Safety, reliability and efficiency are therefore the three key parameters. Safety to prevent harm or damage to people or equipment, reliability to ensure income, and efficiency to guarantee profit margins.

This area can be further broken down into two different lines of business:

- Generation of electrical power.
- Operation of smart buildings.

Abengoa currently operates cogeneration plants in Spain and Mexico, as well as other concessions such as smart buildings, dams and wind farms in Spain, Mexico, Uruguay and Brazil.

Growth is largely a product of ensuring maximum generation availability and prompt delivery of contracted services, such that if customers' needs increase, the company can extend its generation capacity or deliver more products accordingly, thus guaranteeing efficiency and sustainable processes.

Abengoa's asset base has afforded it considerable experience in asset management and provides the platform for business growth. When combined with Abengoa's proven EPC capacities, this clearly makes the company a key player in an excellent position from which to advance. The 300 MW Nuevo Pemex cogeneration plant in Mexico marks the first milestone in a new stage of business growth, which two years previously had been limited to the Spanish market. Abengoa therefore expects to see sharp growth in new markets as it looks to extend its inventory of cogeneration assets.

Abengoa's strategy in relation to cogeneration concessions is to harness the huge market potential currently emerging, relying on its extensive experience in managing these kinds of assets and on the company's vertical integration. The priority market for this line of business is Latin America, a region currently offering huge opportunities, chiefly through large private companies.



# 06.2

Concession-type  
infrastructures

## 2011 in review

### Transmission lines

Transmission assets are a core part of power infrastructure.

These infrastructures are becoming increasingly important given spiraling energy consumption, the widening gap between generation facilities and consumers, and the arrival of renewable power sources within the energy mix.

For many years Abengoa has been profiting from concessions of large power transmission systems, and this particular line of business is becoming increasingly important within the company.

The following projects have entered into operation this year:

Brazil:

- ATE IV line: 230 kV transmission line (TL) on the Canoinhas-São Mateus section brought online on 05/09/2011 and spanning 85 km.
- ATE VI line: Doña Francisca-Santa María TL section brought online on 17/08/2011. The 230 kV line spans 131 km.
- ATE VII line: second autotransformer at the Foz do Iguaçu Norte substation, which entered into service on 13/08/2011.

Peru:

- ATN – Carhuamayo-Cajamarca TL: the following sections of the line are now operating commercially:
  - Section I – Carhuamayo-Paragsha TL, brought online in January 2011.
  - Section II – Paragsha-Conococha and upgrades to the Cajamarca substation, commissioned in February 2011.
  - Section IV – Kiman Ayllu-Cajamarca, commissioned in June 2011.
  - Section III – Conococha-Kiman Ayllu, commissioned in December 2011.

Highlight projects for the year included the following:

- The most important milestone in 2011 for Abengoa's transmission line concessions division was the alliance forged with Cemig (Companhia de Energia de Minas Gerais) through its subsidiary company Taesa (Transmisora Alianza de Energia S.A.), in which each company now holds a 50 % stake in the STE, ATE, ATE II and ATE III concessions, all located in Brazil. In addition to generating considerable value, the agreement strengthens Abengoa's position in the Brazilian market and will help to drive growth in the region. The assets covered by the arrangement span a total of 2,518 km and have been operating for five years on average. Of this grand total, Abengoa will continue to manage 2,138 km through a joint venture with Cemig, thus enabling it to continue expanding its power line business in Brazil and other Latin American countries. Abengoa secured the corresponding contract from ANEEL (Brazilian National Electrical Energy Agency) and the assets were gradually entered into service between 2004 and 2008.
- Abengoa was awarded a contract to operate a new power transmission line in Brazil, specifically the 230 kV C3 Itacaíunas – Carajás line in the state of Pará in the north of the country. The line, which runs parallel to another line in the same region managed by the company ATE III Transmisora de Energia, will meet industrial power demands in Carajás.
- In Peru, Abengoa successfully secured a contract for the ATN 2 Las Bambas-Cotaruse transmission line. The agreement extends the company's network of concessions in the country by a further 130 km for 18 years.



TL concession, Carhuamayo, Paragsha, Conococha, Huallanca, Cajamarca, Cerro Corona, Carhuaquero 220 kV TL Conococha – Kiman Ayllu L4 Norte – Arrival at the Cajamarca Norte substation, Peru

# 06.2

## Concession-type infrastructures

### Solar power

In 2011, Abengoa continued to showcase and consolidate its international leadership in the solar power sector, climbing to 443 MW in operation, 1,060 MW under construction and 150 in pre-construction or advanced development.

The main milestones in 2011 were as follows:

- In Spain, the company commissioned the Helioenergy 1 and 2 facilities, two 50 MW parabolic-trough plants operating at the Ecija solar complex. E.On and Abengoa hold equal 50 % stakes in the venture.

In addition, the two power tower plants (PS10 and PS20) are currently operating at full efficiency, as are the three parabolic trough plants (Solnova 1, Solnova 3 and Solnova 4) and the five photovoltaic plants (Sevilla PV, Casaquemada, Las Cabezas, Copero and Linares). As the facilities have been in service for over a year, Abengoa has been able to make a number of procedural and operational improvements, which are being incorporated into the new solar platforms.

Also in 2011, construction continued on a further eight 50 MW facilities.

- In the United States, considerable progress has been made on the 280 MW Solana plant in Arizona, one of the world's largest solar facility. In addition, the newer 280 MW Mojave solar plant received a federal loan guarantee from the US government, enabling the company to secure financing for the project and commence construction.
- In other regions, the 150 MW integrated solar combined cycle (ISCC) facility in Algeria was successfully commissioned, while construction continued on the 100 MW Shams-1 plant in Abu Dhabi. In addition, a 14 MW solar field is currently under construction for a 480 MW hybrid electrical power plant in Aguas Prietas (Mexico), which will feature Abengoa technology.
- The South African Department of Energy selected Abengoa to carry out two projects: a 100 MW parabolic-trough plant and a 50 MW power tower plant utilizing superheated steam.

Shams-1 (Abu Dhabi, United Arab Emirates)





# 06.2

## Concession-type infrastructures

On a final note, Abengoa continues to be involved in the Desertec Industrial Initiative, which seeks to promote a stable framework for developing renewable energies in desert areas of North Africa and the Middle East for local consumption and exports to Europe.

### Desalination



Bajo Almanzora desalination plant (Almeria)

Abengoa currently has five projects under concession. The desalination plants in Skikda (Algeria) and Chennai (India), both with a treatment capacity of 100,000 m<sup>3</sup>/day and in operation and under maintenance since the end of 2009 and middle of 2010, respectively, are continuing to match expected performance output. The company has been able to use the experience gained from these two projects under concession to improve its R&D&I programs and its other plants under development.

August witnessed partial acceptance of the component units for the Honaine desalination plant, boasting a capacity of 200,000 m<sup>3</sup>/day and awarded by the public company Algerian Energy Company (AEC). This marks a major milestone in the project, as it demonstrates the plant's capacity to generate the committed volume of water in terms of both quantity and quality. In addition, the company initiated the process leading to final acceptance of the entire plant and commencement of the operation and maintenance phase, both scheduled for mid-2012.

In Spain, the Bajo Almanzora desalination plant in Almeria was unveiled at the start of September. The facility has a treatment design capacity of 60,000 m<sup>3</sup>/day. It is the third plant that the company currently operates in Spain, alongside Almeria (50,000 m<sup>3</sup>/day) and Cartagena (65,000 m<sup>3</sup>/day).



Signing of the water purchase agreement for the future Nungua desalination plant (Ghana)

In Africa, Abengoa has signed a contract with the public water utility Ghana Water Company Limited (GWCL) to construct a 60,000 m<sup>3</sup>/day capacity seawater desalination plant in Nungua. The facility will be constructed under a DBOO(T) contract (Design, Build, Own, Operate and maintenance for 25 years, plus possible Transfer). The proposed desalination plant marks a major step forward on the path to improving hydro installations for the supply of drinking water in Ghana, a country experiencing sharp growth in population. The capital city, Accra, which has a population of roughly three million, is finding it difficult to cope with the demand of surrounding towns and villages. The new facility will help to supply water to nearby towns and cities such as Teshie Nungua and Tema. The project has been welcomed by both the Ghanaian authorities and the local population seeing as though it is the first desalination plant in the country and in West Africa as a whole. It has also attracted considerable attention from investors, particularly from the Japanese investment firm Sojitz, with whom Abengoa signed a shareholders' agreement at the end of September to formalize its equity stake in the venture.

Signing of the collaboration agreement with Dalian authorities (China)



# 06.2

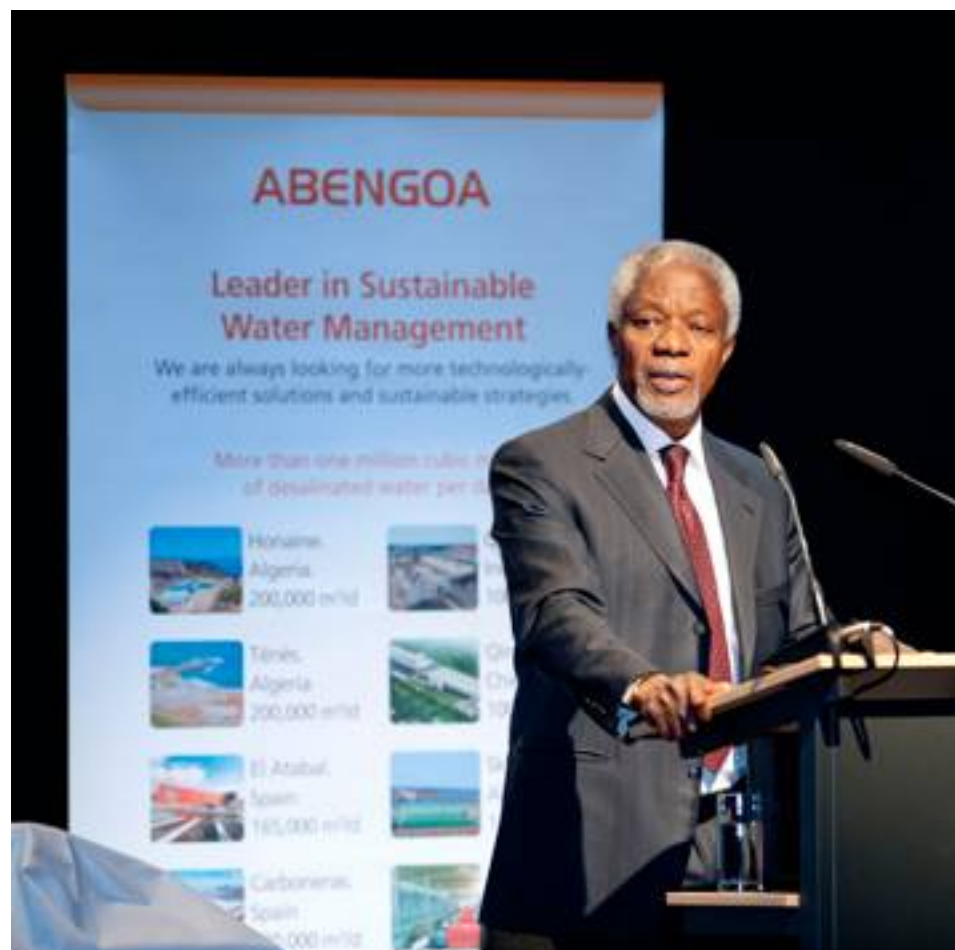
## Concession-type infrastructures

In June, Abengoa signed an agreement with the local Dalian authorities for the joint development on Changxing Island (China) of a desalination program to supply water to the local industries and urban hubs envisaged in the development plan for Dalian Changxing Island (DCI). The project will bring a total capacity of 800,000 m<sup>3</sup>/day to the area for the coming 10 years. Also Abengoa has reached an agreement with the company Hitachi to develop phase one of the project.

Abengoa completed the design and construction in July of the Donna facility in Hidalgo County (Texas). The contract for the plant, which can treat up to 7,500 m<sup>3</sup>/day, was awarded by the state's largest water supply utility, North Alamo Water Supply, and has been completed within budget and several months ahead of schedule. The operation and maintenance of the plant, which was formalized through a separate agreement, got under way in December.

In April, the company sponsored the Global Water Awards gala dinner, organized by Global Water Intelligence, a leading analyst of the international water market. Many big names attended the event, including the former Secretary-General of the UN, Kofi Annan, who handed out the awards to the winning companies, projects and technologies for the year.

Abengoa sponsored the Global Water Awards in Berlin



Abengoa participated in the IDA World Congress 2011 in Perth (Australia). The biannual congress, which took place in September, was organized by the International Desalination Association, an internationally recognized body within the desalination sector. Under the motto "Sustainable solutions for a thirsty planet", the event brought together over 900 delegates from 60 countries to discuss technical concerns and share knowledge and experience.

# 06.2

## Concession-type infrastructures

Abengoa at the IDA World Congress 2011 held in September in Perth (Australia)



## Cogeneration and other concessions

Cogeneration technologies generate electricity and high-temperature heat in tandem for use in industrial processes; an energy-efficient solution being spearheaded by Abengoa.

Heat and electricity are generated from biomass, natural gas or industrial waste for subsequent use in industrial processes, with the surplus sold to the grid.

Abengoa currently has various cogeneration plants:

- Cogeneración Villaricos, S.A. (Covisa), Enernova Ayamonte, S.A. (Enernova) and Aprovechamientos Energéticos Furesa, S.A. (Aprofursa). These three companies generate electrical power while using the resulting heat to produce water or steam. The electricity is then sold, while the heat is used by the host factory.
- Procesos Ecológicos Vilches: company specializing in the recycling of livestock waste to produce fertilizer and electrical power through a slurry treatment plant (pig waste, mixed excrement, urine, water, leftover animal feed and other foreign bodies), combined with a electrical power cogeneration plant.

Procesos Ecológicos Vilches  
cogeneration plant



# 06.2

## Concession-type infrastructures

- Nuevo Pemex: 300 MW plant to be constructed at the facilities of Petróleos Mexicanos (Pemex), the first to be integrated into one of its existing refineries. The power plant is capable of generating electricity and thermal energy through two gas turbine generators with their respective electric generators, and two heat recovery steam generators.

Abengoa also manages a number of other concessions:

- Centro Cultural Mexiquense (cultural center). The complex sits on 17 ha of land and boasts 35,000 m<sup>2</sup> of museums, libraries, workshop modules with over 60 classrooms intended for a range of different art-related subjects, an administrative building, auditoriums, an open-air theater, a concert hall with seating for 1,200 people, a cafeteria, a restaurant and parking for over 1,000 vehicles.
- Irrigation zone of the Navarra Canal. The intention with this concession is to recover investment by levying an irrigation charge.
- Cerrato hydroelectric power plant on the river Pisuergra and mini-stations along the Aragon and Catalonia irrigation canal. Foot-of-dam, run-of-river and diversion plants in northern Spain. Investment here is recovered by selling the electricity generated by the plants.
- Hospitals: operation of parking facilities at the Costa del Sol hospital (Malaga), with Abengoa having already completed construction of the hospital building. The complex is a further example of the company's concessions in operation, which also include the Tajo hospital in Aranjuez (Madrid).
- The company also operates three courthouses in Catalonia: the courthouse of Olot in the province of Gerona and the courthouses of Cerdàñola and Santa Coloma in the province of Barcelona.

The following major milestones were reached in 2011:

- All generation systems at Abengoa's Campus Palmas Altas headquarters in Seville were in full operation in 2011. These systems are:
  - A trigeneration system (CCHP) comprising a 1 MW gas-powered engine-generator, an absorption chiller, a heat exchanger and hot water accumulator tanks, capable of generating electrical and thermal power and cooling.
  - A 100 kWth parabolic-trough system, also featuring an accumulator tank, absorption chiller and pumping system, which produces cold water from solar power.
  - Photovoltaic plants integrated by means of pergolas forming part of the campus' architecture, with an installed capacity of 152.5 kWp.
  - A 10 kW high-concentration photovoltaic panel with dual axis tracking, featuring state-of-the-art solar modules and three single-phase inverters. The electrical power generated by this panel is passed through an electrolyzer to produce hydrogen during the day. This is then used by a 1.2 kW fuel cell to generate electrical power at night, thus powering part of the indoor lighting system of the campus.
- Further inroads into the wind power sector after the Uruguayan National Authority for Power Generation and Transmission (UTE) awarded Abengoa a contract to construct and exploit the 50 MW Peralta wind farm in Uruguay.
- Also within the wind sector, Abengoa took part in an auction staged by Aneel (National Electrical Energy Agency) in Brazil and came away with contracts for three future wind farms to be built in the state of Ceará, Brazil, as part of the Trairi II wind complex, which will boast a total installed capacity of 96.6 MW.
- Abengoa awarded a 25-year contract to supply drinking water, with the project including not only the engineering and construction, but also operation, repair and maintenance of the El Zapotillo-Los Altos de Jalisco-León aqueduct in Guanajuato, Mexico.
- Unveiling of the Centro Cultural Mexiquense de Oriente (CCMO) cultural center, Abengoa's first concession in Mexico. The building, which is a huge boon for the eastern metropolitan area of Mexico City, was constructed in just 18 months and will now be operated over a 20-year term before finally being handed back to the IMC (Mexican Institute of Culture).



# 06.2

## Concession-type infrastructures



**Concecutex**

Outside view of the Centro Cultural Mexiquense de Oriente cultural centre (Mexico)

- Work is continuing on the 300 MW cogeneration plant in Tabasco (Mexico), which will be built at the existing facilities of the state-owned company Petróleos Mexicanos (Pemex). The project includes operation and maintenance for a 20-year term. The new facility will be able to generate up to 800 t/h of steam to supply electricity to the Nuevo Pemex Gas Processing Complex in Tabasco, and will feed surplus power to the Mexican power grid.

## Our activities

### Transmission lines

Abengoa currently has 9,002 km of transmission lines under concession in Brazil, Chile and Peru, with an average remaining life of 23 years, specifically:

- Brazil: 6,696 km of lines under concession.
- Peru: 2,001 km of lines under concession.
- Chile: 305 km of lines under concession.

The company also expects to commission the following lines in the coming years:

- In 2012: Brazil - Manaus and Línea Verde lines, spanning a total of 586 and 987 km, respectively.
- In 2013: Brazil - North Brazil line. This line is set to become the world's longest DC (direct current) transmission line at 2,375 km. Plus the ATS line in Peru, measuring 872 km.

# 06.2

## Concession-type infrastructures

Detailed below are Abengoa's main concessions by region:

### Brazil

Abengoa remains a prominent player in the Brazilian power transmission market. It currently possesses over 6,000 km of transmission lines under concession from public bodies (accounting for roughly 8 % of the national basic power grid).

The following projects are currently in operation:

- **STE - Sur Transmisora de Energía.** Transmission line spanning 386 km awarded by Aneel.
  - 500 kV Uruguaiana-Maçambará section.
  - 230 kV Maçambará-Santo Ângelo section.
  - 230 kV Santo Ângelo-Santa Rosa section.

STE controls the line, which has been in operation since 2004 and traverses 13 municipalities within the state of Rio Grando do Sul.

- **ATE Transmisora de Energía.** 525 kV Londrina (SC)-Assis (SP)-Araraquara (SP) power line, covering a total distance of 370 km.

The transmission line (TL) comprises the 525 kV Londrina-Assis section between the Londrina substation, located in the municipality of Londrina (state of Pará), and the Assis substation, located in the municipality of Assis (state of São Paulo), measuring approximately 120 km; and also the 525 kV Assis – Araraquara TL between the Assis substation and the Araraquara substation, located in the municipality of Araraquara (also in the state of São Paulo), measuring roughly 250 km.

The underlying reasons for the project, which will be carried out by upgrading existing power transmission systems in the southern and southeastern regions, are as follows:

- To enable surplus power to be transferred between the southern and southeastern regions, particularly within the metropolitan area of São Paulo and the region of Londrina.
- To upgrade existing infrastructure within the southern/southeastern regions to enable them to receive up to 3,000 MW of electrical power.
- To upgrade power exchange capacity to 2,500 MW between the north-northeast and south-southeast-central-west systems.
- To interconnect the various hydrographic basins in Brazil.
- To help increase the reliability, security and stability of the Brazilian electrical system.
- To bring about an effective average increase of 900 MW in the guaranteed power provided by the Brazilian electrical system.

- **ATE II Transmisora de Energía.** Colinas-Ribeiro Gonçalves-São João do Piauí-Sobradinho TL, covering a total distance of 937 km.

This TL was awarded as a public concession for the operation and exploitation of electrical power and includes the construction of basic grid transmission installations within the electrical system for Aneel. The line consists of 500 kV installations between Colinas and Sobradinho, starting from the Colinas substation in Tocantins state and extending to the Ribeiro Gonçalves substation in Piauí state, spanning a total of 374 km; a second section measuring 353 km and linking the Ribeiro Gonçalves substation to the São João do Piauí substation, also in Piauí state; and finishing with the TL between the São João do Piauí substation and the Sobradinho substation in Bahia state, spanning a further 210 km. The line became operational in 2006 and the concession is to run for 30 years.

**ATE II** Towers along the 500 kV ATE II Ribeiro Gonçalves (Piauí)-São João do Piauí TL, Brazil





# 06.2

## Concession-type infrastructures

- **ATE III Transmisora de Energía.** ATE III, measuring 459 km, comprises the following TLs and substations:

- Itacaiúnas – Colinas at 500 kV.
- Itacaiúnas – Carajás at 230 kV.
- Itacaiúnas – Marabá at 500 kV.

The company was created to exploit and operate public concessions for the transmission of electrical power, encompassing the construction, implementation, operation and maintenance of basic grid transmission installations within the Brazilian interconnected electrical system. Abengoa was awarded the contract to construct and subsequently operate and maintain the Norte-Sur III 500 kV and 230 kV TLs and substations for a term of 30 years.

### ATE III

230 kV transmission line crossing the river Araguaia (Brazil)



# 06.2

## Concession-type infrastructures

### ATE IV

Bateias substation - lines arriving from the Curitiba substation, Brazil.

- **ATE IV - São Mateus Transmisora de Energía.** Aneel awarded Abengoa a contract for the construction and 30-year operation and maintenance of the following four TLs and substations:

- Bateias – Curitiba TL at 525 kV.
- Canoinhas – São Mateus TL at 230 kV.

Construction of this 85 km transmission line was essential for the power system of the metropolitan area of Curitiba, capital of Pará state, due to the huge local population and the heavy presence of industry within the region.



### ■ ATE V – Londrina Transmisora de Energía

Concession dedicated to exploit and operate public concessions for the transmission of electrical power, encompassing the construction, implementation, operation and maintenance of basic grid transmission installations within the Brazilian interconnected electrical system. Abengoa holds the concession to construct and subsequently operate and maintain the 230 kV TLs and substations for a 30-year term.

ATE V, spanning a total of 132 km, comprises the following sections:

- 230 kV Londrina – Maringá TL, located in the state of Pará and measuring 88 km.
- Jaguarai – Itararé TL, also 230 kV, located in the states of Pará and São Paulo and spanning a total distance of 44 km.



### ATE V

Transmission tower for the 230 kV ATE VI Londrina – Maringá line, Brazil

### ■ ATE VI – Campos Novos Transmisora de Energía

The concession from Aneel envisages the construction and 30-year operation and maintenance of the 230 kV TL and substations. This line upgrades the central electricity grid of the states of Santa Catarina and Rio Grande do Sul to boost economic growth within the region.

The TL covers a total distance of 131 km, and is divided into two sections: Campos Novos – Videira and Doña Francisca-Santa Maria.

- The 230 kV Campos Novos – Videira TL, located in the state of Santa Catarina and covering 68 km;
- and the Doña Francisca-Santa Maria TL, located in the state of Rio Grande do Sul, also 230 kV and spanning 63 km.

# 06.2

## Concession-type infrastructures

### ATE VI

Transmission tower for the ATE VI Campos Novos-Videira line (Brazil)



### ■ ATE VII – Foz do Iguaçu Transmisora de Energía

The company was awarded the construction and 30-year operation and maintenance of the 230 kV Cascavel Oeste-Foz do Iguaçu TL and substations.

ATE VII comprises the 115 km Cascavel Oeste-Foz do Iguaçu TL and two substations, located in the state of Pará.



Carhuamayo-Cajamarca ATN TL concession (Peru)

## Peru

Despite having been general elections in Peru in 2011 and a complicated international climate, Abengoa continued to report growth in all lines of business, particularly in the power transmission lines market.

In 2011, the company focused its attention on the following activities:

- Starting the operation and maintenance of the first sections of the Carhuamayo-Cajamarca TL (ATN).
- Consolidate the skilled workforce of the concessionaire company.
- Managing the corresponding easement and approving the environmental impact study for the proposed Chilca-Marcona TL (ATS).

Abengoa concessions can be broken down into the following two categories:

### Public concessions

- **ATN:** construction of the high-voltage 220 kV Carhuamayo-Cajamarca line and associated substations. The project envisages the design, supply and construction of the entire electrical system and operation and maintenance for a 30-year term.

The project involves 570 km of 220 kV line, two new substations and upgrades to five existing substations. The new infrastructure traverses the Peruvian mountains at an average elevation of 3,000 m above sea level, climbing to a maximum of 5,000 m. The project will benefit the northern reaches of Peru, specifically the provinces of Cerro de Pasco, Huanuco, Ancash, La Libertad and Cajamarca.

# 06.2

## Concession-type infrastructures



L3 – TL concession, Carhuamayo, Paragsha, Conococha, Huallanca, Cajamarca, Cerro Corona, Carhuaquero 220 kV TL Conococha-Kiman Ayllu – L3 cable stringing process (Peru)

In 2011, the following sections of the line were brought into commercial service:

- Section I – Carhuamayo-Paragsha TL: January 2011.
- Section II – Paragsha-Conococha and upgrades to the Cajamarca substation: February 2011.
- Section IV – Kiman Ayllu-Cajamarca: June 2011.
- Section III - Conococha-Kiman Ayllu: December 2011

- **ATS:** construction of the 500 kV Chilca-Marcona-Ocoña-Montalvo TL and associated substations, including the installation of two series compensation capacitors at the Ocoña substation. The project involves the design, supply and construction of the entire electrical system and operation and maintenance for a 30-year term, and comprises 872 km of 500 kV line and 28.5 km of 220 kV line, three new substations and upgrades to three existing substations. The resulting system has a transmission rating of 800 MW and 1,200 MVA of transformer power.

In 2011, the company continued to carry out the engineering work and preliminary studies, to seek licenses and permits, including formalities relating to the easement, and to conduct scoping and environmental impact studies to be able to commence construction. Assuming contractual timeframes are met, the project will be brought into commercial service in July of 2013.

### Private concessions

- **ATN 1:** construction of the 220 kV Paragsha-Francoise TL and upgrades to the Paragsha II and Nueva Francoise substations, including operation and maintenance for a 30-year term. The project embraces engineering work, studies, procurement and construction in relation to the roughly 55 km of high-voltage line, which will be strung at between 4,200 and 4,500 m above sea level within a timeframe of 540 days.

The corresponding contract was awarded in October 2010 and since then the engineering work and preliminary studies have been completed and the main supplies procured. As the public authorities (Ministry of Energy and Mines of Peru) have been late in approving the environmental impact study, there has been a delay in obtaining the necessary permits and licenses. Negotiations are therefore under way with the customer to extend the estimated term for completion by six months. The project is expected to enter commercial service in November of 2012.

- **ATN 2:** this project involves the construction of the 220 kV Las Bambas-Cotaruse overhead line, as well as the 18-year operation and maintenance. The contract includes the engineering and study, procurement and construction of the roughly 130 km-long HV line within a timeframe of 780 days.

The concession was initially arranged through a memorandum of understanding signed in May 2011 and the parties are now negotiating the binding contracts. The project is expected to enter commercial service in July of 2013.

On a final note, and as a result of the forecast market growth for the region, there are a number of mining projects that are currently being explored or for which the relevant permits are being sought. These mines require a one-stop resolution to their long-term electrical power needs and given the experience that Abengoa has gained from the ATN and ATS projects and the synergies that can be created, the company intends to prepare and present one-stop solutions to satisfy the needs of these mining customers.



# 06.2

## Concession-type infrastructures

### Chile

Abengoa is a key player within the Chilean electricity market and the company expects to report high growth from its projected investments for the coming years.

In energy, Chile has a vulnerable power transmission system that must be expanded to meet the needs and growth of the country. The aim is, in fact, to double Chile's electricity generation capacity by the end of this decade, which would effectively mean installing over 8,000 MW of capacity from now until 2020.

Options on the table include interconnecting the north and central trunk systems, installing a second trunk transmission system, or constructing direct current lines to transport energy from the far south of the country to central Chile.

Investments in mining and electrical power projects are also of huge importance for the coming five years, and the company therefore expects an auspicious climate for order intake.

Shot of the Santa Bárbara Trupán  
TL at dusk (Chile)



# 06.2

## Concession-type infrastructures

Abengoa operates in Chile the following projects under concession:

- 1x220 kV Crucero – El Abra line: this 1995 concession comprises a 101 km power line that transmits 100 MW and which is currently in full operation.
- 2x220 kV Santa Bárbara – Trupán line: this 1994 concession consists of a 54 km double-circuit power line that transmits 300 MW and which is currently in full operation in southern Chile.
- 2x220 kV Ralco – Charrúa line: this concession, awarded in 2001, comprises a 140 km double-circuit power line that transmits 600 MW. The line is used to evacuate the power generated by the Ralco plant.
- 15, 66 and 220 kV Palmucho plant lines, Zona de Caída substation: this 2005 concession comprises a transformer substation and 10 km of 23 kV line, which transmits 32 MW to the Central Interconnected System.

All maintenance work on the infrastructure described above is carried out by Abengoa workers and the company duly meets all the availability ratios required by the different systems.

## Solar power

Concessions at Abengoa are divided into the following lines of activity:

- Development of CSP and photovoltaic power plants: this includes prospecting ideal locations for solar plants, carrying out the necessary administrative formalities to commence construction, negotiating project financing and construction agreements and, when needed, identifying potential partners and reaching agreements with them. In addition, Abengoa provides support during the engineering and turnkey construction of the plants.
- Sale of power and plant operation: the solar power plants developed by Abengoa sell their electricity under long-term concessional agreements, meaning the optimum operation and maintenance of these facilities is key to future growth.

Solucar complex  
(Seville, Spain)





# 06.2

## Concession-type infrastructures

Abengoa's portfolio of plants is classified according to the degree of maturity of development.

There are four project phases, which are typically classified as follows:

- **Development:** this chiefly includes site selection, securing of land and assessment of the solar resource; administrative formalities and obtaining licenses, permits and authorizations; ensuring the plant is connected to the grid and arranging the connection infrastructure.
- **Pre-construction/early stage:** this phase includes the steps required to secure project financing for those plants which, as well as having land rights, permits, authorizations and licenses, also meet the relevant requirements entitling them to receive certain revenues (registration of the project in the pre-allocation register, or signing of energy purchase agreements, such as with local electricity utilities in the case of the United States). In this stage, construction activities are started
- **Construction:** start of construction work on the facilities, oversight of engineering and construction work and processing of the relevant permits, as well as support in starting up the facilities.
- **Operation:** this includes taking control of the plant following construction; the evacuation and sale of electrical power; and the operation, maintenance and exploitation of the plants.

### Plants in operation

At the close of 2011, Abengoa held a total of 443 MW in operation. Over the course of 2011, the company gained further experience in operating the two main CSP technologies: power tower and parabolic-trough technologies.

Abengoa has improved its tower technology capabilities thanks to its four-plus years of experience in operating the PS10 plant, the world's first commercial tower plant, and two-plus years of experience operating the PS20 plant with excellent results.

Focusing on parabolic-trough technology, the start-up of Helioenergy 1 and 2 at the Ecija solar complex has brought the company's total portfolio to 250 MW in operation of this thermal power technology, complementing the three 50 MW plants at the Solucar complex, namely Solnova 1, 3 and 4.

In addition, the 150 MW Hassi R'Mel (Algeria) combined cycle power plant with solar field was brought online in 2011.

In photovoltaics, Abengoa is gaining experience from the 12 MW it currently has in operation, which are proving to be of immense value in the development of new technologies.

Each plant has its own characteristics and benefits, as described in further detail as follows

#### Solucar Complex

##### ■ PS10

After successfully undergoing operational testing, PS10 was commissioned in June 2007 to become the world's first commercial plant utilizing power tower technology. Located at the Solucar complex, the plant has an installed capacity of 11 MW and generates enough clean energy to satisfy the power needs of 5,500 households, while slashing annual CO<sub>2</sub> emissions by 6,700 t.

PS10 was the first CSP plant to feature a storage system, enabling it to continue generating electricity for roughly an hour so that it can still produce power during cloudy spells or at the end of the day when solar radiation is insufficient.

Since its start-up, PS10 has matched expected performance levels and helped to prove the viability of tower technology on a commercial scale.

# 06.2

## Concession-type infrastructures

Solucar complex  
(Seville, Spain)



### ■ PS20

PS20, which was commissioned back in February 2009, was only the second of its kind and the world's largest power tower plant in operation at the time. The facility, which forms part of the Solucar complex, has an installed capacity of 20 MW and generates enough electricity to power 10,000 households, while curbing annual CO<sub>2</sub> emissions by 12,100 t.

PS20 features a number of important technological advances, all developed by Abengoa, over the world's first commercial power tower plant, PS10. These include a more efficient receiver and a raft of improvements to the control and operation systems and also the thermal energy storage system.

The technological improvements incorporated into the second plant, which have led to huge improvements in power tower technology, meant the plant successfully passed production testing with results comfortably outstripping predicted results, a pattern that has been validated over the nearly two years of operation of the plant.

This second plant comprises a solar field of over 1,255 heliostats designed by Abengoa, all of which focus solar radiation on a receiver located at the top of a 165 m tower.

### ■ Solnova 1, Solnova 3 and Solnova 4

Each of the three 50 MW plants generates enough electricity to power 25,700 homes while cutting annual CO<sub>2</sub> emissions by approximately 31,400 t. The three plants started operating commercially in 2010.

After over a year in operation with exceptional results, they have more than proved their worth to the company and provide the basic blueprint for future plants currently under construction in Spain, the United States and Abu Dhabi.

These three facilities are the first of Abengoa to employ parabolic-trough technology and the first three of those included on the Spanish pre-assignment register to enter into operation.

# 06.2

## Concession-type infrastructures

Helioenergy 1 and 2  
in Ecija (Seville, Spain)



### Ecija solar complexi

#### ■ Helioenergy 1 and 2<sup>1</sup>

The 50 MW Helioenergy 1 facility at the Ecija solar complex was commissioned in 2011, developed jointly by E.On and Abengoa, together with the 50 MW Helioenergy 2.

The plants mark a major milestone for both companies and underscore the commitment of both to developing solar power.

With over 88.000 employees, E.On is one of the major gas and electric companies.

It is the first complex to be started up by Abengoa with the involvement of an industrial partner. When both plants become fully operational, they will generate enough solar energy to power 104,000 households and help to curb annual CO<sub>2</sub> emissions by 126,000 t.



SPP-1 (Hassi R'Mel, Algeria)

### Hybrid integrated solar combined cycle (ISCC) plant in Algeria

The 150 MW facility, located in Hassi R'Mel, Algeria, comprises a combined cycle plant with 180,000 m<sup>2</sup> of useful reflective area equivalent to 25 MW of thermal power.

Abengoa commissioned the project in 2011 alongside New Energy Algeria.

### PV Plants

#### ■ Seville PV

With an installed capacity of 1.2 MW, Seville PV was the world's first commercial plant to employ low-concentration photovoltaic technology. It has 154 solar trackers on a plot of land occupying 12 hectares as part of the Solucar complex in Sanlúcar la Mayor.

<sup>1</sup> Helioenergy 2 has been effectively included in the Spanish government's "Registro Administrativo de Instalaciones de Producción en Régimen Especial" (concessional type payments) after the closing of 2011. The effects of the registry started on the 1st of January 2012.



# 06.2

## Concession-type infrastructures

The plant can supply clean energy to some 650 households, while curbing yearly CO<sub>2</sub> emissions by over 1,800 t.

### ■ Copero PV

A 1 MW photovoltaic facility built on the grounds of the wastewater treatment plant (WWTP) that Emasesa operates at the El Copero site in Seville. Emasesa and Abengoa are joint 50 % owners of the plant.

### ■ Las Cabezas PV

A 5.7 MW photovoltaic plant with single-axis trackers located in an area of high solar radiation in the province of Seville.

### ■ Linares PV

A 1.9 MW photovoltaic plant with a dual axis tracking system located in Linares (Jaén). The area measures one of the highest in solar radiation in Andalucía.

### ■ Casaquemada PV

A 1.9 MW plant employing dual-axis photovoltaic tracking technology situated at the Solucar complex. The facility includes a 100 kW high-concentration installation featuring state-of-the-art technology.

Casaquemada PV  
(Seville, Spain)



# 06.2

## Concession-type infrastructures

### Plants under construction

Abengoa has solar thermal power plants currently under construction in Spain, the United States and Abu Dhabi for a combined total installed capacity of 1,060 MW, in many cases in alliance with strategic partners.

In the United States, work is in progress on the Solana and Mojave plants, each with 280 MW of installed capacity.

In Spain, the company is currently constructing six 50 MW CSP plants; two on the El Carpio solar complex, two on the Extremadura solar complex and two on the Castilla-La Mancha solar complex.

In Abu Dhabi, work is continuing on the 100 MW Shams-1 plant.

#### El Carpio solar complex

In order to build and operate the two 50 MW parabolic-trough plants, Abengoa struck up an alliance with JGC, with Abengoa holding a 74 % stake in the venture.

Founded back in 1928, JGC Corporation has remained a leading engineering firm ever since. It currently offers a broad range of services in planning, design, engineering, construction and delivery of power, with a proven track record in more than 20,000 projects in over 70 countries worldwide.

Solacor 1 and 2 in El Carpio  
(Cordoba, Spain)

Construction of both plants got under way in the summer of 2010 and is progressing well, with the facility scheduled to be commissioned during the first half of 2012.





# 06.2

## Concession-type infrastructures



Solaben 2 and 3 in Logrosán  
(Caceres, Spain)



Helios 1 and 2  
(Ciudad Real, Spain)

Solana (Gila Bend,  
Arizona, United States)

### Extremadura solar complex

Abengoa and Itochu Corporation forged an alliance to construct two 50 MW CSP plants (Solaben 2 and Solaben 3) in Logrosan (Caceres). The company, which operates both plants, will retain control of the projects with a 70 % stake, while Itochu will own the remaining 30 %.

With approximately 150 offices in 74 countries, Itochu is a leading Japanese trading company operating commercially in the Japanese market, and also in imports and exports and international trade. It offers a wide range of products and services, including textiles, machinery, information and communication technologies, aeronautics, electronic goods, energy, metals, minerals, chemicals, forestry products, financing, real estate, insurance and logistical services.

Construction of both plants is advancing well and remains on schedule, with commercial operation expected to commence in 2012.

Other two plants (Solabén 1 and 6), listed in the pre-assignment register of the Spanish government, have obtained all permits required, having started initial construction activities such as earthwork and land elevation work. Arrangements for the supply of the main equipment have already been made and financing for the project is now in an advanced stage.

### Castilla-La Mancha solar complex

Abengoa is building two 50 MW CSP power plants in the province of Ciudad Real (Castilla-La Mancha), both equipped with parabolic trough technology.

Project financing was secured in 2011 and construction is now well under way, according to scheduled commissioning. Start-up of commercial operation is expected in 2012.

### Solana

Solana, located 70 km southwest of Phoenix, Arizona, is one of the world's largest CSP plants under construction, and will boast 280 MW of gross installed capacity (250 MW net) through cutting-edge parabolic-trough technology. Solana will generate enough energy to power 70,000 US households, while cutting yearly CO<sub>2</sub> emissions by 475,000 t. The resulting power will be sold to APS, the largest electric utility in the state of Arizona, through a 25-year power purchase agreement.

Solana will include six hours of storage through molten salt technology, enabling it to store energy during cloudy spells and after sunset. This storage capacity will allow Solana to generate enough electricity to meet peak evening demand during the Arizona summertime.



# 06.2

## Concession-type infrastructures

At year-end 2011, work on the plant was under way and progressing well, having started the installation of the troughs.

The construction and operation of Solana will bring with it huge benefits, including the creation of between 1,600 and 1,700 jobs during construction and 85 permanent positions for the plant's operation and maintenance.

### Mojave

This project stemmed from the signing of a contract with Pacific Gas & Electric (PG&E) to supply the electricity to be generated at the new Mojave Solar plant, boasting a gross capacity of 280 MW. The facility will be located 150 km northeast of Los Angeles and will create about 1,600 new jobs in the local area during its construction and 85 permanent positions to handle the associated operation and maintenance work.

In 2011, Abengoa obtained a federal loan guarantee from the US government and successfully secured the necessary financing for the project.

Various components of this groundbreaking parabolic-trough plant were designed by Abengoa itself and manufactured locally.

Construction has effectively started in 2011.

The project will provide a huge economic boost to the area by contributing significantly to California's renewable energy targets, replacing fossil fuels with solar energy and other alternative sources to curb greenhouse gas emissions.

Mojave Solar (Mojave Desert, California, United States)





# 06.2

## Concession-type infrastructures

Shams-1 (Abu Dhabi,  
United Arab Emirates)

### Shams-1, the largest solar plant in the Middle East

A consortium comprising Abengoa and Total won an international tender to develop and operate, in joint venture with Masdar, the largest solar power plant in the Middle East. This first solar power project in the Middle East marks one of the first steps by the Abu Dhabi government to introduce renewable energy into a region which presently remains highly dependent on hydrocarbons. It also represents a strategic milestone for Abengoa due to the vast scope for development in the region.



The Shams-1 plant, construction of which started at the end of 2010, sits on roughly 300 ha of land in the Abu Dhabi desert and will have an installed capacity of 100 MW. The facility will include close to 600,000 m<sup>2</sup> of ASTRØ parabolic troughs designed by Abengoa.

Shams-1 employs cutting-edge parabolic trough technology. Of the plant's many innovative features, we would highlight its dry cooling system and its ancillary heating boiler. The dry cooling system reduces water consumption at the plant considerably, while the ancillary boiler heats the steam as it enters the turbine, notably boosting the efficiency of the cycle. Both features place Shams-1 at the very forefront of parabolic trough technology.

Construction is progressing according to plan and the plant is due to enter service during the second half of 2012.

# 06.2

## Concession-type infrastructures

### Plants in pre-construction/advanced development

Abengoa has been awarded the first two CSP projects in the country by the South African Department of Energy.

#### KaXu Solar One

The South African Department of Energy has selected Abengoa to construct a 100 MW parabolic-trough solar plant.

KaXu Solar One, a 100 MW solar power plant employing parabolic-trough technology, will have a thermal storage capacity of 3 hours and will sit on 1,100 ha of land close to the city of Pofadder, in the north of the Northern Cape province. Around 800 jobs will be created during the construction phase, while 35 permanent jobs will be required for the subsequent operation and maintenance. The project will also create in the region of 200 direct or indirect jobs within the local community. The facility makes a hugely important technological advance by utilizing dry cooling systems.

The venture is owned by Abengoa, with a 51 % stake, and Industrial Development Corporation (IDC), with a 49 % share.

IDC is South Africa's largest financial development institution and has helped to drive forward the industry on the path to ensuring economic growth within the country.

#### Khi Solar One

The second project for which the South African Department of Energy has selected Abengoa is a 50 MW plant featuring superheated steam tower technology.

Khi Solar One (50 MW) is set to become Abengoa's third commercial power tower plant and its first outside Spain. The facility, with two hours of thermal storage, marks a major technological step forward in terms of efficiency by using higher process temperatures and having a nominal capacity two and a half times higher than that of the previous power tower built by Abengoa in Andalusia. This is thanks to the new generation of superheated steam technology developed by Abengoa at its R&D centers. As the plant will utilize dry cooling systems, its water consumption is slashed by 80 %. The tower plant will be constructed on a 600-ha plot of land near Upington, also in the Northern Cape province. Roughly 600 jobs will be created during the construction stage, while a further 35 jobs will be required for the subsequent operation and maintenance of the plant.

The venture is owned by Abengoa, with a 51 % stake, and Industrial Development Corporation (IDC), with a 49 % share.

IDC is South Africa's largest financial development institution and has helped to drive forward the industry on the path to ensuring economic growth within the country

### Plants in development

Abengoa has a dedicated team of over 100 people working on plant development in Spain, the United States and the other markets in which the company operates. Over recent years, Abengoa has channeled much of its time and resources into developing solar power plants. As a result, it has a sizeable portfolio in different phases of development and embracing both CPS and photovoltaic technologies.

#### Spain

Abengoa owns more than 1,000 MW in development in CSP plants in different autonomous regions. Most of these plants will be built following the introduction of the new regulatory framework in 2014.

# 06.2

## Concession-type infrastructures

### United States

Abengoa has had a team of experts working on plant development since 2006, enabling the company to launch its two groundbreaking facilities in Arizona and California.

In addition to these Solana and Mojave plants, the company currently has other projects in various phases of development, including both CSP and photovoltaic technologies.

### International development

Outside Spain and the United States, Abengoa has teams capable of offering the best possible solution to every possible need in those markets considered attractive due to their high levels of solar radiation and regulatory control. The company currently has various projects under different phases of development in both CSP and photovoltaic technologies.

## Desalination

Desalination business is divided into three areas:

- Development of water treatment plants, including membrane technology, requiring to invest in the facilities and oversee their design and construction.
- Operation and maintenance and sale of water from the same plants or from plants owned by third parties under long-term concession agreements.
- Development of new technologies through its R&D&I department.

## Project development

### Algeria

Abengoa presently has three concession contracts in Algeria with the state-owned company Algerian Energy Company (AEC):

- Skikda: 2011 marked the second year of service with the plant operating at 100 % capacity. The facility was the first concession to be awarded in Algeria.
- Honaine: this desalination plant is largest facility in terms of capacity that Abengoa will operate. It can produce in the region of 200,000 m<sup>3</sup> of desalinated water per day and supply close to one million people.
- Ténès: also boasting a capacity of 200,000 m<sup>3</sup>/day, this is the first desalination plant that Abengoa will build in its entirety. It is currently under construction, with operation and maintenance due to commence in 2012.

Honaine desalination plant  
(200,000 m<sup>3</sup>/day)





# 06.2

## Concession-type infrastructures

Shot of the Chennai desalination plant (100,000 m<sup>3</sup>/day) in production since July 2010

### India

In July 2005, the company signed a financing agreement for the Chennai desalination plant located in the province of Minjur, in southeast India. The arrangement was reached with the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), a public company from the country's fourth largest city, which is also known as Madras. The contract follows a project finance DBOOT (Design, Build, Own, Operate, Transfer) model, with the facility to be the first plant to be developed under this model in India. Total investment for the project exceeds €100 M.

The sale of water fit for human consumption has been arranged under a 25-year concession. The desalination plant, with a 100,000 m<sup>3</sup>/day capacity, entered into operation and maintenance in July 2010 and has been performing in line with expectations ever since. The facility employs reverse osmosis membrane desalination technology, with pretreatment by flocculation, lameller settling, chemical filtration and treatment, post-treatment by remineralization, and energy exchangers. The design and construction of the plant proved to be a genuine challenge due to high salinity, strong tides and the monsoon season, all of which complicated working conditions.



### China

Located in one of China's most important ports in Shandong province, the Qingdao desalination plant currently under construction has been designed with a capacity of 100,000 m<sup>3</sup>/day and will supply drinking water to 500,000 of the 7.6 million population of Qingdao.

The resulting water will be supplied to Qingdao Highren Water Supply Group, a public corporation attached directly to the municipal government of Qingdao. The contract envisages the design, financing, construction, operation and maintenance of the facility for a 25-year term. It is the first contract to be signed exclusively with local Chinese banks, which will finance 70 % of the total investment, equivalent to roughly €135 M.

# 06.2

## Concession-type infrastructures

Qingdao desalination plant  
(100,000 m<sup>3</sup>/day)

It features a groundbreaking design both for pretreatment (ultrafiltration membranes) and the centralized pumping system, thus helping to boost energy efficiency.

Commissioning and commencement of operation and maintenance is scheduled for the middle of 2012.



The Ghanaian Minister for Water visiting Abengoa facilities in Seville

### Ghana

The most recent contract secured by Abengoa is a concession for the Nungua desalination plant located on the outskirts of the country's capital city, Accra. The contract has been signed with the public company Ghana Water Company Limited. Total project financing of \$110 M will be closed in early 2012 so construction period can be started after.

The proposed 60,000 m<sup>3</sup>/day capacity desalination plant represents a major step forward on the path to improving the hydro facilities for the supply of drinking water within the country, whose population is experiencing heavy growth. The capital city, Accra, with a population of roughly three million, is finding it difficult to cope with the demand of surrounding towns and villages. The new plant will help to supply water to nearby towns and cities such as Teshie Nungua and Tema.

### Plants in operation and maintenance

In addition to the Skikda and Chennai plants described above, Abengoa has three operation and maintenance agreements in effect in Spain:

- Almeria: the Almeria desalination plant, with a capacity of 50,000 m<sup>3</sup>/day, has been in service since 2005. The water it produces is supplied to the city of Almeria for human consumption and the operation and maintenance agreement is for 15 years.
- Cartagena: with a total capacity of 65,000 m<sup>3</sup>/day and employing reverse osmosis technology, the plant, located in the province of Murcia, has been operational since the middle of 2005. Total project investment exceeds €55 M and the plant will be operated for a 15-year term. The membranes have been changed to boost the nominal capacity of the plant to 110 % of its original capacity.

# 06.2

## Concession-type infrastructures

Shot of the Almeria desalination plant (50,000 m<sup>3</sup>/day)

- Bajo Almanzora: the desalination plant, located in the province of Almeria, was unveiled in September of 2011, with the operation and maintenance phase due to commence at the start of 2012. The facility has a pre-design capacity of 60,000 m<sup>3</sup>/day and entailed a total investment of €73 M. The plant will be operated for a 15-year term, as with the other two plants. The facility also features a number of medium-voltage frequency converters, which increase the profitability of the plant while reducing energy consumption.

Abengoa can therefore produce a grand total of over half a million cubic meters of desalinated water per day.



### R&D&I

Abengoa has a strategy centered on the development of proprietary technologies in the desalination area. It has a 3,000 m<sup>2</sup> R&D&I center at its disposal, where over 40 researchers work, including seven doctorate holders and experts in membrane technology, desalination processes and water treatment. The center offers state-of-the-art facilities, including laboratories, exhibition hall, experimentation areas and a control room, allowing the company to optimize and streamline the running of our operational plants via satellite connection.

The company is currently developing four R&D&I programs:

- Desalination program, which focuses on improving the efficiency of the reverse osmosis process while lowering associated investment, operation and maintenance costs.
- The Potabilization-Purification-Reuse program seeks to optimize membrane-based water treatment processes so as to save energy and produce less sludge, and to develop sludge treatment and elimination technologies, such as supercritical oxidation.
- Filtration membrane program, which focuses on the development of proprietary technology applied to seawater or brackish water desalination pretreatment processes; water filtration for potable use and urban and industrial wastewater treatment for water regeneration and reuse.
- Sustainability program, through which the company is developing new solutions that incorporate renewable energy sources into desalination processes.



# 06.2

## Concession-type infrastructures



Inside a pilot plant

Abengoa's main investment in desalination has therefore been in its R&D&I programs, which are key to the future growth of the company. It's also worth noting that previously committed funds were effectively invested in the companies handling the projects under concession in Algeria, India and China.

Abengoa also completed the purchase of the remaining 49 % equity stake in the Texan company NRS Consulting Engineers, in which it has held a majority stake since October 2008. The full acquisition of NRS has helped to create synergies between Abengoa and its subsidiary by fusing the capacities and experience of both companies.

# 06.2

## Concession-type infrastructures

### Cogeneration and other concessions

#### Cogeneration concessions

This section includes the company's main cogeneration plants by country:

##### Spain

- Aprofursa, Covisa and Enernova power plants

These plants generate electrical power while utilizing the resulting heat to produce water or steam. The electrical power is sold to the host industry or transmitted to the grid (market or tariff option), while the heat is used by the host industry. This kind of activity requires long-term power purchase agreements with the host industries, fuel purchase arrangements and plant operation and maintenance contracts.

Detailed below are the main characteristics of each plant:

##### ■ Aprofursa

This plant, located in Alcantarilla (Murcia), has a power output of 12.7 MW and employs a dual Deutz motor configuration.

The facility uses a heat recovery boiler to superheat exhaust gases from the diesel turbines before transferring the heat to the host factory, and generating electricity to be sold to the grid.

##### ■ Covisa

This plant, situated in Cuevas de Almanzora (Almeria), has an installed capacity of 20.7 MW and employs a set-up comprising two Wärtsilä engines.

Wartsila engine room at Covisa





# 06.2

## Concession-type infrastructures



Enernova cogeneration plant in Ayamonte (Huelva)



**Procesos Ecológicos Vilches**  
Gas drying and treatment at PEV



Turbines for the Nuevo Pemex cogeneration plant in transit

The facility utilizes the exhaust gases from the two engines to generate saturated steam and hot water in a heat recovery boiler. The heat dissipated by the engine cooling circuits is used to desalinate the water that feeds the host factory.

### ■ Enernova

This combined cycle plant, which features a LM1600 General Electric gas turbine and an Allen steam turbine, has an installed capacity of 19.6 MW and is situated in Ayamonte (Huelva).

The exhaust gases from a gas turbine generator are used to generate superheated steam in a heat recovery boiler for expansion in a steam turbine, generating electricity and thermal heat as hot water for use at the fish farm.

### ■ Procesos Ecológicos Vilches

Specialized in the recycling of livestock waste to produce fertilizer and electrical power through a slurry treatment plant (pig waste, mixed excrement, urine, water, leftover animal feed and other foreign bodies) combined with a electrical power cogeneration plant.

Although its contribution to the cogeneration business (approximately 380 MW) is relatively little, what impresses is the fact that it eliminates excess slurry, for which there is currently no other environmentally and economically viable alternative.

Business takes place in the municipality of Vilches, in the north of the province of Jaen in Andalusia. Future investments will focus on improving energy efficiency and environmental protection.

## Mexico

### ■ Abengoa Cogeneración Tabasco (ACT)

ACT is a concession engaged in efficient electricity generation, as defined by the Mexican Energy Regulation Commission (Comisión Reguladora de Energía de México). This involves producing electrical power and high-pressure steam by burning natural gas and using the resulting combustion gases to generate high-pressure superheated steam.

The company is chiefly involved in the following lines of business:

- Generating 277 MWh of electrical power to be used at various plants belonging to Petróleos Mexicanos (Pemex) and to be transported to consumer connection points by the distribution grid of the Mexican Electricity Commission (CFE).
- With the combustion gases, steam is generated and delivered (up to 800 t/h) at the Nuevo Pemex gas processing complex, owned by Pemex Gas y Petroquímica Básica, a Pemex subsidiary, and located in the municipality of Villahermosa, state of Tabasco.

The cogeneration facility is structured into two separate phases: the construction phase, which in turn comprises five stages before the plant enters service, and the operation and service delivery and acceptance phase.

# 06.2

## Concession-type infrastructures

### Other concessions

This section provides a description of Abengoa concessions other than cogeneration assets, including dams and smart buildings:

#### Spain

The company operates in the following sectors:

- Smart buildings (courthouses, penitentiaries, cultural centers, etc.).
- Hospitals.
- Rail transport.
- Power transmission lines.
- Renewable energies (photovoltaic plants, wind farms, ocean wave and tide facilities, etc.).
- Energy efficiency.

The following are prime examples of these kinds of concessions:

- Hospital Costa del Sol: the contract envisages the 40-year exploitation of the hospital building and underground parking lot. The hospital building has a floor area of 31,200 m<sup>2</sup>, while the parking lot occupies 25,500 m<sup>2</sup> (960 spaces).
- Hospital del Tajo: the contract envisages the exploitation (management and maintenance) of the hospital for a 30-year term. Gross surface area totals 58,000 m<sup>2</sup>.
- Courthouses: Abengoa owns surface rights to construct and maintain the courthouses at Olot, Cerdanyola and Santa Coloma de Gramanet, and to operate the buildings through a lease with the regional government of Catalonia. Olot courthouse (Gerona) has a gross floor area of 3,376 m<sup>2</sup>, while the courthouse at Cerdanyola del Vallés (Barcelona) has 8,288 m<sup>2</sup> and the one at Santa Coloma de Gramanet (Barcelona) 7,559 m<sup>2</sup>.
- Irrigation zone of the Navarra Canal: this concession involves exploiting the infrastructure of the irrigation zone of the Navarra Canal in relation to phase one, meaning up to the river Aragon, a tributary of the River Ebro, spanning 23,611 hm. This phase will provide service to over 6,600 irrigation subscribers from 27 municipalities, thus guaranteeing high-quality irrigation water, paving the way for a rich variety of crops and improving the competitiveness of the agricultural sector.
- Cerrato hydro power station on the Pisuerga river, Palencia: this run-of-river hydro facility can handle a flow rate of 70 m<sup>3</sup>/s through two 2,030 kVA Kaplan turbines and a further turbine that operates an environmental flow of 7 m<sup>3</sup>/s. The center has a total installed capacity of 4 MW

Cerrato hydro power station on the Pisuerga river, Palencia



# 06.2

## Concession-type infrastructures



Cerrato hydro power station on the Pisuerga river, (Palencia)



Mini hydro station sluice gate to keep water levels constant on the Aragon and Catalonia Canal.



Inside the CCMO theater

- Mini-stations along the Aragon and Catalonia irrigation canal: these stations were built to harness the hydro power of eleven rapids on a stretch of the canal as it passes through the provinces of Lerida and Huesca. At each site, the canal has been widened to allow for the construction of a parallel canal or channel to the right in order to feed the mini hydro station. After driving the turbine, the flow is fed back into the canal at the end of the rapid. The eleven stations have a combined power output of 7 MW.

### Mexico

- Centro Cultural Mexiquense de Oriente (CCMO) cultural center

Boasting a gross floor area of 35,000 m<sup>2</sup> and sitting on a 17 ha. plot of land, the center will welcome over six million local inhabitants. Its avant-garde design makes it an unmistakable local landmark with the stunning views of the Texcoco valley and the surrounding area as its backdrop.

The complex includes 8,500 m<sup>2</sup> of museums, libraries, workshop modules with over 60 classrooms intended for a range of different art-related subjects, an administrative building, auditoriums, an open-air theater, a concert hall with seating for 1,200 people, a cafeteria, a restaurant and enough parking for over 1,000 vehicles.

The customer is the Mexican Institute for Culture (Instituto Mexiquense de Cultura, IMC) and Abengoa has been entrusted with the operation of the center for 20 years. After this, the building will be handed back to the IMC in accordance with the terms of the applicable framework (projects to provide services). The buildings are fitted with cutting-edge technology to ensure optimum functioning, including the use of photovoltaic cells to generate enough power to illuminate the parking area.

- El Zapotillo aqueduct

The Mexican Water Commission (Conagua) has chosen Abengoa to build the El Zapotillo aqueduct, which will provide an efficient, sustainable and secure means of supplying drinking water to nearly one and a half million inhabitants. The proposed El Zapotillo – Los Altos de Jalisco – León Guanajuato aqueduct (Mexico) will draw water from the El Zapotillo dam and feed it to the city of León and the municipalities of Los Altos de Jalisco.

The engineering work includes the construction of 139 km of large diameter piping; pumping stations with a total installed capacity of 24,000 kW; a drinking water treatment plant of 3,800 L/s; a storage tank capable of holding 100,000 m<sup>3</sup> and a 40 km distribution circuit within the municipality of León. All to purify and transport a maximum of 5,600 L/s, of which 3,800 L will be channeled to the city of León, in Guanajuato, and the rest to the municipalities of Jalisco state.

Abengoa has been tasked with the engineering, construction, outfitting, operation and maintenance of the infrastructure. The company will operate the concession for 25 years: 3 years to start it up and the remaining 22 for operation and maintenance. Estimated revenue for the operating period exceeds \$800 M.

# 06.2

## Concession-type infrastructures

### Uruguay

- Palmatir

Construction and exploitation of the Peralta wind farm (50 MW) in Peralta, Tacuarembó (Uruguay). The farm is to be built at the start of next year, before then moving on to the operational phase.

### Brazil

- Wind farms

Secured contracts from Aneel (Brazilian Electrical Energy Agency) for three wind farms with a combined capacity of 64 MW, namely Santo Antonio Pádua, São Jorge and São Cristovão, all located in the municipality of Trairí in Ceará state (Brazil). Construction is scheduled to get under way in 2012 and Abengoa has been entrusted with the subsequent operation of the facilities.

**06.3**

Annual Report 2011 | Industrial production

This activity brings together Abengoa's high-tech businesses, including biofuels, industrial waste recycling, hydrogen, energy crops, ocean energy and solar technology development. The company enjoys a strong leadership position in these emerging industries across the geographical regions where it operates.



# 06.3

Industrial  
production

Key financial figures	2009	2010	2011	Var. 11-10 (%)
Sales (€ M)	1,542	2,250	3,136	39.4
Ebitda (€ M)	221	345	366	6.1
Ebitda margin (%)	14.3	15.3	11.7	-23.5

Key figures - Bioenergy	2009	2010	2011	Var. 11-10 (%)
Installed capacity (ML)	2,550	3,140	3,175	1.1
Annual production (ML)	1,492	2,341	2,758	17.8

Key figures - Recycling	2009	2010	2011	Var. 11-10 (%)
Installed recycling capacity (t)	1,278,300	1,489,163	1,543,300	3.6
Waste managed (Mt)	1.8	2.2	2.2	-2.5

## Our business

### Bioenergy

Over 2011, Abengoa became entrenched as one of the leading biofuel producers in Europe (1,500 ML of annual production capacity), the United States (1,440 ML) and Brazil (235 ML), making for total installed capacity of 3,175 ML.

In Europe in 2011, bioethanol prices were driven by the balance of supply and demand created by imports subject to only light tariffs. Though volatile, bioethanol prices did not follow the upward trend in the commodities market generally, owing to troubled harvests and the pressure of the global imbalance of supply and demand.

In the United States, the ethanol market started 2011 in close alignment with the pattern seen in the previous year. The industry was in a state of overcapacity and margins were pared down rigorously to maintain output. Mid-2011 saw some improvement in the balance of supply and demand, possibly as a result of a rise in demand in preparation for the summer, continued growth of 10 % blends, and the development of the export market.

In Brazil, bioethanol is sourced wholly from sugarcane. In 2011 the Brazilian market performed anomalously. Bioethanol supply dropped off throughout the year, reflecting rising sugar prices (producers prioritized and maximized sugar production) and a decline in Brazilian sugarcane output, which was 18 % down year on year. The market took in imports to meet internal demand.

High ethanol prices are expected in 2012, given that supply on the Brazilian market will continue to fall short and sugarcane output will be scant.

Since petrol prices in Brazil are artificially capped by government regulation, Brazilian bioethanol prices are driven chiefly by global demand and supply for sugar and international free trade policies. In the wake of the 2008 economic downturn, the biofuels market remains turbulent, creating both risks and opportunities for global operators. Abengoa's production and logistics know-how and its presence on several continents will garner it an attractive chance to grow.

In 2011, Abengoa began a far-reaching process of diversification and shareholder value creation by incorporating new lines of business that extract fresh value from our existing assets. As a result, it has identified opportunities to use the sugar produced at all its facilities—from cereal starch, cane sugar or lignocellulosic biomass—and ferment it to make new biofuels and bio-based products. This process begun in 2011 will support future diversification of products and the production of higher value-added compounds and fuels.

# 06.3

## Industrial production

Abengoa has set the following targets in the area of biofuels:

- To become a global benchmark in the production and commercialization of biofuels and bio-based chemicals manufactured from renewable raw materials.
- To be recognized as a leading international company in research and development, widely respected for its technological innovation in converting fermentable sugar biomass to bioethanol, biodiesel, aviation kerosene and bio-based chemicals, and adapting first-generation assets to diversify the product portfolio.
- To provide an optimal work environment to attract the best possible human talent and maintain operational excellence.
- To attract the interest and win the respect of the financial community through sustained growth and technological innovation.

Abengoa, with operations in the area of biofuels in five countries on three different continents, currently owns fourteen plants for producing bioethanol and other process-related coproducts, along with a biodiesel production plant, distributed as follows:

- Europe (Spain, France and the Netherlands);
- North America (United States), and
- Latin America (Brazil).

These plants cater to the demands of global bioethanol markets from practically any corner of the world. Most sales stem from current producer countries, as well as Germany, the United Kingdom, Scandinavia, Italy and South Asia.

Abengoa seeks out growth by consolidating operations in all business areas, investing continuously in technology to streamline production and sales processes, and developing new biofuel and bio-based chemicals production technologies that enable the company to use sustainable raw materials and thus curb greenhouse gas (GHG) emissions.

Activities adhere to best industrial practices. The company has been striving for many years to obtain sustainable raw materials and produce sustainable products so as to make sustainability the cornerstone of its business. This commitment to the environment is beginning to make itself felt in society, and most governments are now addressing this overriding concern through legislative change.

The strategic plan explores the impact that sustainability can have on the company, based on the information provided by market reports or internal reports.



# 06.3

## Industrial production

The main objective for 2012 and subsequent years is to continue performing all activities in accordance with best practices in terms of risk management and process efficiency and making sustainability an absolute priority.

A key objective will be to consolidate production and sales. The company's global presence will enable it to harness arbitrage opportunities that are sure to arise on the markets. In 2012, the company will continue to focus on quality, measured in terms of sustainability ahead of quantity. The company's main concerns will be to improve the sustainability of all production assets, to consolidate operations at the latest plants to have been commissioned, and to continue construction of a second-generation bioethanol plant in Hugoton, United States.

### Recycling business

Despite the tough prevailing economic climate, the recycling market continues to evolve steadily, driven by increased regulatory pressure and rising environmental awareness at the global scale. World population increase is another growth vector for the industry.

Business has gradually improved over the course of 2011 and is set to grow further in the coming years.

Abengoa provides innovative and technologically viable solutions for industrial waste recycling, and aims to become a world benchmark in this sector, while helping to forge a more sustainable world. This commitment is reflected in its lines of business:

#### ■ Steel and galvanization waste recycling:

- Manages common steel and stainless steel waste, as well as waste from the galvanization process by recycling a variety of metals, doing away with the need to dump them and minimizing the requirement for further mining. The company is the European leader in steel waste recycling.
- Offers the iron and steel industry high value-added environmental services through the treatment and valorization of the residual dust generated from both common and special steel production processes, as well as other waste containing zinc from the steel galvanization sector.

View of a zinc furnace in Amorebieta



# 06.3

## Industrial production



Waelz furnace  
in Erandio (Spain)

### ■ Aluminum waste and salt slag recycling:

- With its Europe-wide waste and raw material procurement network, Abengoa is one of the European leaders in primary aluminum production waste recycling, having an annual capacity of 225,000 t distributed across three recycling plants. Abengoa can use any aluminum-content waste to produce new alloys without generating any new waste in the process, thus fully closing out the cycle.
- As regards spent pot lining (SPL) and salt slag recycling, Abengoa boasts an annual capacity of 630,000 t, distributed over five sites. This figure can be seen to be particularly significant when viewed in the context of the fact that the total European salt slag market is approximately 1 Mt.
- Abengoa is the world leader in selling related machinery and technology, such as ingot conveyor belts.



Filling ingot molds  
at an aluminum plant

### Industrial Waste Management:

In this area —embracing the group's industrial waste management businesses in Spain and Latin America, sulfur recovery and plastics and PCB management— Abengoa:

- Manages, transports, treats and temporarily stores hazardous and non-hazardous industrial waste for valorization, recovery, reuse or eventual controlled disposal.
- Designs and builds infrastructures for safe, efficient and environmentally friendly waste management.
- Recovers wastes generated by the petrochemical industry by applying a clean, safe process, thus providing solutions to the environmental issues raised by oil companies' sulfur wastes. The process produces sulfuric acid and oleum (a compound rich in  $\text{SO}_3$ ) for subsequent commercialization.
- Abengoa manufactures special low density polyethylene pellets by recycling film used as greenhouse covering.
- The company collects, transports and disposes of transformers, condensers and materials contaminated with PCB (polychlorinated biphenyls).



Aluminum leaves facility in  
Las Franquesas del Vallés (Spain)



# 06.3

## Industrial production



Abengoa facilities in Lünen,  
Germany



Waste management facilities  
in Ajalvir, Spain

Abengoa aspires to become a world leader in industrial waste recycling and management, thus contributing to sustainable development.

Within the industrial production segment, the company has a strong international presence, with recycling businesses in 11 countries and operating out of numerous sites in Europe, Turkey and Latin America. Its ambitious strategic plan combines organic and inorganic growth to continue to gain size in the markets where it operates.

In the steel recycling business, strategy focuses on entrenching the company's present European leadership by diversifying markets and entering other regions, thus supporting international expansion.

In addition, forthcoming operational improvements will sharpen Abengoa's competitive edge in important ways.

Growth strategy in the aluminum recycling business area envisages organic growth in Central Europe and international expansion in the salt slag, SPL and other waste businesses, thus promoting the company from European leader to worldwide benchmark.

In industrial waste management, efforts will focus on growth, with a research emphasis on recovery/value extraction for biofuels and bioplastics production.



Abengoa crystallizers  
in Valladolid, Spain

# 06.3

## Industrial production

Abengoa's business is based on sustainable development, around which its activities and strategies revolve. Through this business model, Abengoa's activities are aimed at:

- Developing sustainable solutions for managing industrial waste while fully respecting and preserving the environment.
- Reintroducing secondary raw materials into productive cycles.
- Waste-free production.
- Offering a new range of waste treatment services for industry.



Bilbao engineering faculty students  
visit facilities in Erandio (Spain)



Abengoa facilities  
in Iskenderun, Turkey

For 2012, Abengoa's strategic objectives in the area of industrial waste recycling are to:

- Entrench its leadership position in the European steel waste recycling market by continuing to execute its strategic plan, which stipulates the development of new capabilities in Europe and Turkey, where we now have a presence.
- Develop the steel waste recycling business in new regions of Southeast Asia, which offer attractive opportunities.
- Achieve organic growth in Europe in the steel waste recycling business by leveraging its leadership position and capabilities in salt slag treatment.
- Move forward with developing the salt slag business in the United States and the Middle East, where we already have some projects under development.
- Make significant R&D progress in the industrial waste management business unit, with a focus on urban waste treatment to produce biofuels.

Abengoa will also remain vigilant throughout 2012 for possible opportunities for inorganic growth, particularly in the steel and aluminum waste recycling sectors.

# 06.3

Industrial  
production

## Solar power

In addition to the energy development and sales concession business, Abengoa develops groundbreaking solar technologies within a global market offering huge growth potential.

Due to its ongoing efforts in research and development, the company has proprietary technology which places it at the forefront of solar technologies able to generate clean and efficient power. The objective is to lower the cost of solar power so as to quickly become competitive with fossil fuels, while taking the cost of emissions into consideration.

In the industrial production segment, Abengoa's business focuses on the development of new technologies through research, development and innovation, and the manufacture and sale of key components for solar thermal and photovoltaic plants. In addition, Abengoa provides industrial systems based on solar thermal or photovoltaic technology to generate industrial steam and electricity at industrial facilities.

Abengoa conducts research, development and innovation in Spain and the United States:

**Spain:** Solucar complex in Seville, with pilot plants under construction and in operation.

**United States:** Denver, with an R&D center.

Since the inception of the solar business, Abengoa has acquired a wealth of experience along the different stages of the solar thermal business value chain. This vertical integration enables Abengoa to achieve synergies between the activities of development, operation and technology, such as designing optimal solutions, controlling key components and their supply, and enhancing cost competitiveness.

In 2012, an increasingly competitive environment will mean that Abengoa will continue to pursue innovation in its priority solar technologies to retain its industry leadership and its edge over the competitors. The company will continue its ongoing collaboration with leading research institutions to lower costs and raise the efficiency of its products.

## Hydrogen, energy crops and ocean energy divisions

### Hydrogen business

The current energy paradigm, in which fossil fuel use predominates, is wholly unsustainable. The use of hydrogen as an energy vector effectively resolves many of the issues we now face, and all the more so if obtained from renewable sources. Hydrogen power supports local economies, creates jobs, improves the balance of payments, assures security of supply, and is clean to produce and use.

Abengoa provides hydrogen- and fuel cell-based solutions for niche markets where demand for the benefits of this fuel is already on the rise, and develops solutions for the future Hydrogen Economy.

Abengoa seeks to become a world benchmark for hydrogen- and fuel cell-based solutions as a necessary link in achieving a sustainable energy paradigm.

Operating from its headquarters in Seville, Spain, the company's activities include electricity and heat production using fuel cells in their various technological implementations, hydrogen production from renewable sources, and clean, efficient hydrogen use.

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Its business is diversified across a range of high-potential segments. The division's strong research and development investment and the experience it has amassed in developing this technology over the years stand surety for stable and positive future growth. Abengoa Hydrogen is a key player in the hydrogen and fuel cell market in Spain and internationally, favoring synergies among industry players and the spread of this breed of new technologies.

### Energy crops

The international biomass market is undergoing a sea-change, driven by the shift in the world energy pattern brought about by the search for new, sustainable energy sources and the concern to reduce CO<sub>2</sub> emissions.

In 2011, volume delivered to the market was very strong compared to previous years, and the upward trend in prices held steady.

This scenario, combined with biomass scarcity in the developed world, has led to increased biomass exports from innate producer regions, where energy plantations are beginning to entrench their position as the go-to sources for covering the expected rising demand of the coming years. These factors have prompted Abengoa to look to this market as one of the arenas in which it can develop new businesses, and, recently, to create a specific business unit for energy crops, which mission is to create and integrate expertise on biotechnology, agricultural engineering and logistics to achieve competitive advantages in the sustainable production of selected biomass as "bespoke" input material for various energy industries.

Abengoa aims to become a reference in the management of forest biomass in the areas of production, processing and use of biomass as an industrial input by deploying innovative solutions that support sustainable development.

In furtherance of its strategy in energy crops, Abengoa has incorporated new lines of business relating to:

- Energy crop research, development and innovation,
- Biomass base access, and
- Development of biomass processing industries.

The energy crops business unit is present in two geographical regions:

- Uruguay: operating in the forest biomass industry since 1996.
- Brazil: permanent establishment in 2011 to implement energy crop projects and biomass trading.

Abengoa's approach is to achieve integration at the global scale of the sustainable production of energy crops as an input material for a wide range of industries. The company is developing innovative science and technology platforms driven by human resources specializing in a diverse spectrum of fields: genetic improvement, biotechnology, biocomputing, agricultural engineering and industrial engineering.

The company's key marketing strategy is to develop and implement turnkey solutions for the sustainable supply of biomass from producer regions to a diverse range of biomass-based industries. These bio-based industries are located in a variety of geographical regions, and cater for local and international markets.

One of the challenges the new business unit faces is to attract fresh talent and grow the existing structure, which embraces a wide gamut of special fields, ranging from machinery operators to biotechnologists, engineers, biocomputing engineers, agricultural engineers and economists.



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Abengoa's strategic planning in this area benefits from input from the technology teams working on research, development and innovation and biomass access for the company's various industrial projects.

Their analysis and the data outlined above serve as the basis for specifying the company's desired positioning in the coming years. AEC will seek to secure the required science and technology expertise to implement and manage efficient energy crop plantations and so pave the way to the growth of sustainable bioenergy products by entering a range of high-value markets.

2012 objectives:

- Production of forest biomass for energy purposes in Uruguay.
- Installation of plantations for biomass production in Brazil.
- Development of energy crop projects at the global scale.

## Ocean energy

The term "ocean energy" means electricity generation by devices making use of the various forms of energy offered by the world's oceans: waves, tides (currents), tides (tide-mark differences), thermal gradient, saline gradient.

Although the ocean energy industry as a whole is still immature, wave and tidal energy are somewhat more developed.

The technical potential for electricity generation is vast: an estimated 90,000 TWh/year (EU-EAO, 2008). According to International Energy Agency projections, installed capacity by 2035 will come to 17 GW worldwide. In Europe, against the backdrop of achieving the targets under the Renewable Energy Directive 20/20, the various countries with ocean resources have already published their individual targets for 2020. The United Kingdom intends to install 2,000 MW; France, 1,000 MW; Ireland, Portugal and Denmark, 500 MW each; and Spain, 100 MW.

The industry's present challenge is to move past the pilot/demonstration phase. Next, rapid progress should be made in the experience curve of the commercial phase so as to produce electricity at a cost that competes realistically with conventional energy sources and more mature renewable energies, such as solar and wind power.

In addition to the challenges facing all renewable energy sources (investment per MW, efficiency ratios), ocean energy is especially concerned with the issues surrounding survival in the aggressive environment of the sea and the operation and maintenance costs that this entails.

In the ocean energy sector, Abengoa's goal is to cover the entire value chain (technology, development, financing, engineering, construction, operation and maintenance) on ocean energy generation farms using hydrokinetic resources (wave and ocean current power).

Abengoa aims to become a world leader, using proprietary technology, in the development, construction and operation of ocean energy generation farms.

The ocean energy business is currently structured into three activities: R&D, Engineering/EPC, and Development.

The ocean energy division has its headquarters in Spain and is present —directly or via alliances with partners— in the United Kingdom, Ireland and the United States.

Today, solid foundations are already in place for Abengoa to build and grow its ocean energy division:

- The high availability of marine resources worldwide is already reflected in quantitative targets for 2020 and 2035, as outlined earlier.

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- Ocean energy is an emerging industry in which new entrants like Abengoa can still gain a strong foothold.
- Abengoa's has strong capabilities —as already demonstrated in other business areas, such as solar power, desalination, transmission— in asset development, financing, construction and operation.
- Talent, processes and R&D culture.
- Abengoa's ability to enter into the necessary alliances with top echelon partners.

2012 will be a key year in the development of Abengoa's new ocean energy business. Recruitment will be completed for the company's initial organizational structure, and technological/strategic projects and alliances will lay the foundations for:

- Developing proprietary technology according to the specified roadmap.
- Developing proprietary engineering/EPC capabilities in the context of real pilot/ demonstration phase projects.
- Developing a pipeline of in-company projects via first time exploration.

## 2011 in review

### Biofuels

At present, Abengoa ranks as one of the leading biofuel producers in Europe, the United States and Brazil, with an annual production capacity of 3,175 ML.

The bioenergy business unit is currently reporting excellent levels of business, reflecting its standing as one of the world's leading bioethanol producers and marketers. Production at existing plants is living up to the company's full possibilities, and the forthcoming plant at Hugoton, United States, will further strengthen the company's critical mass.

After ten years of developing technology to convert lignocellulosic biomass into fermentable sugars for subsequent processing into bioethanol, in September 2011 Abengoa started to build the world's first commercial plant specified to process various agricultural wastes and energy crops into biofuels. With this milestone, after five years of implementing the various phases of the project, the company has proven its world leadership in this promising industry. The plant is expected to be fully operational within the first half of 2013. This will be the world's first second-generation plant and the company's seventh bioethanol plant in the United States, so bringing Abengoa's total biofuel output in the US to over 1,500 ML.

There is now a clear need for a change of practices and policies and various governments have already begun to act accordingly. Business performance depends largely on favorable legislation that facilitates the development of new technologies while enabling biofuel culture to expand and combat the obvious signs of climate change.

Legislation aimed at combating climate change has been a key aspect on the agenda of the US government over 2009 and 2010. The main objective is to reduce the GHG emissions generated by the transportation fuel sector. The main act currently championing the development of the bioethanol sector, and underpinning the RFS (Renewable Fuel Standards) and the rules and regulations governing production and biofuel implementation requirements, is the Energy Independence and Security Act, which was approved in 2007 and enacted in 2010.

Two new legislative acts were enacted on June 25, 2009 in order to consolidate and kick-start the biofuel market over the coming ten-year horizon. European Directive 2008/28/ EC on renewable energy sources dictates that at least 10 % of transportation fuel within EU member states must be produced from renewable energies by 2020. The amendments

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made to Directive 2009/30/EC on fuel quality include an additional incentive for using biofuels by ushering in a compulsory reduction in greenhouse gas emissions during gasoline and diesel life cycles between 2011 and 2010.

Abengoa has developed a sustainability certification standard, RED Bioenergy Sustainability Assurance (RBSA). Specified in accordance with the Renewable Energy Directive and adopted by the European Commission, the standard enables certification candidates to demonstrate compliance with the sustainability requirements under the Directive as regards any input material or production process, from agricultural production through to marketing of the biofuel, including industrial processing stages. The European Commission's endorsement of RBSA certification is proof of the excellence of Abengoa's sustainability and environmental conservation initiatives in its biofuel production processes.

On January 21, 2011, the Environmental Protection Agency (EPA) approved the use of 15 % ethanol (e15) blends in light motor vehicles manufactured in or after 2001. Various regulatory issues remain to be resolved for e15 to be permitted throughout the country, but this approval constitutes a major step forward for the ethanol industry by creating a market beyond 10 % blends.

Against this backdrop, Abengoa has managed to harness the existing legislative framework and the biofuel markets, and has likewise been able to roll out its expansion plans over 2011, reinforcing the bioethanol and biodiesel projects initiated in previous years in Europe, the United States and Brazil, as well as cogeneration projects in Brazil to increase the overall performance of the plants already operating within the country.

For Abengoa, 2011 was a year of growth, with a wealth of success stories reported in the United States, Europe and Brazil. All objectives were met, while exploring new paths to expansion and market penetration:

- Started construction on the world's first second-generation (2G) commercial plant in Hugoton, Kansas, which uses lignocellulosic biomass to obtain sugars, which are then fermented into ethanol.
- Obtained federal loan guarantee worth \$132.4 M from the US Department of Energy for construction of the Hugoton plant.
- Hugoton plant gained backing from the US Department of Agriculture (USDA) to increase availability of non-food crops for biofuel production.
- Commissioning with total loading of a plant in Portales, NM, capable of producing 115 ML of bioethanol annually.
- Operations firmly established at the Europoort, Rotterdam, Netherlands.
- Operations firmly established at the two cogeneration facilities in Brazil, with a combined installed capacity of 140 MW.
- Started expansion of sugar cane milling capacity at the São Luiz plant, boosted from 2.8 Mt to 3.5 Mt annually.
- Houston, Texas terminal storage capacity increased to 13 ML.
- Abengoa increased ethanol and DGS (distilled grain soluble) export activity by barge along the Mississippi and Ohio rivers.
- Increased direct DGS sales to global markets.
- Promoted and expanded a network of direct blend (e5, e10 and e85) biofuel service stations in Spain, which already boasts 30 distribution points and has distributed 900,000 L.
- Reached agreement to sell 65,000 t of CO<sub>2</sub> produced to Messer in France.
- Started scaling and commercial-scale pre-production of enzymes at the lignocellulosic biomass plant at Babilafuente, Salamanca.

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- Completed Cenit I+DEA project after four years of work.
- Abengoa's biofuels sustainability standard (RBSA) approved by the European Commission.
- 100 % of bioethanol deliveries supported by certification to Abengoa's biofuels sustainability standard (RBSA).
- First sustainability certificate awarded to an agricultural production chain under Abengoa's RBSA standard.
- Started construction of the Ecoalga project experimental plant.
- Launched the BIOFAT technology demonstration project to produce biofuels from micro algae.
- Staged the 10th World Biofuels Conference.
- Biomass seminar staged at the new Hugoton biomass plant.
- Abengoa's Brazilian subsidiary certifies to SA 8000 international social accountability standard.
- Abengoa's European trading subsidiary secured ISO 9001, ISO 14001 and OHSAS 18001 certification.
- Indiana and Illinois plants secured ISO 9001, ISO 14001 and OHSAS 18001 certification.
- ISO 14001 and OHSAS 18001 certification awarded for the cogeneration processes at the São Luiz and São João plants.

## Recycling

In 2011 Abengoa maintained strong volumes across its various business units.

The steel waste recycling division treated a total of 633,118 dry tons (t) of iron and steel dust with zinc and other metals content, of which 544,460 t came from common steel manufacturing in Europe and Turkey, while the remaining 88,658 t were collected from the main stainless steel production centers in Europe and South Africa. In addition, 16,234 t of galvanization waste was recycled.

The company's growth strategy of capacity increases and geographical expansion led to the construction of a Waelz Oxide washing plant in Gravelines, France, which will have a nominal annual treatment capacity of 100,000 t. The facility, scheduled to come online in the first half of 2012, will cover the production washing needs of the French and German Waelz plants.



Computer visualization  
of the future Waelz Oxide washing  
plant at Gravelines,  
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Moreover, after obtaining an Integrated Environmental Authorization in April, in late 2011 urbanization work began at the site of the future steel dust recycling plant at Villafranca de los Barros (Badajoz), with capacity to process 110,000 t annually. Construction is scheduled for completion by mid-2013.

Permits were obtained for building a Waelz Oxide washing facility at the Port of Bilbao —the Gravelines project's sister installation— which will purify the output of the Erandio and Extremadura plants.

In 2011, the aluminum recycling segment processed spent potlining (SPL) waste to provide large producers with a one-stop and hitherto unavailable definitive waste recovery solution.

Abengoa held its leading position in Spain's industrial waste recycling sector, managing 768,202 t of industrial waste, 13 % of which corresponded to recycled industrial waste, versus 10 % last year.

In late 2011, commissioning work began on a new sulfur waste recovery plant, which will provide major environmental improvements in all fields. The facility is equipped with the latest and most efficient technologies, many of which qualify as best available techniques according to the applicable BREF.

The new facility at Bilbao Port in the Zierbena district (Biscay, Spain) will be able to treat 120,000 t of sulfur while producing 350,000 t of sulfuric acid and oleum, effectively meaning it will be able to generate roughly 90,000 MWh per year of electricity.

Aerial view of the new sulfur  
recovery plant in the Port of Bilbao  
(Zierbena, Spain)



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Hazardous waste landfill site in  
Antofagasta, Chile

In the industrial wastes segment in Latin America, Abengoa started up the country's first commercial incinerator, which is capable of treating 800 t/year of inflammable and hospital waste. In Chile, work was completed on the second hazardous waste landfill site, which will be able to store 64,000 m<sup>3</sup> of the material. In Mexico, Abengoa has secured a remediation project, entailing the management of over 25,000 t.



## Solar power

In 2011, Abengoa continued to showcase and consolidate its international leadership in the solar power sector, climbing to 443 MW in operation, 1,060 MW under construction and 150 MW at the pre-construction or advanced development stage; what is more, Abengoa started work on two innovative plants offering viable, efficient solutions going forward.

In Spain, at the Solucar complex, Abengoa continues to develop demonstration plants for various thermal and photovoltaic technologies, reinforcing its status as a reference for the world.

Highlights were:

- The construction of the Solugas project, a pilot tower plant using hybrid solar/gas technology. This plant will go into operation in 2012. The purpose is to demonstrate the performance of the towers at high temperatures, using air as the heat transfer fluid and a gas-cycle instead of the steam-cycle.
- The CRS Sales project, which is under construction and will come online in 2012, testing the engineering and manufacturing of the solar power receptor prototype that uses a mixture of molten salts as the heat transfer fluid.
- Other projects, improving the operational efficiency of the direct steam generation parabolic trough plant and the continual validation of the thermal storage technology with molten salts.

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In the United States, research projects are underway such as the development of new heat transfer fluids (HTF) and the design of new parabolic trough technology structures.

Abengoa's structure manufacturing plants have supplied parabolic trough collectors for the Ecija, El Carpio, Castilla-La Mancha and Extremadura solar complex plants in Spain, Shams-1 in Abu Dhabi, Hassi R'Mel in Algeria, and Ain Beni Mathar in Morocco. Structure supply has been started for the Solana plant in the United States.

Throughout 2011, as a result of exclusive research and development completed by Abengoa over the course of several years, the high concentration photovoltaic (HCPV) module reached the market. This technology achieves 29 % efficiency.

In the field of industrial facilities, Abengoa has successfully designed and engineered the world's largest industrial steam system. Located in Antofagasta, Chile, the plant will have a maximum capacity of 10 MW. The company also constructed a solar thermal plant, to supply hot water, on a plot of land lying adjacent to the Kraft Foods facilities in Brazil, along with a small demonstration plant at Red River College of Applied Arts, Science and Technology in Winnipeg, Canada, and two 40 kW rooftop photovoltaic systems at various premises of the company Cummins Power Generation in Fridley and Shoreview, Minnesota.

High-concentration photovoltaic  
(HCPV) module



## Hydrogen, energy crops and ocean energy

### Hydrogen business

Against the background of society's increasing interest in renewable energy and environmental conservation, Abengoa's research, development and innovation seeks to create new energy technologies based on the pairing of hydrogen and fuel cells. The company is therefore pursuing projects leading to concrete outcomes as to the technical and economic viability of hydrogen as a sustainable fuel.

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A highlight project in 2011 was the continuation of the engineering and supply work for Navantia within the framework of the Air-Independent Propulsion System (AIP) for the S-80 submarines which the Navantia shipyard is constructing for the Spanish Navy. Over the year, the research division delivered the first units of the bioethanol processor (which uses this biofuel to produce hydrogen for the submersible), the power adjustment system (which adjusts the power produced by the fuel cell) and the AIP control system (which controls the functioning of all devices involved), and testing began on all three systems.

A particular highlight in December 2011 was the signing of an MoU (Memorandum of Understanding) and a collaboration agreement with the North American company FuelCell Energy, Inc. for the joint development of molten carbonate fuel cell technology and the construction of cogeneration plants based on these devices.

### Energy crops

Research, development and innovation activities for biotechnology-supported biomass production are underway initially in Uruguay; they are set to start in Brazil shortly, and other countries are being considered for further expansion.

The unit aims to develop technological solutions that allow for productive and economic integration among:

- New, sustainably managed forest crops.
- Socially high-yielding afforestation and reforestation projects.
- (Existing and planned) biomass-based industrial plants.
- Global market in solid biofuels and cellulosic materials.

The expected contributions of research to the industrial value chain include:

- Steps prior to biomass processing, where the aim is to improve energy crop sustainability by emphasizing: characterizing the productive potential and fitness of biomass, securing sustainable supply for various industries, incorporating biotechnologies to production processes.
- Steps subsequent to biomass processing, where the aim is to develop technologies in support of identifying sustainable industrial bio-based products, with high potential for applications (process control, quality assurance, market positioning, etc.).

At year-end, Abengoa signed a contract with Schandy to operate the Montes del Plata lumber terminals at the cellulose plant currently under construction in Uruguay. The seven-year agreement is for \$8 M a year and requires an investment in equipment and machinery approaching \$20 M.

### Ocean energy

In 2011, the ocean energy business emerged as one of Abengoa's strategic undertakings for the coming years. Reaping the benefits of the installations business three years ago, Abengoa has strongly bolstered this division by assigning it increased human resources and funding and raising its profile as a first step of a long-term strategy.

In this connection, it is worth highlighting:

- Cooperation agreement signed with the Irish company Wavebob Ltd. to research, develop and commercialize wave energy generation systems.
- Implementation of several lines of research —oscillating water column, point absorber, etc.— via various R&D programs.
- Abengoa coordinates the Ocean Energy Forum of the Spanish Maritime Technology Platform, alongside Iberdrola and APPA. In addition, Abengoa is the deputy chair of



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the Technical Committee for Electricity Production Standardization AEN/CTN206/SC114 "Ocean Energies: Waves and Currents Energy Converters"

- Abengoa is a member of the marine section of APPA (the Spanish association of renewable energy producers), the European Ocean Energy Association (EU-OEA) and OREC, the US Ocean Renewable Energy Coalition.

## Our activities

### Biofuels

Abengoa remains a benchmark company in the development of new technologies geared towards the production of biofuels and bio-based chemicals and the sustainability of raw materials, channeling to such end a tremendous amount of resources into research. In addition, its trading division means that the company is a service provider capable of offering global solutions, with an impressive capacity for marketing and managing commodities, reliably backed by its global production and raw material procurement capacities and highly efficient operations – cornerstones that afford reliability and critical mass, which are key to optimum business development.

Abengoa's winning combination of international marketing capacities with cellulosic bioethanol technology, coupled with agricultural, productive and local marketing capacities, gives rise to key synergies that will enable the company to post significant growth in the global ethanol market while obtaining the technology to cut the cost per liter of ethanol.

Abengoa contributes to sustainable development in the area of biofuels by marketing fuel compounds obtained from renewable sources (biofuels) through the use of environmentally friendly technologies that help to bring about a net reduction in polluting emissions, for use in both public transportation and private vehicles.

Also, the company creates new opportunities for sustainable rural development by providing incentives for energy crops and the creation of farming industries, thus helping to maintain employment and income levels in rural areas.

Bioethanol and biodiesel are renewable and clean energy sources which, for some time now, have proved to be a reliable and credible replacement for gasoline and diesel fuel in vehicle engines, while also helping to diversify and improve the security of the energy supply. Their use, either in a pure state or blended with fossil fuels, reduces CO<sub>2</sub> emissions, slows down climate change, and reduces the emission of polluting agents into the environment.

The company's activities in biofuels can be grouped into six main areas:

- Procurement of raw materials.
- Bioethanol origination.
- Production.
- Bioethanol, DGS and sugar trading.
- Cogeneration
- New technologies.

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## Procurement of raw materials

One of the driving forces behind the positive business results reported by the bioenergy business unit is the procurement of raw materials for producing biofuels.

As it currently stands, the most important grain cereals for the production of bioethanol at Abengoa's plants are wheat, barley, corn and sorghum, not only due to their alcohol yield, but also their significant protein yield, highly valued in the livestock feed sector (DGS). For biodiesel production, the most frequently used oils are soybean and palm.

Since operations began, Abengoa has managed to build up a wealth of experience in both the supply and logistics of commodities. It has displayed great prowess and versatility both on the international stage and when purchasing within the domestic market, and has also secured direct supply agreements with farmers, thus ensuring that the group's plants have the volume of materials they require. Similarly, the company has in-depth knowledge of all applicable rules and regulations governing operations in the European Union and North America.

In Brazil, Abengoa grows sugarcane while ensuring sustainable rural development, biodiversity and regional economic growth ensuring that the company's production plants are properly supplied by signing contracts with landowners, carrying out the necessary work for combined use of the land, and with farmers, by providing the necessary resources and advice in order start up production.

Abengoa has developed internal capabilities enabling it to diversify raw material procurement for its 2G plant in Hugoton. The plant will supply itself with agricultural wastes having no present value for farmers and other energy crops growing in hitherto untended marginal areas.

## Bioethanol origination

In addition to Abengoa's bioethanol production capacity, which is marketed by the trading companies, the latter also carry out bioethanol origination from third-party producers to add this product to the pool, thus allowing for greater flexibility and competitiveness in terms of the customer portfolio.

## Production

Bioethanol is produced in plants across Europe, the United States and Brazil. Obtained from cereal grains through chemical processes and treatment, bioethanol is used as a vehicle fuel to produce either ETBE (a component of all types of gasoline), or for direct blending with gasoline in varying proportions, the most widespread being e85, e15, e10 and e5 (gasoline with bioethanol percentages of 85, 15, 10, and 5 %, respectively).

A coproduct of the cereal-based bioethanol manufacturing process is DGS, a high-protein compound obtained by extracting starch from cereal grains that is ideal for producing livestock feed.

As a coproduct from the process of bioethanol production from sugarcane, sugarcane bagasse is obtained, and used as fuel in cogeneration plants annexed to the bioethanol production facilities.

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## Bioethanol, DGS and sugar trading

Abengoa has operations in key locations for worldwide bioethanol trading and exports, namely Rotterdam (Holland), affording immediate access to the Europort; St. Louis, Missouri (U.S.), right in the heart of the country's main cereal production and cattle breeding region; and in São Paulo (Brazil), the birthplace of bioethanol-from-sugarcane production. Through all these facilities, Abengoa is able to meet the bioethanol, DGS and sugar demands of the European, United States, and Brazilian markets.

Market fluctuations, prevailing political conditions throughout the different territories and other factors affecting operations, in terms of procuring raw materials and producing the products to be commercialized, are all carefully analyzed from a global standpoint in order to afford us a better vision of the global market. Meticulous analysis and risk management improve the performance of corporate processes, always within the context of sustainable development, and respect for the environment, human rights and the community remains one of the company's guiding principles. Abengoa is able to optimize supply to the various markets by arbitrating exports and imports, thus offering its customers the option of selecting the solution best tailored to their needs by providing the necessary reliability and flexibility throughout its bioethanol supply process.

## Cogeneration

Some of the current bioethanol production facilities are equipped with cogeneration systems that use natural gas or sugarcane bagasse to generate the steam and electricity required to operate the plants. At present, the cogeneration systems mounted at the plants in Spain, Netherlands and Brazil produce more than enough electricity to meet the needs of the plants themselves. The surplus electricity is fed back into the power grids of the country in question, further enhancing the profitability and sustainability of the facilities.

## New technologies

Abengoa aims to become a leading figure within the biofuels sector, create sustainable solutions for the transportation sector, and develop bio-based chemicals derived from renewable raw materials. The company's activities in this area focus on developing biofuel and bio-based chemical production technologies that use renewable raw materials, including cereal grains, sugarcane, energy crops and agricultural wastes (lignocellulosic biomass).

The company has pilot facilities (0.4 ML annual capacity) in York, Nebraska, and demonstration plants (5 ML annual capacity) in Babilafuente, Salamanca, Spain, as well as biochemical and molecular biology laboratories in Babilafuente and Seville and a laboratory equipped with bench-scale facilities at the University of Seville for testing and improving catalyzers.

In Europe, the company's activities are supported by European Commission grants within the framework programs (Abengoa ranks sixteenth in terms of funds received under the Seventh Framework Program), the Government of Spain under various programs, and a range of local entities.

This support demonstrates the high quality of the company's research and development programs, since mandatory third-party assessment reveals that Abengoa's research performance is excellent.

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### Projects by territory

#### Europe

Abengoa is the European leader in bioethanol production for use as a vehicle fuel. The company currently operates three plants in Spain: in Murcia, Salamanca and La Coruña, and has a yearly production capacity of 545 ML. In addition it operates a biodiesel production plant in San Roque, with a production capacity of 225 ML per year. Abengoa has, furthermore, firmly established the operations of its bioethanol plant in France, with a production capacity of 250 ML per year.



Abengoa's plant at the Europoort,  
Rotterdam, Netherlands

Having begun operations in 2010, Abengoa's plant at the Europoort, Rotterdam, Europe's largest bioethanol plant and one of the largest in the world, with an annual grain-to-bioethanol production capacity of 480 ML. Apart from bioethanol, the Europoort plant has an annual DGS and high-quality CO<sub>2</sub> production capacity of 360,000 t and 400,000 t, respectively. The CO<sub>2</sub> is transported through pipelines to the various greenhouses in the region and is used to help grow crops, thus reducing reliance on natural gas, enhancing sustainability and cutting total GHG emissions.

Moreover, over the course of 2011 Abengoa continued to operate its second-generation bioethanol plant at Babilafuente, Salamanca, Spain. With an annual production capacity of 5 ML of bioethanol from lignocellulosic biomass, this is the



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world's first plant to utilize this technology on such a scale.

Since start-up, the Babilafuente demonstration plant has completed over 7,000 hours of operation achieving a yield in excess of 250 L per ton of straw; the target is to exceed a yield of more than 300 L per ton. These results are demonstrating the viability of enzymatic hydrolysis technology, which the company has been developing and strongly investing in for some time.

The Babilafuente plant is also carrying out the scaling and industrial production of enzymes using an organism licensed from Dyadic International, a US company that owns industrial enzyme production technologies for cellulose hydrolysis. About 120 t of enzymes in two batches were successfully produced. The properties of the resulting cocktail are analogous to those of the best experiments performed at the laboratory-scale trial phase.

In addition to marketing bioethanol, Abengoa continued work over 2011 on an e85 (bioethanol 85 %, gasoline 15 %) supply network in Europe, primarily in Spain, where it already has over thirty publicly accessible service stations and several fleet supply points, and has sold over 900,000 L of e85. This network is key to expanding the reach of bioethanol, and although the project is still in its early stages, it promises to become an undisputed reality within the next few years, capable of supplying biofuels to consumers across Europe.

Abengoa has signed in France an agreement with the gas producer and supplier Messer for the sale of 65,000 annual t of CO<sub>2</sub> generated at the Lacq bioethanol production plant, France, during the cereal grain fermentation process. The agreement provides that Messer is to build a CO<sub>2</sub> purification, liquefaction and storage facility annexed to the Porte d'Abidos (Lacq) bioethanol plant. The Messer group will use the CO<sub>2</sub> for various industrial applications: chemicals, food, etc. With this initiative, the plant will reduce greenhouse gas emissions by 18 %, so total emissions savings will exceed 70 % in 2012, once the new facility is in operation. The installation will constitute an important milestone, being the first of its kind in the area, and will significantly bolster the Lacq industrial estate where it is to be located, and favor the rise of innovative projects that will nurture the emergence of new local industrial tissue.

The Cenit I+DEA project, led by Abengoa, is scheduled for completion after 4 years of work. The project brings together 25 companies and 27 research centers and has a total budget of over €27 M. The project scope embraces the entire bioethanol cycle, from raw material production to biotechnology developments (energy crops and enzymes) and processing technologies, through to bioethanol use in combustion engines.

The RED Bioenergy Sustainability Assurance (RBSA) certification standard developed by Abengoa was adopted in July 2011 by the European Commission (EC) in the first decision of its kind taken by Brussels.

Specified in accordance with the Renewable Energy Directive, the RBSA standard enables certification candidates to demonstrate compliance with the sustainability requirements under the Directive as regards any input material or production process, from agricultural production through to marketing of the biofuel, including industrial processing stages.

In addition to stipulating mandatory operational requirements for all economic players involved and for the management and maintenance of the standard itself, RBSA sets the highest quality requirements for the processes of independent auditing and certification of the information supplied.

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Finally, the system comprises innovative methodologies to calculate greenhouse gas emissions and develop sustainable maps, so as to support effective and rigorous supply chain implementation of these new sustainability requirements. Biofuels developed will be marketable throughout the EU under the "sustainable" certificate, which will uniquely recognize this assurance everywhere in the European Union.

Leonesa Astur de Piensos, which produces and markets cereals, became the first company to receive Abengoa's biofuel sustainability certificate (RBSA). The company successfully completed the process of securing Abengoa's biofuel sustainability standard (RBSA) in August of 2011

Construction work began on the Ecoalgas project experimental plant. The aim of the project is to evaluate technologies for growing microalgae and cyanobacteria as raw materials for producing biofuels and animal feed and for sequestering CO<sub>2</sub> generated by fermentation in the bioethanol production process. The supply of raw materials and CO<sub>2</sub> emission reduction during fermentation processes for bioethanol production are key, strategic points for the development of second-generation biofuel production technologies.

World Biofuels Conference,  
Seville



The Ecoalgas project's experimental plant will have a total floor area of 5,000 m<sup>2</sup>. Located in Cartagena (annexed to the bioethanol production plant), it will be fed by the CO<sub>2</sub> generated in the cereal grain fermentation process.

Construction completion and commissioning are scheduled for January 2012.

May 2011 saw the official launch of the Biofuel From Algae Technologies (BIOFAT) project, within the European Commission's Seventh Framework Program. Led by Abengoa and involving another seven European partners, the project aims to demonstrate micro algae-based biofuel production technology on a large scale using a cultivation area of up to 10 hectares in Cartagena. BIOFAT's total budget of €11 M carries a related grant of €7.8 M.

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On May 10, 2011, the Hospital de los Venerables church in Seville was the venue for the 10th World Biofuels Conference 2011, in the context of the Focus-Abengoa Forum on Energy and Climate Change.

The 10th World Biofuels Conference is one of the activities set in motion by the Focus-Abengoa Forum on Energy and Climate Change, an entity that supports initiatives in energy research and discussion of issues surrounding renewable energies and corporate action. The purpose of the forum is to contribute to the debate on the change of energy model from a multidisciplinary perspective.

World Biofuels 2011 aims to promote, through public debate, a genuinely open platform for researching, presenting and contrasting ideas and results through whatever actions are deemed relevant at any given time, in accordance with the nature of the issues to be analyzed.

Abengoa's European trading subsidiary has achieved certification of its integrated management system pursuant to the requirements of ISO 9001:2008 (quality management system), ISO 14001:2004 (environmental management system) and OHSAS 18001:2007 (occupational health and safety management system).

All three certificates were awarded by Bureau Veritas Certificación S. A. on January 21, 2011. The certification scope covers services provided by the company, including: the marketing of bioethanol produced by any pool participant via the framework service agreement, integrated management of supply, including logistics and terminals coordination, risk management, third-party bioethanol purchases (Buy/Sell) and bioethanol market analysis.

The company operates the following production facilities in Europe:

### ■ **Ecocarburantes Españoles**

- Owned by Abengoa (95 %) and IDAE (5 %).
- Installed capacity of 150 ML of bioethanol per year.
- Annual DGS production capacity of 110,000 t.
- Electrical power production capacity of 135,000 MWh per year.
- Annual grain consumption of 300,000 t.
- Estimated annual consumption of wine and sundry alcohol of roughly 50 ML.

Bioethanol plant in Valle de Escombreras, Cartagena, Murcia



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It currently employs 79 highly qualified workers.

Part of the CO<sub>2</sub> produced during the grain-to-ethanol transformation process is sold to facilities close to the plant, thereby eliminating the need for these companies to produce their own additional CO<sub>2</sub> and, therefore, making the bioethanol production process even more efficient and curbing CO<sub>2</sub> emissions into the atmosphere. Similarly, electricity is generated during the production process, which provides power for the entire plant, with the surplus delivered to the national power grid.



Bioethanol plant in Teixiero-Curtis,  
La Coruña

### Bioetanol Galicia

- Owned by Abengoa (100 %).
- Installed capacity of 196 ML of bioethanol per year.
- Annual DGS production capacity of 130,000 t.
- Electrical power production capacity of 204,000 MWh per year.
- Annual grain consumption of 340,000 t.
- Estimated annual consumption of wine and sundry alcohol of roughly 50 ML.

The plant is currently in operation in Teixeiro (A Coruña). It currently employs 82 highly qualified workers. The surplus electricity generated during the bioethanol production process, which greatly outstrips actual plant consumption, is delivered to the national power grid, thus enhancing the profitability of the process.

### Biocarburantes de Castilla y León

- 100 % owned by Abengoa.
- Installed capacity of 200 ML of bioethanol per year.
- Annual DGS production capacity of 120,000 t.
- Electrical power production capacity of 204,000 MWh per year.
- Annual grain consumption of 585,000 t.
- Estimated annual consumption of wine and sundry alcohol of roughly 25 ML.

Bioethanol plant in Babilafuente,  
Salamanca





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The plant is located in Babilafuente, Salamanca, Spain. It currently employs 110 highly qualified workers.

As with the other Spanish plants and in accordance with applicable law, plant-generated electricity that is not employed in bioethanol production is delivered to the power grid.

### ■ Abengoa Bioenergy France

- Owned by Abengoa (69 %) and Oceol (31 %).
- Installed capacity of 250 ML of bioethanol per year.
- Annual DGS production of 145,000 t.
- Annual grain (corn) consumption of 500,000 t.
- Estimated annual consumption of wine and sundry alcohol of roughly 50 ML.

The facility owners are Abengoa (69 %) and Oceol (31 %), an association of the region's main agricultural cooperatives and industries. The company employs 73 highly qualified employees.

This plant employs corn and low-quality vegetable alcohols as raw materials and is located on the Petrochemical Platform at Lacq, Pyrénées-Atlantiques (France).



Bioethanol plant in Lacq, Pau, France

### ■ Abengoa Bioenergy Netherlands

- 100 % owned by Abengoa
- Projected annual bioethanol production capacity of 480 ML.
- Annual DGS production capacity of 360,000 t.
- Electrical power production capacity of 400,000 MWh per year.
- Annual grain consumption of 1.2 Mt.

The company employs 84 highly qualified employees.



Bioethanol plant at the Europoort, Rotterdam, Holland

### ■ Lignocellulosic biomass plant

- 100 % owned by Abengoa
- Cereal straw-based bioethanol production capacity of 5 ML per year.

The biomass plant was completed in December 2008 and has been fully operational since September 2009. It is the world's first plant to utilize enzymatic hydrolysis technology at this level of output. It is located within the Salamanca bioethanol plant, meaning that both facilities share common services and process chains. The ethanol it produces is distilled to 42 % and then concentrated and dehydrated.

The facility is being used to improve the design of the commercial plants of tomorrow, gauge operational costs, identify bottlenecks and streamline operations.

### ■ Abengoa Bioenergía San Roque

- 100 % owned by Abengoa.
- Annual biodiesel production capacity of 225 ML.
- Annual crude glycerin production capacity of 18,500 t.
- Annual vegetable oil consumption of 205,000 t.



Biomass-to-bioethanol plant in Babilafuente, Salamanca

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Biodiesel plant  
in San Roque, Cadiz



The plant is located on a site annexed to Cepsa's Gibraltar Refinery on the Palmones de San Roque industrial estate (Cadiz, Spain). It has been designed to operate with different kinds of vegetable oil - soybean, rapeseed and palm - and does not therefore depend on just one supply source. Its entire biodiesel output is supplied to the Cepsa refinery. The plant directly employs 55 highly qualified workers.

### United States

Abengoa is one of the leading bioethanol producers in the United States. It currently boasts an annual installed production capacity of around 1,440 ML, distributed among its six plants located in Nebraska, Kansas, New Mexico, Indiana and Illinois. The company is also one of the main marketers of ethanol and DGS for animal feed.

Abengoa's production assets in Nebraska, Kansas and New Mexico enjoy direct access to the western United States market via the BNSF and UP railroad lines and road tankers. The production assets in Illinois and Indiana afford access to the eastern United States market via the CSX, NS, CN and KCS railroad lines, road tankers and river barges.

Abengoa is also a market leader in second-generation biofuels and sustainability. All the company's production assets are compliant with United Nations Global Compact guidelines on human rights, labor rights, environment and the fight against corruption. Abengoa strives constantly to reduce its biorefineries' carbon footprint.

Abengoa has obtained a federal loan guarantee worth \$132.4 M from the US Department of Energy for construction of the first commercial-scale plant to produce second-generation ethanol from biomass. Located in Hugoton, Kansas, construction commenced on the plant in September 2011.

The construction period is expected to be 24 months, during which an estimated 300 direct jobs will be created in the area. Once completed, the plant will have a production capacity of around 100 ML of clean, sustainable cellulosic ethanol per year, and will create a further 65 jobs in the course of future operation.

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The project is designed to convert close to 300,000 annual t of agricultural waste, such as corn stover (stalks and leaves), into approximately 100 ML of biomass ethanol per year, using an innovative enzymatic hydrolysis process. The plant will maximize the utilization as raw material of crop waste that would otherwise go unused. It is calculated that the plant will replace the consumption of 59 ML of gasoline annually, so avoiding atmospheric emissions totaling more than 139,000 t of CO<sub>2</sub>.

The hundreds of jobs that will be created in connection with this project will generate revenue of around \$5 M annually for the United States. In addition, the project provides a new outlet for Kansas' farm produce, and thus strongly benefits the local area and the state as a whole.

Abengoa has also won the backing of the US Department of Agriculture (USDA) for the development of the Hugoton plant.

A set of four Biomass Crop Assistance Programs (BCAPs) will be introduced to increase availability of non-food crops for biofuel production. The program will be implemented in connection with the future Hugoton plant in Kansas. Fast-growing energy crops are used to produce biofuels or energy in various forms, such as heat and electricity.

In early 2011 Abengoa resumed operations at its bioethanol plant in Portales, New Mexico. The facility is designed to produce up to 115 ML of ethanol annually. Given its energy efficiency and its exclusive use as raw material of sorghum, a cereal crop normally grown without need of irrigation in Roosevelt County and its surrounding area, The plant provides a model of sustainable fuel production in America, allowing farmers to preserve their way of life and preserve water resources. The resumption of operations and the hiring of 40 new employees for the plant entail major economic benefits for Portales and Roosevelt County.

The company has increased the capacity of its Houston Ship Channel storage terminal to a total of approximately 13 ML. Operated by the company under lease, the terminal allows for loading and unloading to or from train, truck, barge and ship, while also providing direct access to international waters, thus opening up imports and exports to and from the United States. It also complements the company's bioenergy hubs in two other major international ports, namely Rotterdam in Europe and Santos in Brazil.

In 2011, Abengoa achieved an increase in maritime bioethanol exports. The company also raised DGS and pellet export activity by barge along the Mississippi and Ohio rivers. The trading subsidiary has positioned itself with strategic terminals in various areas of the United States, the highlight being its Gulf of Mexico terminal.

On November 17, Abengoa staged a biomass seminar at its new Hugoton biomass plant. The event brought together over 200 delegates to discuss the development of the project and to witness a demonstration of biomass collection techniques and the recently developed equipment and machinery.

This new equipment has the potential to revolutionize the way in which agricultural waste can be collected safely and sustainably, which will lead to long-term gains for both producers and the cellulosic ethanol industry.

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The company continued to implement the STOP safety program at all plants, thus improving occupational safety and enhancing plant efficiency.

The Indiana and Illinois facilities received OHSAS certification for the ISO 9001:2000, 14001:2004 and 18001:2001 standards; hence all plants in North America hold official OHSAS certification, underscoring the commitment of Abengoa to quality, safety and the environment. This set of rules is a verifiable health and safety system and was considered to reflect the company's desire to have in place a standardized occupational health and safety system that can be used for the purposes of certification and registration. With the initial audits now finished, the companies operating the plants in Indiana and Illinois and the trading company now satisfied the requirements to secure the ISO 9001, ISO 14001 and OHSAS 18001 certificates. All U.S. plants are now registered under these standards.

In North America, Abengoa has made a commitment to implement ISO 8000 at all plants and at the corporate headquarters in St. Louis, Missouri.

The company operates the following production facilities in the United States:

### ■ Abengoa Bioenergy Corporation – Colwich

- 100 % owned by Abengoa.
- Installed bioethanol production capacity of 95 ML per year.
- Annual installed DGS production capacity of 70,000 t.
- Combined annual consumption of corn and sorghum of 240,000 t.

The plant currently operates at 100 % capacity and continues to report excellent efficiency and consistent operations. Production capacity amounts to 95 ML per year, achieved through continuous batch cooking and fermentation processes. The plant currently employs 46 highly qualified workers.

It is one of the oldest dry mill bioethanol facilities in the United States, having been operating non-stop for the last 25 years. The DGS it produces is not dried in the process and 100 % of the coproduct is sold in its natural state. The plant can process corn and sorghum at the same time and 50 % of its energy requirements are covered with methane from a municipal solid waste landfill.

### ■ Abengoa Bioenergy Corporation – Portales

- 100 % owned by Abengoa.
- Installed bioethanol production capacity of 115 ML per year.
- Annual installed DGS production capacity of 75,000 t.
- Annual consumption of corn and sorghum of 260,000 t.



Bioethanol plant  
in Colwich, Kansas

Bioethanol plant in Portales,  
New Mexico





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Expansion work was completed in 2006 to double production capacity by utilizing batch cooking and fermentation processes, with two separate distillation and dehydration stages. The DGS it produces is not dried in the process and 100 % of the coproduct is sold in its natural state. The plant can operate with corn and sorghum simultaneously and has an annual installed bioethanol production capacity of 115 ML. The fully operational plant employs 46 highly qualified workers.

### ■ Abengoa Bioenergy Corporation – York

- 100 % owned by Abengoa.
- Installed bioethanol production capacity of 210 ML per year.
- Annual installed DGS production capacity of 145,000 t.
- Annual corn consumption of 520,000 t.

Bioethanol plant in York,  
Nebraska



Bioethanol plant  
in Ravenna, Nebraska



The plant currently operates at 100 % capacity and continues to report excellent efficiency and consistent operations. More than 50 % of the produced CO<sub>2</sub> is captured and refined by an on-site customer. The facilities also provide services and logistical support to Abengoa's adjacent pilot biomass plant. Production capacity amounts to 210 ML per year, achieved through continuous batch cooking and fermentation processes. The plant currently employs 55 highly qualified workers.

### ■ Abengoa Bioenergy of Nebraska

- 100 % owned by Abengoa.
- Installed bioethanol production capacity of 340 ML per year.
- Annual installed DGS production capacity of 230,000 t.
- Annual corn consumption of 825,000 t.

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Construction on the plant got underway in 2005 and was completed in 2007. The plant is currently operating at 100 % capacity according to specifications and boasts an installed bioethanol capacity of 340 ML per year, achieved through continuous fermentation. It employs 60 highly qualified workers. The facility is the first in North America to utilize continuous fermentation technology.

The project includes a double railway circuit for simultaneous loading and shipment of 10 ML of bioethanol in 95 tank cars.

The plant is designed to recycle all process water, which is then treated and made ready for reuse. The plant therefore consumes less water, produces minimal pollution and has the minimum possible impact on the ecosystem.

### ■ Abengoa Bioenergy of Indiana

- 100 % owned by Abengoa.
- Installed bioethanol production capacity of 340 ML per year.
- Annual installed DGS production capacity of 230,000 t.
- Annual corn consumption of 825,000 t.



Bioethanol plant in Mount  
Vernon, Indiana

The plant is located near Evansville, Indiana, in the so-called Corn Belt and next to the Ohio River, one of the country's main river routes. The bioethanol and DGS produced on-site can be transported by truck, train or boat to supply the markets on the eastern side of the United States, or exported to other markets.

The Indiana plant currently employs 60 workers. When operating at full capacity, it consumes 825,000 t of corn, and produces 340 ML of bioethanol and 230,000 t of DGS per year.

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## Industrial production



Bioethanol plant in Madison,  
Illinois

### ■ Abengoa Bioenergy of Illinois

- 100 % owned by Abengoa.
- Installed bioethanol production capacity of 340 ML per year.
- Annual installed DGS production capacity of 230,000 t.
- Annual corn consumption of 825,000 t.

The plant in Madison, Illinois, is sited next to the Mississippi River, one of the main communication and transport arteries running through the U.S. Midwest. The facility generates bioethanol and DGS from corn and gets through 825,000 t of cereal grain per year as raw material. It produces 340 ML of bioethanol and 230,000 t of DGS per year and employs 60 people.

### ■ Abengoa Bioenergy Biomass of Kansas

- 100 % owned by Abengoa.
- Annual biomass-to-bioethanol production capacity of 100 ML.
- Daily biomass consumption of 1,000 t, including power cogeneration fuel.



Biomass used to produce  
second-generation  
bioethanol

The aim of the project is to construct a plant capable of producing 26 Mgal (100 ML) of cellulosic ethanol and 22 MW of renewable energy from biomass (mix of agricultural waste, wood waste and non-food energy crops). The plant will be located to the west of Hugoton, Kansas, and will create 65 permanent jobs.

The Hugoton plant, on which construction commenced in July 2011, is scheduled to come into operation in June 2013.



# 06.3

## Industrial production

### Brazil

Brazil is one of the world's largest markets for bioethanol, and bioethanol production is expected to continue growing sharply thanks to the success of flex-fuel vehicles, which currently account for nearly 90 % of vehicles sold in Brazil and which can run on either gasoline or bioethanol.

Abengoa is the only company worldwide that operates in the world's three largest bioethanol markets: Europe, the United States and Brazil. Having streamlined operations in Brazil, the company is reporting sharp growth in production throughout all its existing plants. It is also weighing up the merits of constructing a new plant and is marketing its production overseas more effectively, thanks to the sales networks the company has in place. Moreover, the company is making technological advances and improving sugarcane bagasse to cellulosic ethanol technology so as to increase production in the mid-term and cut costs efficiently.

The company currently operates three plants: two sugarcane-to-bioethanol plants, with an annual installed capacity of approximately 235 ML of ethanol and 640,000 t of sugar, and one plant that produces 30,000 t of sugar and 25,000 t of molasses.

2011 also saw the operational entrenchment of the company's two cogeneration plants in Brazil. Over a full sugarcane growing period, the plants achieve installed capacity of 140 MW, generating 373,073 MWh per year for sale; this power is brought to market under contracts compliant with Brazilian electricity industry regulations.

Cogeneration at the plant located  
in São Luiz, Pirassununga, Brazil





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The raw material for these two plants is sugarcane bagasse, which is fed into the boilers to produce steam. The steam is then used to generate electricity in order to feed the production processes. The cogeneration plants are located in the state of São Paulo, one at the São Luiz plant in the city of Pirassununga, and the other at the São João plant in the city of São João da Boa Vista.

In August 2011, Abengoa started extension works on the plant located in São Luiz, Pirassununga, Brazil. The project will replace the present mill—with capacity to process 620 t of sugarcane per hour—with a new facility specified to process 750 t of sugarcane per hour.

When the new sugarcane mill comes into operation at the Pirassununga plant in March 2012, milling capacity will increase from the current 2.8 Mt to 3.5 Mt of sugarcane annually. Coupled with the enlargement of the São João plant in 2010, Abengoa will have installed sugarcane processing capacity of 7.3 Mt by the upcoming 2012 growing period.

In March 2011, the Brazilian subsidiary was officially certified under SA 8000. As the first industry player to earn this quality mark, the company gains a key competitive edge, and assures compliance with internationally recognized management standards.

The SA 8000 standard is the first internationally recognized human resources management certificate and constitutes a key building block of Corporate Social Responsibility. The aim of certification is to assure employee rights by laying down procedures and systematically specifying processes for managing human resources and suppliers.

By certifying to the standard, Abengoa has become a pioneering corporate citizen in the Brazilian bioenergy industry. It is the only Brazilian producer of sugarcane-based bioethanol to have attained this certificate.

In October of 2011, the two cogeneration plants of Abengoa in Brazil were audited by the Spanish Association for Standardization and Certification (AENOR) under ISO 14001 (environmental management) and OHSAS 18001 (health and safety) standards. The reports confirmed that cogeneration activities at the São Luiz and São João facilities presented no “non-compliances”. AENOR issued the corresponding certificates midway through December 2011.

The certificates mark a new milestone for Abengoa in Brazil, which was awarded the ISO 9001 certificate in 2009 for all agricultural divisions and its two plants in Pirassununga and São João da Boa Vista, ranging from the sugar cane plantation up to marketing of the crystalline sugar, ethanol and electrical power. The standard remains in effect today.

Abengoa signed a partnership agreement with IAG (Instituto de Administração e Gerência), a related entity of the Pontifício Universidade Católica do Rio de Janeiro, PUC/RJ (Brasil), widely acknowledged as the country’s leading private institution, to cooperate in the training of project managers.

The company operates the following production facilities in Brazil:

### ■ Abengoa Bioenergia São Luiz

- Installed capacity of 91 ML of bioethanol per year.
- Annual sugar production of roughly 285,000 t.
- Electrical power production capacity of 172,000 MWh per year.
- Annual sugarcane consumption of 3 Mt.

Bioethanol plant in Pirassununga,  
São Paulo, Brazil



# 06.3

## Industrial production



Bioethanol plant in São João, São Paulo, Brazil



Sugar production plant in Santo Antônio de Posse, São Paulo, Brazil

### ■ Abengoa Bioenergia São João

- Installed capacity of 144 ML of bioethanol per year.
- Annual sugar production of roughly 360,000 t.
- Electrical power production capacity of 201,500 MWh per year.
- Annual sugarcane consumption of 3.5 Mt.

In August and September 2010, in both Pirassununga and São Joao plants electricity cogeneration commenced at 70 MW each, using sugarcane bagasse, the raw material used in the company's own sugar and ethanol mills.

Now that these plants are in operation, Abengoa has added a third major product, energy, to the sustainable development of its bioenergy businesses in Brazil.

### ■ Abengoa Bioenergia Santo Antônio de Posse

- Annual sugar production of roughly 30,000 t.
- Annual sugarcane consumption of 300,000 t.
- Annual molasses production of roughly 20,000 t.

This particular sugar and molasses production plant only accounts for business and sales within Brazil, albeit to a lesser extent than the other plants operating in the country. The company is currently streamlining processes to up operational performance.

## Recycling business

Abengoa engages in different activities in the industrial production segment, focusing on industrial waste recycling.

The company manages over 2.2 Mt of waste, channeling 1.3 Mt into the production of new materials through recycling.

Steel waste recycling provides a high value-added environmental service via the treatment and recycling of waste resulting from the manufacture of common and stainless steel and of waste produced from the steel galvanization process. Abengoa has eight production plants in Europe and one in Turkey, which play a fundamental role in the zinc recovery cycle, avoiding zinc loss by cutting down on dumping and helping reduce the need to mine zinc, nickel and chrome. The company is the European leader in the treatment and recovery of steel dust and the only organization in Spain to offer an integral steel dust collection and treatment service for recovery.

The aluminum waste recycling division provides collection and treatment services for aluminum-containing waste, manufactures and markets aluminum alloys, and designs, builds and assembles aluminum recycling equipment, helping in particular to decrease CO<sub>2</sub> emissions as compared to the primary aluminum industry. The division also recycles salt slag, a hazardous waste generated from the aluminum waste recycling process, and hazardous spent potlining (SPL) waste from used electrolytic cells. Recovery of salt slag and SPL provides a viable alternative to dumping. The purpose, in the case of salt slag, is to separate the metallic aluminum, the salt and the aluminum oxide, while for SPL, the aim is to eliminate cyanides and soluble fluoride salts. All solid metals thus obtained are reused, bringing the recycling cycle full circle and making valuable use of all aluminum-containing waste.

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Zinc facilities in Freiberg,  
Germany

The industrial waste management division handles all stages of the industrial waste management cycle: ranging from transportation, temporary storage, treatment and valorization, to recovery and controlled and safe final disposal, all in strict accordance with Spanish and European environmental law. It also provides high value-added industrial cleaning services to most industrial sectors and has an area that provides effective solutions for the collection, transportation and elimination of PCB-contaminated materials, transformers and condensers, and for recycling the film used to cover greenhouses. Lastly, it provides a range of fully-comprehensive soil decontamination solutions.

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Salt obtained as a product of the salt slag recycling process in Lünen (Germany)

PCB-contaminated material treatment plant in Cartagena, Spain



### Steel and galvanization waste recycling

Despite the present economic juncture, in which industry continues to operate at lower volumes than prior to the economic downturn, the business unit experienced considerable year-on-year growth over 2011 by utilizing more installed production capacity at its stainless steel waste recycling plants, due to the opening up of new foreign markets for raw material procurement. The overall figures of the common steel dust recycling division include the full-year manufacturing figures for the site at Iskenderun, Turkey.

Abengoa is the European leader in zinc waste recycling and aims to become a leading global player in steel dust recycling, on the back of international expansion driven by acquisition of facilities already in operation and construction of new plants equipped with proprietary technology in countries producing high volumes of steel or having high growth potential in the iron and steel sector.

In 2011, the company processed a total of 649,352 t of waste, of which 83.8 % (544,460 t) was residual dust from common steel foundries, making for an 12.7 % increase year on year and thus avoiding the need to mine almost 222,000 t of zinc and giving back almost 122,122 t to the production cycle.

The company has also processed a further 88.8658 t of dusts obtained from stainless steel production processes (3,5 % more than in 2010), recovering its iron and high-value metal content, such as nickel and chrome.



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Steel flakes recovered  
in the Landskrona facility, Sweden

In both cases, less energy is used and less CO<sub>2</sub> (greenhouse gas) is released into the atmosphere than if the same commodities were obtained by primary processes.

16,234 t of galvanization waste were recycled for processing into zinc oxide, zinc ingots (ore and electrolytic) and fine zinc ashes.

This input volume has enabled the company to obtain 188,420 dry t of Waelz Oxide, representing a year-on-year increase of over 9.4 %. The volume of treated Waelz Oxide (D-L.W.O.®) was higher than the previous year's, standing at 123,724 t. The stainless steel dust recycling plants also produced 39,514 t of nickel and other metal alloys, 2.9 % below than in 2010, and 48.364 MWh of electricity was self-produced at the production facility in Sweden.

To achieve these results, Abengoa now operates nine facilities worldwide, eight in Europe and one in Turkey.



Waelz furnace in Erandio (Spain)

The treatment and recovery of dust from gas filters installed at electric arc steel furnaces manufacturing common steel is carried out at five plants operated by this business unit, across four countries: Germany, France, Turkey and Spain.

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Stainless and special steel manufacturing wastes, which in addition to iron contain metals such as nickel, chrome and molybdenum, are recycled at two other European plants: in France and Sweden.

Finally, Abengoa's Sondika and Amorebieta plants treat zinc waste and zinc alloys generated by the galvanization, metal injection and construction sectors. In 2011 these facilities recycled a combined total of 16,234 t of waste, reflecting a 14.9 % increase in treatment volume.

Total products and byproducts produced by the two sites came to 14,185 t, 2.6 % more than in 2010, of which over one half (58.4 %) corresponded to zinc oxide (ZnO), with the remainder mainly comprising ingots of zinc ore, ingots of electrolytic zinc and the fine zinc ashes.

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The powerful rise in business at the Sondika and Amorebieta sites is due to three factors: (i) gradual recovery in zinc oxide ceramic markets; (ii) research-driven widening of the range of finished products, based on the use of raw materials with a lower zinc purity; and (iii) opening up of new domestic and international markets in the tire and rubber manufacturing industries.

Thanks to the sterling work conducted in 2009 and 2010 to penetrate new territories and diversify its waelz oxide customer portfolio, the company managed to sell a grand total of 186,310 t of this product, 7.9 % up on figures for 2010 and close to the entire output for the year, making it one of the world's leading primary zinc foundries.

27,867 t of nickel-rich and other steel alloys were sold (7.6 % up year on year).

Moreover, the high prices that zinc fetched on the international market over the year (the listed price on the London Metal Exchange, or LME, averaged close to \$2,200 per ton of Zn-SHG) have had a positive economic impact on profits, despite being largely offset by the previously signed metal price hedging agreements.

The facilities within the steel dust and galvanization recycling division invested over €6 M in property, plant and equipment in 2011, the most significant entries being the acquisition of new industrial equipment and improvements to the efficiency of certain core operations and processes.

## Aluminum waste recycling

Abengoa is currently the European leader in aluminum waste and salt slag recycling, operating in accordance with a unique business model that integrates the two branches of aluminum waste recycling.

The main competitive edges underpinning Abengoa's goal of continued sustainable growth include in-depth knowledge of the processes and technologies involved in aluminum waste recycling, a broad range of products derived from secondary aluminum and excellent commercial relations with customers and suppliers of raw materials.

### Aluminum-content waste recycling and comprehensive re-use for aluminum alloy production

The aluminum waste recycling business unit recovers aluminum contained in various different types of waste. The company does this by collecting and transporting waste and aluminum scrap metal, carrying out its integral recovery and producing and marketing aluminum alloys. Recycled aluminum waste is primarily used to produce alloys, which are then sold to the construction and automotive industries and turned into components. It is worth noting that this line of business is particularly effective at reducing CO<sub>2</sub> emissions.

Abengoa carries out these activities at three plants - Biscay, Valladolid and Barcelona (Spain) – and has achieved an uncontested lead in the Spanish market.

Its strategic goals and business processes mirror the commitments assumed by the aluminum industry: to eliminate, in the mid-term, the dumping of solid waste directly and indirectly generated by the industry. The company is working tirelessly to incorporate further innovative treatment technologies for recovering waste, thereby helping the industry to move forward sustainably.



Slag drop in the Waelz furnace in Erandio (Spain)

# 06.3

## Industrial production

### Recycling of salt slag, SPL, filter dust, fine particles generated by aluminum sludge crushing and other aluminum industry wastes

Salt slag is a hazardous waste generated by secondary aluminum production in rotary ovens. The European market accommodates a volume of 0.9 to 1 Mt annually.

Abengoa's aluminum waste recycling model, based on proprietary technology, involves the end-to-end comprehensive recovery of all waste generated by the aluminum industry and aluminum goods at the end of their life cycle. It is precisely the salt slag and SPL recycling business that brings this process full circle and makes it a meaningful venture.

As is also the case with the manufacture of parts and other products, oxides and other impurities are incorporated along the aluminum production value chain. The valorization of these is more costly, because of both the technical difficulties involved in the industrial process and also the lower financial value of the products that can be recovered. Due to its physical and chemical properties and in particular its lightness, aluminum plays a crucial role in helping to curb greenhouse gases within the transportation sector.

Our plants also recover other types of waste from the aluminum industry, such as gas filtering dust and the dust obtained from milling and grinding aluminum dross.

The company has also been treating the waste produced by primary aluminum electrolysis (SPL) since 2011. This hazardous waste, which contains cyanides and soluble fluoride salts, is generated during the process of obtaining primary aluminum from minerals. Due to the significant volume of waste generated, 22 kg per ton of primary aluminum to be precise, the need to recycle SPL has become one of the industry's most pressing environmental challenges. To date, there have only been partial treatments of the waste and most ends up being dumped at authorized sites. Abengoa, on the other hand, offers fully comprehensive management with integral waste recovery and provides leading waste producers with a definitive solution.

### Sale of machinery and technology

The machinery and technology sales division provides technical support to the aluminum waste recycling plants, and is engaged in the design, construction, assembly and start-up of installations for the aluminum and zinc industries. It boasts an extensive portfolio of more than 100 installations in 40 different countries. Its main products include automated lines for producing 5-25 kg aluminum ingots, casting wheels, rotary ovens and sludge cooling and treatment facilities.

Milestone projects carried out in 2011 include: commissioning of a casting line for Aluar in Argentina and start-up of an ingot casting line for Hillside in South Africa. The company also designed, manufactured and delivered casting lines for Balco and Hindalco in India and made its first delivery to Maaden in Saudi Arabia.

A highlight was the project set in motion in partnership with Hindustan Zinc to supply zinc and lead casting lines, representing product and market diversification for the business division. Despite the difficulties stemming from the widespread slump in investment, this business unit has completed all its projects and its order intake is sufficient to guarantee work for the next twelve months.

Salt slags treatment facility in the UK



Spent potlining (SPL)



Ingot mold train





# 06.3

## Industrial production

### Industrial waste management

Through its centers and offices located across Spain, Abengoa aims to provide its customers with an integral waste management service, while minimizing or reducing the potential environmental impact through suitable management.

The company's main competitive edge is the fact that it operates across the integral industrial waste management cycle and is therefore able to harness significant synergies between the various links in the chain. Demand for Abengoa's industrial waste management services flows in from small and medium-sized companies with a strong local component, and also from the environmental divisions of large industrial companies generally associated with the construction trade.

The current economic crisis affecting the automotive, steel, chemical, petrochemical and construction industries has led to a significant drop in waste generation. This is due to low levels of industrial activity, which have had a negative impact on the company's business.

#### Industrial waste

Abengoa manages, recycles, valorizes and reuses waste through cutting-edge technology under the 3R rule: "Reduce, reuse and recycle", based on the premise that the best waste is no waste. This way, materials that can be put to subsequent use are recovered, thus helping to reduce our reliance on new raw materials. The company accomplishes this not only through its 15-plus network of centers distributed throughout Spain, which treat waste to reduce the associated contamination, but also through its transfer centers, at which waste is separated, classified and sent off for recovery, recycling and/or valorization, thus reducing the consumption of natural resources. Lastly, it has a safety storage landfill site for the controlled disposal of waste that cannot undergo any further form of treatment.

Industrial waste management  
center, Ajalvir, Spain



# 06.3

## Industrial production

Abengoa held its leading position in Spain's industrial waste recycling sector, managing 768,202 t of industrial waste, 13 % of which corresponded to recycled industrial waste, versus 10 % last year.

### Industrial cleaning

The industrial cleaning division's activities contribute to the sustainable development of the industries it serves, combining the goals of minimizing waste production, maximizing waste recovery, reusing raw materials and developing more efficient equipment, leading in turn to lower energy consumption. Its wide range of services includes mechanical and high pressure hydrodynamic cleaning processes, ultra-pressure hydrodemolitions and hydrocutting; chemical cleaning and steam blowing; air through circuits and boilers; changes of catalyst beds; cleaning of refinery tanks and oil installations, both manually and with automated systems; on-site waste treatment by means of mobile and fixed plants, and cleaning of interchangers.



Abengoa industrial cleaning worker

International expansion continued with chemical cleaning and steam blowing contracts for the Hassi Ramel solar thermal plant in Algeria, in addition to the company's domestic presence in the pre-operational chemical cleaning market for thermal power and solar thermal plants, where the division secured chemical cleaning and steam blowing contracts for the Helienergy I and II solar thermal plants in Ecija, Seville, and dismantled the Iberdrola thermal power plant at Santurce. In addition, the division was awarded contracts by Cepsa and Repsol to extract and load catalyzers.

### Soil decontamination

In 2011, the soil management and decontamination department, now firmly established as the leading Spanish player in soil investigation and restoration, focused on on-site decontamination contracts at oil industry terminals (fuel storage). At these facilities, the company performs various free-phase hydrocarbon recovery projects using pneumatic pumps or double phase (liquid/gas) recovery employing a high vacuum system deployed via wells drilled specifically for the purpose. In addition, on-site treatment is being finalized using bio-cell technology to bio-restore 30,000 t of contaminated soil for reuse at the original site.



Abengoa employees performing soil decontamination work

# 06.3

## Industrial production

Another highlight of the first quarter of 2011 was the assembly and commissioning of an on-site mobile soil washing plant in Gibraltar, which will start work on decontaminating soil from the new airport tunnel.

### Sulfur recovery

As part of the Sefanitro Special Plan for Inland Renovation (PERI) of the Baracaldo district in Biscay province, in the context of the sulfur waste recovery business, the land occupied by desulfuration's facilities was rezoned as residential urban land. This prompted the scheduled shutdown of activities in July 2011. The facilities are currently being dismantled.

So that the division can continue its sulfuric acid and oleum production using waste sulfur from petrochemical plants and reusing process heat to generate power, in late 2009 construction work began on a new plant on land owned by the Port of Bilbao (Zierbena). The new site is currently at the commissioning stage.

### Plastics

Plastics division manufactures special low density polyethylene pellets by recycling the film used for covering greenhouses. The sold pellets are then used for a variety of applications, such as manufacturing films for the construction industry (waterproofing and protection), sacks and bags, irrigation piping and electrical and telecommunications ducts. They can also be injected or otherwise used to obtain modified asphalts. Abengoa is the only Spanish organization capable of carrying out the complete recycling cycle from collection to product manufacturing.

Over 2011, Abengoa recycled 14,883 t of film and used irrigation pipes, and likewise produced 11,311 t of polyethylene pellets, thus maintaining its position as market leader in the low density polyethylene recycling business, a field in which it operates in all the major regions of cultivation under plastic in Spain: Alicante, Murcia, Andalusia and Extremadura.

Over the past few years plastics' research, development and innovation department has developed a process to reuse fiberglass waste —hitherto a non-recyclable material which in Europe alone accounts for 120,000 t of landfill annually— so providing a solution to what has so far been an unsolved environmental issue.

Plastics facilities  
in Murcia (Spain)



# 06.3

## Industrial production

The division's work culminated with the construction of a pioneering fiberglass recycling plant. The facility will use fiberglass to reinforce plastics and so obtain a material with applications in the automobile and white goods industries, in building insulation, and even for making wind turbine blades. The plant's most innovative feature is the process that blends the fiberglass with a thermoplastic mesh to produce the compound.

This flexible facility is capable of increasing its capacity and widening the range of wastes it can recycle. The research, development and innovation department is already working on new recycling processes for other materials, including wood and rubber.

### PCB

Operates out of Cartagena (Spain) and specializes in providing effective solutions for the collection, transportation and elimination of transformers, condensers and materials contaminated with PCB (polychlorinated biphenyls). Using cutting-edge technology, the company recovers all reusable materials while eliminating all contaminated materials for good.

More than 1,900 t of PCB-contaminated devices and materials were treated by the company during 2011, confirming its market leadership in Spain.

## Latin America

### Argentina

The Argentinian subsidiary is chiefly concerned with satisfying the needs of various industries, organizations and public and private institutions regarding the management, recycling, recovery, treatment and final disposal of industrial wastes. Abengoa provides these environmental management services using the best technology available on the Argentine market, combining experience, technology and responsible handling of resources.

Activities are carried out mainly in Buenos Aires province, specifically in the localities of Pacheco, Campana and Zárate, where the company's treatment plants are situated. Administrative and sales functions are performed at head office, located in the City of Buenos Aires.

Abengoa provides the following services in Argentina:

- Industrial waste transportation and incineration.
- Waste inertization and final disposal in safety landfills.
- Laboratory services.
- PCB and waste export operations.
- Auxiliary services, including waste and contaminated material crushing and compacting.

It is also involved in industrial cleaning, physical and chemical cleaning of aqueous waste, recovery and distillation of stainless steel solvents, sludge centrifugation, tank cleaning, and the production of an alternative fuel for cement furnaces called Combustec®.

In 2011, to improve the Pacheco plant's crushing capacity, a new crushing machine was purchased, which is now in the process of being installed. To develop and improve the industrial analysis laboratory business unit and offer customers a wider range of services, new safe distillation systems were installed.



# 06.3

## Industrial production

Laboratory  
at Argentina site



Facilities in Antofagasta,  
Chile



At the Campana plant, survey work is underway to enlarge the landfill site. In addition, discharge of leachates was directed to the front section of the plant. The procedure has been approved by the Buenos Aires province water administration, ADA, construction work is in progress, and a compliance check has been requested

### Chile

Abengoa develops in Chile the integral management of solid hazardous and non-hazardous industrial waste, through temporary storage and final disposal systems. The company provides treatments to recover and minimize the hazardous nature of the waste, giving priority to recycling whenever possible. The waste, which is mainly produced by mining and industry, is managed safely and responsibly, contributing to the country's sustainable development.



# 06.3

## Industrial production

In operation since May 2008, the Sierra Gorda plant stands on a 40 ha site located in the Atacama Desert, 120 km inland from the city of Antofagasta and 1,600 km from the capital, Santiago.

In 2011, the division managed 12,907 t of waste. In May of the same year, the company obtained certification under the ISO 9001, ISO 14001 and OHSAS 18011 standards.



Peru's incinerator, the country's first facility of its kind

In addition, close to 300,000 M Chilean pesos were invested in building a 64,000 m<sup>3</sup> safety landfill site for hazardous waste disposal, to meet demand from the region's industrial and mining sectors.

Finally, various contracts awarded by mining companies were performed to the customers' full satisfaction. Key customers include Cía. Minera Quebrada Blanca (Teck), Cía. Minera Lomas Bayas (Xstrata), Soc. Minera Química (SQM), Compañía Minera Ines de Collahuasi (Angloamerican), Electroandina (Endesa), Terminal Portuaria Mejillones, Minera Las Cenizas, among others.

### Peru

In Peru, the company specializes in providing industry with integral environmental services, including the collection and transportation of solid and liquid wastes, waste conditioning and treatment, incineration, final disposal in safety landfills, integrated management on site, and exportation of PCBs.

Abengoa operates the country's first safety landfill licensed to accommodate industrial waste. The company now has approximately 918 customers and manages over 24,000 t of industrial waste annually.

The year 2011 also saw Abengoa start up the country's first commercial incinerator, which is capable of treating 800 t/year of inflammable and hospital waste.

During 2011, construction work was completed on the new safety storage landfill site in Trujillo, 563 km north of Lima, scheduled to come into operation in December 2011. This is the first safety landfill located in the north of Peru, and its first basin is designed to accommodate 40,000 t of waste.

# 06.3

## Industrial production



Laboratories in Peru

Over the year, major investments were made to improve Peru's facilities.

One highlight project involved the commissioning in November 2011 of a wastewater treatment plant capable of processing approximately 10,000 t of wastewater per year, so considerably increasing waste capture.

November 2011 also saw the commissioning of an inertization machine, which will significantly improve the present density of the deposit by performing a suitable blending of wastes.

Finally, the company Repsol Exploración awarded a two-year contract for the integrated management of all waste generated at the Arica and Nuevo Mundo base camps on oil and gas exploration lots 39 and 57, respectively.

The service covers waste removal from storage facilities at each base camp, packaging, transportation (river-borne and overland), treatment and final disposal.

It is estimated that the company will process and arrange the final disposal of approximately 1,000 t of waste.

### Mexico

The Mexican subsidiaries are involved in the management of hazardous waste for industry and the public sector. These activities foster sustainable development by offering a responsible alternative to the management of hazardous waste, which might otherwise lead to significant environmental contamination.

In 2011, Abengoa continued to expand its business of managing waste ultimately intended for third-party facilities. Whereas previously specializing almost exclusively in hazardous waste confinement, the company is now experiencing demand for cement furnaces, confinement of non-hazardous waste, incineration, recycling of waste containing valuable metals, and government-ordered destruction.

A highlight for 2011 was a remediation project, entailing the treatment of over 25,000 t, nearly 9,000 t of which was successfully treated during the year. Waste treated over the year amounted to 12,002 t.

## Solar power

In the Industrial Production segment, Abengoa's business focuses on the development of new technologies via research, development and innovation, and the manufacture and sale of key components for thermal solar and photovoltaic plants.

The development of new technologies that can be applied in-company or sold to third parties is one of the competitive advantages that drive Abengoa's growth and future viability. Technology evolves swiftly, and companies must have the right expertise available to deal with new projects and market requirements.

This ongoing investment in R&D affords Abengoa more probabilities of offering competitive technologies going forward and the chance to offer a portfolio of solutions tailored to each project and/or market.



# 06.3

## Industrial production

### R&D

R&D projects are conducted using the Stage-Gate methodology, based on stage-by-stage development with progress assessments to evaluate the degree of achievement of the pre-established targets and the potential of the technology under study. This methodology is used to achieve excellence in R&D development and management, minimizing the risks.

The key aims of the R&D program include obtaining better operating temperatures in both power tower and parabolic trough technologies, in order to boost the efficiency of the power cycle, enhance plant control and operation systems, cut technology investment and operation costs, optimize storage systems and develop new and more efficient photovoltaic technologies.

In line with these challenges, in 2011 the company continued to operate a number of pilot plants at the Solucar complex, which have enabled it to consolidate various key innovation concepts:

- Over 1,800 hours of operation of a tower-mounted superheated steam generation receiver at temperatures above 500 °C.

Eureka and GDV  
(Seville, Spain)



Molten salts (TES)  
(Seville, Spain)



- Water certified as an alternative heat carrier to oil in parabolic trough loops. The direct steam generation (DSG) plant, which also came into operation in early 2009, is ratifying the control system developed by Abengoa in direct steam generation systems.
- Validation of thermal storage. The operation of a demonstration molten salt plant since 2009 has enabled the company to accumulate considerable experience in the use of this fluid to store energy in the form of sensitive heat and to quantify the global performance of this kind of storage.
- The Solugas project, a Brayton cycle plant, and the CRS Sales project, a tower plant with a molten salts receiver, are under construction and scheduled to come online in 2012.
- The development of new photovoltaic technologies based on the experience acquired at the photovoltaic laboratory that has been in operation since 2008 at the Solucar complex.



# 06.3

## Industrial production

Solugas (Seville, Spain)



As a result of this R&D activity, Abengoa has proprietary technology that is protected through patents. Accordingly, the company owns priority rights over a number of significant and crucial inventions which in 2011 gave rise to applications for 27 patents, with a total of 107 solar technology patents petitioned in the last few years.

The company is currently developing both its own research projects and joint projects in cooperation with institutions and universities. The company has close links with prestigious institutions such as the National Renewable Energy Laboratory (NREL), the leading renewable energies laboratory in the United States, Spain's Energy, Environmental and Technological Research Center (Centro de Investigaciones Energética, Medio Ambientales y Tecnológicas - CIEMAT) and the thermodynamics department of the German Aerospace Centre (DLR).

Lastly, Abengoa is involved in programs that receive grants to support R&D projects promoted by public and private organizations. In the last three years, the company has been awarded five grants for different projects from the United States Department of Energy, a project under the EU's 7th Framework Program, as well as other projects to develop new technologies subsidized, among others, by the CDTI and the Andalusia regional government. The CENIT project led by Abengoa and with a budget of €24 M is especially significant.

### Supply of key components

Ensuring a reliable supply of high-quality key components is essential for the company. Consequently, through investees, Abengoa controls the design and manufacture of certain components considered to be critical, such as the heliostats for the solar tower technology.

The heliostat structures are then manufactured in Seville, and assembled in each plant's assembly building. Since 2010, work has been ongoing to develop new heliostats to enhance the plants' technical and economic features. Furthermore, Abengoa is working with companies specializing in the design and manufacture of receivers in order to maximize the performance of these elements, and at the same time to reduce their costs.

In parabolic trough technology, Abengoa designs its collectors, and are assembled at the assembly facilities located at the plants themselves.

The parabolic trough mirrors are manufactured by Rioglass Solar, with which Abengoa signed an agreement to assure supply of this key component. This has translated into lower cost, greater security of supply and improved efficiency and durability of the mirrors in the field.

In photovoltaic technology, Abengoa has started to market its second-generation photovoltaic concentration system, which it has developed over the past few years.

### Industrial applications

Abengoa designs, engineers and manufactures parabolic-trough systems to supply industrial customers with industrial steam. This steam can be used in a wide range of different processes, such as copper refining, heating for buildings and generating heat.


 PS10 heliostats  
(Seville, Spain)

# 06.3

## Industrial production

The company also designs and installs industrial photovoltaic plants for the supply of electricity.

- Minera El Tesoro mine, Chile: Abengoa has designed and engineered the world's largest industrial steam system. Located in Antofagasta, Chile, the facility will have a maximum capacity of 10 MW and will achieve an annual 50 % reduction in the amount of fossil fuel used in the copper refining process. It will also cut annual CO<sub>2</sub> emissions by 10,000 t. The plant is scheduled to enter into service in June of 2012.
- Kraft Foods, Brazil: Abengoa has constructed a solar thermal plant, to supply hot water, on a plot of land lying adjacent to the Kraft Foods facilities in Brazil. The aim of the project is to meet the parent facility's hot water requirements. The plant is scheduled to be brought online in March of 2012.
- Red River College, Canada: Abengoa has installed a small demonstration plant at Red River College of Applied Arts, Science and Technology in Winnipeg, Canada, with the aim of testing the technology under extreme temperatures.
- Rooftop photovoltaic systems: Abengoa has installed two 40 kW plants at various premises of the company Cummins Power Generation in Fridley and Shoreview, Minnesota.

Parabolic trough mirrors



## Hydrogen, energy crops and ocean energy divisions

### Hydrogen

Abengoa's hydrogen business is strongly oriented to research and development as a source of expertise enabling it to offer its customers new and better products in its chosen fields. The company's Seville facilities therefore include a Fuel Cell Testing and Characterization and Advanced Hydrogen Technologies Laboratory. Designed by in-house technical specialists, the laboratory is equipped with gas pressure storage systems and hydrogen storage systems based on various technologies.

# 06.3

## Industrial production

In addition to its internal activities, Abengoa is a key player in the hydrogen and fuel cell market in Spain and internationally, favoring synergies among industry players and the spread of this breed of new technologies. The company is currently acting as president of the Spanish Hydrogen Association (AeH2), president of the Spanish Technological Platform for Hydrogen Technologies and Fuel Cells (PTE-HPC), and vice president of the Spanish Fuel Cell Association (Appice). In addition, it is a founding member of the Industry Grouping (NEW-IG) which has launched the Europe-wide Joint Technology Initiative, or JTI, for fuel cells and hydrogen in partnership with the European Commission.

Abengoa has accordingly adopted the "innovation ecosystem" approach: over its history, it has established alliances with technology centers, public research institutes, universities, organizations, and other private enterprises, bearing fruit in the form of cooperation agreements, accords and joint ventures. Highlights include partnerships with centers such as Aicia, Ciemat, Cidetec, Csic, ECN, Inta, Imdea, Fraunhofer, etc. and universities including those of Seville, Huelva, Jaen and Rey Juan Carlos, inter alia.

Finally, another highlight was the fuel cell system installed at Campus Palmas Altas in 2010 and used throughout 2011 as a test bench. The system consists of a facility at the gateway to the campus where the power generated by a large photovoltaic panel over the course of the day feeds the electrolyzer, which converts demineralized water into hydrogen. The gas thus produced is stored for future use feeding a fuel cell system.

### Energy crops

Abengoa has created a new business unit based on over 15 years' experience in the forest biomass sector in Uruguay. Activities over these past few years have focused on:

- Harvesting and forest loading of lumber.
- Supply of biomass for industrial energy.
- Forest logistics: beach operation, loading and transport.

The start of the energy plantations venture has been followed by the following activities:

- Energy crop research, development and innovation.
- Biomass base access (biomass and land).
- Development of biomass processing industries.

The unit has the following projects underway:

- Development of energy crops in Uruguay to support the biomass required for the Alur 6MW cogeneration plant.
- Development of a pellet production plant in Uruguay with capacity for 2000 kt per year and a 10 megawatt cogeneration option.

### Ocean energy

The ocean energy business is currently structured into three activities:

- Research and development, in which technology is developed via a range of programs and alliances.
- Engineering, where the capabilities and know-how are being developed to undertake EPC ocean energy farm projects and related offshore work in the near future.
- Development, in which future energy farms are set in motion.

# 06.3

## Industrial production

Research and development projects carried out in 2011 include:

- Tecoagua project. Cenit project implemented in cooperation with the Canary Islands Technology Institute and Canal Isabel II, among others, and the University of Granada. The project concerns the design, development and construction of an oscillating water column model that will generate electricity to power a desalination plant. At present, the project works with a scale model at the trial phase in the tank installed at CEAMA in Granada. The technical and economic viability of scaling up the model is under analysis.
- Genera project. An internal investment project to cooperate on the development of point absorbers with Irish technology firm Wavebob. The partnership is working together on the mechanical design of the wave-driven generator of the pre-commercial prototype and on future generation design analysis.
- Orecca project. Off-shore Renewable Energy Conversion platforms Coordination Action is a dissemination project within the Seventh Framework Program underway in partnership with over 25 different entities, including European universities and companies such as ENEL and IT Power. The aim is to create a working framework for knowledge-sharing and to develop a roadmap for research in the offshore renewable energy field. Project members have been directly involved in analyzing the existing legislative and environmental framework, assessing national policies and identifying existing investment opportunities.
- Sowfia project. Streamlining of Ocean Wave Farms Impact Assessment is a dissemination project within the Seventh Framework Program underway in partnership with several European universities and leading ocean energy institutions such as the Wave Energy Centre and European Ocean Energy. Project members are involved in identifying barriers and accelerators facing the development of wave-driven generator farms in Europe, and lead a Europe-wide workshop to share knowledge and analysis of the present state of the existing technology.
- Ecoboya project. This partnership with the compound materials department of the University of Cadiz aims to design, build and test a current generator and fuel cell to power a telemetry buoy in the Port of Seville. Initial analysis is underway of buoy-wave interaction for various sites in order to predict behavior as required for the subsequent design of the anchoring system.





# 07

## Abengoa and innovation

Key figures	2009	2010	2011	Var. 11-10 (%)
Patent applications (cumulative)	15	117	190	62
PhDs number	8	22	131	41

## Innovation at Abengoa

Abengoa's growth model is based on technological leadership and thanks to its unflinching commitment to R&D&I, this approach enables the company to generate value through new products and processes while improving those already on the market, thus affording it a competitive edge. Abengoa's ability to generate and draw value from knowledge has proven key to its success and leadership in developing new technologies, processes and knowledge, all geared towards providing groundbreaking and environmentally-friendly technological solutions, which generate value in the mid- and long-term and give the company numerous competitive advantages.

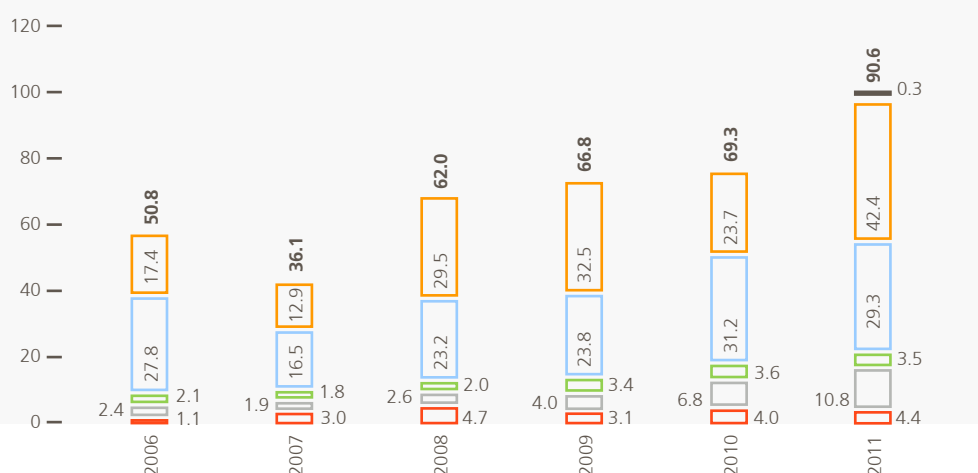
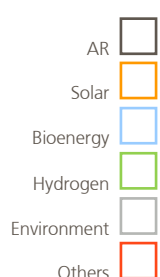
At Abengoa, most investment in R&D&I is channeled into applied research and into developing technological innovation, thus mirroring the company's strategic objectives.

R&D&I investment in 2011 amounted to €90.6 M, marking a year-on-year increase of 30.8 %, accounting for approximately 1.4 % of sales and placing annual growth in investment at 12 %. This figure does not factor in investment in innovation, which, though not readily quantifiable, is a key element of Abengoa's strategy.

The table below shows how Abengoa's investment in R&D has evolved over the past few years in each distinct sector.

### Investment in R&D

\* All investment pertaining to Telvent has been removed



Innovation management at Abengoa is a central part of the strategy implemented by each business unit, represented by its "Three Horizons", where R&D programs are defined aimed to develop new products and processes or improvement of existing ones. R&D programs are general in scope and are aligned to the Abengoa's technology development strategy

# 07

## Abengoa and innovation

Abengoa's focus on innovation entails a commitment to a range of initiatives. Some of these are already in progress, while others are at the preparatory stage:

- A ten-year strategic plan that clearly specifies our research and development activities over the coming years, setting out precisely defined targets for technological advancement in terms of specific subject matter and time frames, tied to McKinsey's "Three Horizons."
- R&D valuation: economic assessment of research and development so as to monitor profitability and traceability.
- Highly qualified R&D staff with a profile suited to these new requirements.
- Major increase in the research and development budget, with funds being earmarked for highly innovative projects.

## Abengoa Research

Just as with human development, the greatest advances within the business world have always come from technological development. Leading corporations that have remained at the top of their game over the years have always based their success on technology.

The year 2011 witnessed the launch of Abengoa Research, created with the core values of Abengoa firmly in mind as a new tool with which to foster R&D&I activities: commitment to and drawing value from knowledge in order to remain at the forefront of technology and the business world over time.

Although officially incorporated back in February, Abengoa Research only started operating in October on the path to becoming an international benchmark in R&D and in generating knowledge and applying it to energy and sustainable development.

Abengoa Research pursues the following objectives:

- Generating and applying knowledge within the areas of energy and sustainable development.
- Acting as a technological base for all existing and future Abengoa businesses
- Generating competitive edges in Abengoa's business areas based on research and technological development.
- Providing top-tier technical support services to Abengoa's business units.
- Helping to develop new technologies and calculation, design and verification tools within Abengoa.
- Increasing the scientific and technical scale of R&D projects for Abengoa and its component companies.
- Honing the skills of the highly qualified experts who work in the various scientific and technical fields related to Abengoa's business.
- Disseminating any scientific and technical advances that could be relevant to Abengoa's business.

In 2011, Abengoa Research focused its attention on recruiting researchers. The company evaluated over 400 applications sent in by researchers from over 30 different countries, with the main requirements being:

- PhD holders (engineers, physicists, chemists).
- Excellent research skills.
- Extensive work placements outside Spain at prominent research centers.
- Current and active involvement in publications and/or patents in their chosen field.

# 07

## Abengoa and innovation

Abengoa Research will conduct its research in the following areas of knowledge:

- Materials and nanotechnology.
- Fluid mechanics.
- Solid mechanics and structures.
- Thermal engineering.
- Process engineering.
- Biotechnology
- Electrical engineering.

This unflinching commitment to R&D has been further consolidated through the creation, alongside the Loyola Andalusia University Foundation, of Loyola-Abengoa Research (LAR), a pioneering joint university/corporate R&D center that will be based at the company's headquarters, Campus Palmas Altas, in Andalusia.

LAR is a research center focusing on renewable energies and sustainable development. It will operate as a scientific and technological forum capable of creating viable solutions for the future and as a space to train professionals specializing in R&D&I.

## Areas of innovation

Abengoa generates, acquires and applies knowledge within the field of sustainable development. Technological innovation is a key factor in the areas of energy and the environment: generating electricity from solar radiation, producing biofuels, desalinating water and recycling industrial waste.

Abengoa's future strategy and vision embraces significant R&D activity with a view to driving business in the area of renewable energies, primarily hydrogen, ocean energies and biomass. Abengoa therefore seeks to forge alliances with top-tier international technological partners so as to develop competitive proprietary technology in these renewable energies, emulating its success in solar energy.

### Solar power

For Abengoa, innovation and the development of new technologies are key priorities in the field of solar power. The aim is to offer technologies capable of generating clean energy at costs that prove competitive with fossil fuels, including the cost of CO<sub>2</sub> emissions. Two main drivers will combine to lower costs: increased market volume and more efficient new technologies.

For Abengoa, developing an extensive R&D&I program covering all the different envisaged horizons affords it a huge competitive edge. This fact is particularly significant given the company's role at various different stages of the value chain: manufacturing technological components, operating as a plant developer and maintaining facilities, inter alia.

In the field of solar power, Abengoa's unflinching commitment to research, development and innovation is thus characterized by:

- A global presence: the company employs a team of over 150 people at research sites across the world, including Seville and Madrid in Spain and Denver in Colorado, USA.
- Collaboration with leading international institutions, including the likes of: the Spanish Solar Energy Institute (Technical University of Madrid), Ciemat and the leading Spanish



# 07

## Abengoa and innovation

universities, NREL, the University of Rochester and the University of California, Merced in the United States, the DLR and the Fraunhofer ISE in Germany, the CSIRO in Australia and the CNRS in France.

- Programs are funded through two distinct yet complementary sources. On the one hand, through considerable internal funding within Abengoa, and on the other, through existing aid programs and public subsidies. The main subsidies continuing or secured in 2011 were as follows:
  - In Spain, and focusing on solar thermal technologies, 2011 witnessed the completion of the Cenit Consolida project, with a total budget of €24 M. Turning our attention to photovoltaic technologies, Abengoa is involved in the Cenit Sigmasoles and the Cenit Liquion projects.
  - In Spain, work continued on three projects financed by the CDTI to develop receivers and salt storage systems and also new thin-film technologies.
  - In Spain and with the Eureka seal of quality, Abengoa secured funding for two concentrating solar power (CSP) projects. The company also walked away from the Innacto tender with four projects financed by the Spanish CDTI (three in photovoltaics and one in concentrating solar power).
  - In the United States, Abengoa is continuing work on five concentrating solar power R&D projects being financed by the US DoE.

### Description

Abengoa develops its technology research and innovation via the Stage-Gate methodology so as to achieve excellence in project development and management and bring its efforts into alignment with the organization's strategic goals.

At the initial stage, the project to be undertaken is defined and preliminary research work completed. Next, the team conducts a thorough analysis and theoretical and practical modeling of the solution. This stage also requires the team to search for suppliers, sign cooperation agreements, and so on. The next stage involves the construction of a prototype or pilot plant. The data generated by the plant during operation is then analyzed so as to validate the system before moving on to the large-scale commercial operations stage.

These pilot plants enable Abengoa to test and confirm whether its own innovative solutions provide a viable response to the technological challenges posed by solar power. These challenges can largely be broken down as follows: (i) increasing converting solar power efficiency into electricity and (ii) lowering costs. Specifically, pilot plants enable us to test the following:

- Greater operating temperatures to render the thermal cycle more efficient.
- New materials to withstand the high temperatures and steep temperature gradients involved in each operating cycle.
- New thermal storage systems to facilitate energy supply management. This is one of the key advantages offered by solar thermal technology, in that other renewable energy sources are not manageable in this way.
- Use of new heat transfer fluids, such as water, for direct generation of steam, thus avoiding the need for expensive heat exchangers -which entail a loss of performance- or molten salts to achieve higher operating temperatures.
- Improvements in plant control and operation to enhance efficiency and reliability.
- Developing concentrating photovoltaic technology for competitive power generation at plants located in the Sun Belt.
- Electrical storage that brings photovoltaic generation into balance with electricity use, thus improving the integration of photovoltaic power with the network.

# 07

## Abengoa and innovation

In response to these challenges, the company continued to operate several pilot plants as part of the Solucar complex (Sanlúcar la Mayor, Seville, Spain) over the course of 2011. The projects have validated a range of key innovative concepts:

- Eureka tower, which operates with superheated steam generated in a second receiver, reaching temperatures of over 500 °C. The plant entered service at the start of 2009 and has since accumulated over 1,800 hours of operation.



Torre Eureka

- Over the course of 2011, construction work continued on other central receiver plants (molten salt and pressurized air), the pilot versions of which will become operational in 2012.
- Also in 2011, improvements were made to the direct steam generation (DSG) plant, which also entered service towards the start of 2009.
- Validation of thermal storage: the ongoing operation of a molten salts demonstration plant since 2009 has provided invaluable experience in the use of this storage medium and has allowed the company to gauge the overall performance of this kind of storage.

# 07

## Abengoa and innovation

As a result of this R&D&I activity, Abengoa has proprietary technology protected through patents. The company therefore holds priority rights over numerous significant and crucial inventions within the solar sector, which have led the company to seek a grand total of 107 domestic patents in different stages of concession.

### Major milestones of 2011

The R&D program in the solar business unit rests on four main pillars:

#### Central receiver and tower technology

Abengoa centers its research on central receiver and tower technology and this is what sets it apart from its competitors.

One of the internationally recognized hallmarks of Abengoa is its use of tower and heliostat technologies in its quest for efficiency, particularly in the solar component of the plant.

In 2011, besides operating the Eureka plant to produce superheated steam, the company undertook research and development relating to one of the main components of a solar plant: the receiver.

The Eureka facility reaches higher temperatures to produce superheated steam, thus improving the overall efficiency of the steam cycle. The plant features 35 heliostats and a 50 m tower mounting the experimental superheating receiver. The approximate power of the plant is 3 MW thermal.

The CRS molten salt project (co-financed by the Spanish CDTI) involves the engineering and manufacture of a solar receiver tower prototype in which the heat transfer fluid is a mixture of molten salts.

In addition, the Solugás project (co-financed by the European Union's Seventh Framework Programme), which got under way in 2008, aims to demonstrate the functioning of tower technology at higher temperatures, using air as the heat transfer fluid and a gas cycle instead of steam.

In both projects, considerable progress has been made in constructing the pilot facilities, which will enter service over the first half of 2012.

Also in 2011, Abengoa developed a new heliostat allowing the company to slash costs by nearly 20 % in addition to the cost reduction obtained in 2010.

#### Parabolic troughs

Parabolic-trough technology offers great potential for improvement in a wide range of its components, including structure, mirror fixing approaches, tubes and interconnections. Abengoa is researching all of these components. At its prototype facilities at the Solucar complex, the company tries out many different configurations in an ongoing search for an optimum ensuring the utmost efficiency at a competitive cost.

Since 2007, the company has operated an experimental loop comprising four collectors and using thermal oil as the heat transfer fluid. Potential optical and thermal improvements have been assessed and all the key components of the technology have now been identified.

The direct steam generation plant was also modified in 2011 to improve its operation, which was resumed four months ago. This plant comprises three loops and uses steam as its heat transfer fluid. By removing the need for an oil-steam exchanger, the technology boosts overall plant efficiency. Yet this direct generation technology requires a far more critical degree of control than thermal oil; the coexistence of two phases of matter in the receiver tube makes for higher instability.

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## Abengoa and innovation



Parabolic trough

We are also developing two new types of collector that use different materials so as to avoid commodity price risk.

Research is also continuing under the Cenit Consolida project to improve components and transfer fluids. Here, the sought-after qualities are maximum durability and minimum environmental impact.

### Storage technologies

The electricity-generating at solar thermal plants is on his way to be sufficiently mature to be treated as a viable alternative to conventional thermal power plants. In order to get round the seasonal nature of solar radiation, thermal energy storage is a key factor.

The size of the energy storage system attached to a solar plant is determined by the plant's main transfer fluid -steam or thermal oil. Vapor stores heat in latent form, while oil stores it in sensible form.

Parabolic trough plants use thermal oil, and thus thermal storage in the form of sensible heat. A hot body (e.g., a heat transfer fluid) is brought into contact with a cooler liquid, solid or gaseous medium in which the heat is to be stored. As a result, the storage medium heats up. Using the sensible heat of the material, the medium stores energy as and when its temperature rises.

This technology continued to undergo testing in 2011 at an experimental plant. The experience provided a highly valuable lesson in operation and optimization for the construction of future commercial solar plants with attached storage systems, such as the 280 MW Solana plant under construction at Phoenix, Arizona, where work got underway at the end of 2010.

Where heat is exchanged with a fluid that in that same process undergoes a change of phase -becoming steam- the storage technology makes use of the energy associated with the change of phase of the material or mix of materials. Abengoa is currently involved in various R&D projects within this particular area and for which we expect to see the corresponding pilot plants on the near horizon.

Furthermore, Abengoa has been involved in various projects to generate hydrogen from solar thermal and photovoltaic energy.

### Photovoltaic technology

#### ■ Concentrating photovoltaics (CPV)

In partnership with NREL and several North American universities and colleges, the company is developing new concentrating photovoltaic concepts, highlights include: a new generation of Fresnel lens photovoltaic concentrators, a semistatic low-concentrating system and other innovative technologies. In the mid-term, these new concepts are destined to play a key role in photovoltaic systems capable of generating electricity at competitive costs.

The company has been heavily involved in the development of solar trackers for concentrating photovoltaic applications. It successfully installed several CPV devices on a 400 kW plant at the ISFOC (Institute of Concentration Photovoltaic Systems) in Puertollano (Ciudad Real, Spain).

#### ■ Technologies with new materials:

Abengoa is constructing an R&D technology center at Sanlúcar la Mayor (Seville), where it intends to conduct research applied to new materials, photovoltaic cells,

TES



Concentrating photovoltaics





prototypes and photovoltaic thin-film technologies. The knowledge thus generated will lead to proprietary and competitive technologies in support of Abengoa's future industrialization projects.

■ **Photovoltaics laboratory:**

The photovoltaics laboratory built in 2008 has tested and measured the performance of a wide range of photovoltaic systems under real operating conditions. Based on the data thus gathered, the laboratory has developed an experimental software application to analyze the cost of generating energy using different technologies and configurations, prevent or solve problems arising over the lifetime of photovoltaic systems, and identify the optimal technology and configuration for different kinds of facility.

## Bioenergy

Abengoa intends to become a market leader in the biofuel sector while developing sustainable solutions for the transportation sector and creating bioproducts from biomass. The company focuses on the development of technologies for producing biofuel from lignocellulosic biomass, especially bioethanol via enzymatic hydrolysis and gasification and the catalytic synthesis of alcohols, and also on obtaining high value-added bioproducts.

The company has pilot facilities (0.4 ML/year) in York (Nebraska, US) and demonstration plants (5 ML/year) in Babilafuente (Salamanca, Spain), along with biochemical laboratories in Babilafuente and Seville and a laboratory with test bench plants at Seville University in order to test and improve catalysts. Abengoa is also developing the first production facility to produce second-generation ethanol commercially in Hugoton (Kansas), which will have an approximate capacity of 100 ML/year. The facility has already received significant development aid from the US Department of Energy.

In Europe, company business is part financed by aid received from the European Commission under its framework programs (Abengoa in the area of bioenergy ranks sixteenth in terms of support received under the VII Framework Programme), from various programs of the Spanish government and from different local bodies.

This support is a testament to the quality of the company's research and development programs as it requires them to be assessed by third parties. The results obtained so far have been outstanding.

## Major milestones of 2011

In the area of sustainability and energy consultancy, a highlight has been the design, development and subsequent approval from the European Commission for Abengoa's own voluntary scheme (RBSA) through which to demonstrate compliance with the statutory requirements imposed by the Renewable Energy Directive 2008/29/EC. In addition, work continues on designing and improving sustainability management and strategic development systems and supporting interaction with stakeholders.

In the field of gasification and catalysis, in 2011 the company continued its ambitious program to develop heterogeneous catalysts for converting synthesis gas (syngas) into ethanol. The company has filed applications for two Spanish patents to protect groundbreaking catalysts that improve on existing state-of-the-art. We have continued to develop technical and economic models and analyses for various configurations of thermochemical biomass conversion, and to explore the different options for introducing biomass gasification technologies.

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## Abengoa and innovation



The European Commissioner for Energy, Günther Oettinger, pictured here on July 19, 2011 while recognizing Abengoa's own voluntary RBSA scheme as one of the seven approved schemes for demonstrating compliance with the sustainability requirements enshrined in the European Energy Directive 2009/28/EC.



Biofuel synthesis laboratory

BCyL plant in Babilafuente (Salamanca).

Our pilot plants are constantly evolving. We have introduced improvements to the starch-based production process so as to raise the performance of ethanol/grain conversion. At the same time, we are experimenting with new enzymes in order to assess the resulting improvements in performance and reduction of impacts. Major progress has thus been made in output performance as measured by liters of ethanol per ton of grain. Abengoa's biofuels division has also been working on the development, assessment and validation of new processes to recover value from the coproducts of cereal-based bioethanol production, with special focus on improving coproduct consistency, enhancing protein digestibility and concentration, and developing pig and free-range poultry feed.



A particular highlight for 2011 was the construction of an experimental plant in Cartagena, at which we intend to test various configurations of processes and technologies as part of an ambitious algae program, which includes isolation, characterization, development of laboratory-scale techniques to cultivate the algae and incorporate them into biofuels, and optimization of production systems to render them viable, culminating in the industrial integration of the resulting process. The experimental results obtained will be critical to proving once and for all that this technology can indeed produce new raw materials for biofuel plants and animal feed and, in synergy, capture of the fermentation CO<sub>2</sub> generated during bioethanol production, thus allowing for further savings of greenhouse gas emissions within the transportation sector.

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## Abengoa and innovation

Experimental Ecoalga facility in Cartagena, Spain. The Ecoalga Project has received funding from the Spanish Ministry of Science and Innovation under the 2008-2011 National Scientific Research, Development and Technological Innovation Plan. The plan is managed by the Spanish Institute of Oceanography under the Special State Fund for Stimulating the Economy and Employment, Plan E.



V Conference of the European Union's VII Framework Programme for R&D in Spain, organized by the CDTI and the Sociedad para la Transformación Competitiva del Gobierno Vasco (SPRI) under the title "Towards a Common Research and Innovation Strategy".

Moreover, Abengoa was deemed eligible to take part in the VII Framework Programme, heading proposals with a budget of over €10 M and thus helping to drive forward domestic and European SMEs and research centers. Abengoa has therefore improved on its position in the interim evaluation of the 7FP, in which it was ranked third within Spain for returns on 7FP funds, behind Telefónica and Atos Origin, and sixteenth on the European stage





### Enzymatic hydrolysis

Enzymatic hydrolysis technology is one of the key target areas for Abengoa is focusing its technological development efforts in order to diversify the range of raw materials from which biofuel and bioproducts can be produced. The main objective is to be able to produce bioethanol from raw lignocellulosic materials, chiefly straw from different cereal crops and herbaceous crops.

As a result of our work, we are now developing our own second generation proprietary technology at a pilot plant in York, Nebraska, coupled with our BCyL demonstration plant in Salamanca, Spain, which is the largest of its kind in the world producing this kind of second generation biofuel.

The BCyL demonstration plant has been operating non-stop for over 5,000 hours, delivering conversion performance figures above design specifications and illustrating its flexibility at utilizing different kinds of biomass.

The company is currently developing the Hugoton project (Kansas), where it intends to build its first commercial plant to produce 100 ML of bioethanol every year from sugar cane, wheat straw and switch grass (second generation bioethanol). These facilities will unquestionably be heralded as a milestone by the international community and thanks to its sterling work, Abengoa will have a technology that can be used worldwide. The company intends to grant licenses to third parties to improve the sustainability of the transportation sector.

### Catalysis

As an alternative route to enzymatic hydrolysis technology, the company has also been busy working on biomass gasification and syngas conversion into ethanol through catalytic processes. In this particular field, Abengoa has been working to combine these technologies, and patents have been obtained for various catalysts and operating processes, making the company the leading figure in this technology.

Similarly, all the knowledge of catalytic processes gained from the development of ethanol synthesis technology is being channeled into other catalytic processes for converting ethanol into products with a greater value-added, such as butanol and jet fuel, and for transforming sugars directly via catalytic processes.

### Enzymes

Abengoa has obtained a license from Dyadic to use and modify an organism that produces the enzymes required to convert cellulose into sugar. This represents a critical and essential step in developing enzymatic hydrolysis technology.

BCyL demonstration  
plant in Salamanca





# 07

## Abengoa and innovation

Abengoa boasts a highly qualified team of engineers, chemists and biochemists, all of whom are working to develop this technology, focusing on aspects relating to the suitability of the organism to the production of the optimum enzymatic cocktail, and on the fermentation process needed to make this a reality on an industrial scale. The pilot facilities at York and the BCyL demonstration plant are essential for developing the enzymes and allow Abengoa to have a single base for testing worldwide.

Thanks to this technology, Abengoa has the product it needs for enzymatic hydrolysis technology, which it will use at its own plants and at third-party facilities that employ this same process for producing bioethanol

### Bioproducts

Abengoa has a unique platform for producing sugar at its existing facilities and at the second-generation plants it is currently developing. One of the main objectives of this development program is to produce bioproducts through technologies in which we already have considerable experience (via fermentation), or through new processes that prove technologically competitive. The aim of this program is to increase the value-added of our plants through the new products we can obtain. We are confident that over the coming years these new products will provide a sustainable and economically competitive alternative to fossil fuels and will greatly reduce our dependence on oil derivatives.

The incorporation of bioproducts into the production output of our plants opens up a new field of applications with a number of different end-uses, where innovation is key to gaining a position of leadership in the use of the selected technologies.

Our prowess in R&D, both in terms of processes and biochemistry, demonstrates our ability to develop new technologies and provides a solid base from which to ensure the success of this program.

### Algae

In 2009, Abengoa set in motion an ambitious algae program to isolate, characterize, select and improve organisms, develop laboratory-scale techniques for cultivating and processing these organisms in biofuel settings, optimize production systems so as to attain viability, develop post-cultivation processes of conversion into target products, and finally integrate the productive process with industrial activities.

### Sustainability

Abengoa is developing specific technological solutions to trace our products from the raw material to the end user, enabling the company to label them, assess and verify their environmental benefits and ensure the global sustainability of producing them, with special emphasis placed on environmental concerns in the regions where the raw materials are produced. This process has led to a complete management system currently in place throughout the company and which could be licensed out to third parties.

The entire system is being incorporated into a single information and reporting platform, which encompasses management applications for raw materials and production, life cycle analysis calculations, GIS-based systems and information on processes. This platform will allow us to have a product that can be used to manage the sustainability of numerous different processes and will be of particular value for biofuels.

## Desalination

Water is essential for ongoing life and is considered a right of every person on earth. Nevertheless, close to a third of the world's population lives in countries that suffer from moderate to high water stress, while roughly 20 % has no reliable source of drinking water.

Only 3 % of the planet's water is fresh water and only 0.3 % is available from rivers and 0.6 % from underground sources, with the rest tied up in the polar icecaps. As a result, most of the planet's water is either seawater or otherwise difficult to access. In addition, humankind dump much of its waste into watercourses and coastal waters, leading to undesirable changes in their structure.

Water is therefore a scarce natural resource and we must learn to manage it sustainably and harmonize economic growth with water availability.

## Description

At Abengoa, innovation applied to water treatment is geared towards creating value by developing new water treatment technologies that respect sustainable development.

With this in mind, the company has a strategic R&D&I plan in place specifically for water, which rests chiefly on four levers:

1. Own resources, primarily our R&D&I department and R&D&I center.
2. Research and development aid and subsidies from different bodies.
3. Agreements with universities.
4. Technological agreements.

R&D center in  
Dos Hermanas (Seville)



# 07

## Abengoa and innovation

The solution to water scarcity lies in the proper management of scarce resources, the generation of alternative water resources, and factoring in sustainability criteria for water treatment and use.

Abengoa's commitment centers on developing desalination technology through reverse osmosis, allowing us to render seawater and brackish water drinkable, and on developing wastewater treatment and regeneration technologies, enabling us to reuse the water and therefore generate new water resources in regions suffering from water stress.

The company also develops hollow-fiber filtration membrane technology using polymeric materials, which can be applied to both desalination processes and water treatment processes for potabilization, purification and regeneration.

### Major milestones of 2011

R&D&I in the field of water treatment is divided into four programs: two vertical ones focused on developing water treatment processes, particularly Desalination and Potabilization – Purification - Reuse, respectively, a third horizontal program that aims to develop filtration membranes, and a fourth general program to seek out innovative solutions based on ensuring the sustainability of the water cycle.

#### Desalination

Abengoa is focused on enhancing the efficiency of the reverse osmosis (RO) process and on lowering associated investment and operation and maintenance costs.

Work tends to follow two lines: optimizing the RO desalination process on the one hand, and developing new desalination technologies on the other.

One of the most important aspects of desalination processes is the final remineralization stage, whereby the desalinated water is given the final properties it requires for its intended use. In this area, Abengoa has developed a new post-treatment system for remineralizing water desalinated through reverse osmosis. The system allows us to attain the desired quality in terms of the solid content of mineralized water, but with a 15 % saving in water consumption in comparison to the conventional systems currently found on the market.

#### Potabilization – Purification - Reuse

The aim here is to optimize membrane-based water treatment processes so as to save energy and produce less sludge, develop sludge treatment and elimination technologies and undertake research on supercritical oxidation.

As with desalination, work tends to focus on two lines. On the one hand, developing membrane-based wastewater treatment systems (including both urban and industrial water), thus allowing for water regeneration and subsequent reuse. On the other, developing advanced water treatment systems for removing emerging contaminants from both drinking and wastewater, and obtaining energy from water purification processes.

Abengoa has developed a wastewater treatment system based on pressure filtration with proprietary microfiltration membranes. The system has been tailored for two applications: Firstly, as a tertiary treatment for the regeneration and reuse of effluent from water purification plants and, secondly, to treat liquid effluent from industrial processes, including biofuel production, for subsequent reuse within the same process. In both cases, research has been conducted at pilot-scale.

### Filtration membranes

The aim here is to develop proprietary hollow-fiber membrane micro- and ultrafiltration technologies, which can be applied to seawater or brackish water pretreatment processes; water filtration for potable use and urban and industrial wastewater purification for regeneration and reuse.

Work tends to focus on two lines: On the one hand, developing proprietary hollow-fiber polymeric membrane technology for both micro- and ultrafiltration and, on the other, gaining knowledge of membrane-based water filtration processes through an approach that includes not only theory but also experiments.

Abengoa has conducted in-depth analyses of the behavior of membrane filtration systems for water pretreatment for desalination. The company has carried out in-situ experiments to explore seawater filtration through micro- and ultrafiltration membranes, using outside-in and inside-out pressure filter systems under different operating conditions and for different membrane cleaning and regeneration strategies. These experiments are conducted in China.

### Sustainability program

The purpose of this program is to develop and apply sustainability criteria when designing solutions, incorporating renewable energy sources (solar, wind, marine) into desalination processes, and conducting life cycle assessments (LCA) of the different water treatment processes.

Work has focused primarily on two lines: applying solar power to desalination and the LCA of desalination, potabilization and purification processes.

Work has continued on the construction and commissioning of a solar thermal powered demonstration desalination facility. The system involves a multi-effect desalination process (MED) powered by the thermal energy collected by a field of parabolic troughs. In order to render it more efficient, the system features a double-effect absorption pump

## Ocean energy

In 2011, Abengoa decided to drive forward its sea power business by creating a new business line.

There are two key factors underpinning the success of this new activity: firstly, the company's impressive track record in developing turnkey renewable energy projects and secondly, access to state-of-the-art technology specific to this field. In addition to the knowledge that Abengoa's own R&D team has built up over years of research (track record), the company also strikes up strategic alliances with specialized technology firms to offer solutions for different kinds of plant (access to cutting-edge technology).

### Description

This line of business draws together all the different offshore renewable energy generation activities, including wave power, marine current power and, of course, offshore wind power. Our multi-disciplinary team is made up of engineers and scientists with differing fields of expertise; a core team of workers that will grow as needed, given the unique problems associated with working in marine environments.

This reflects the global strategy of Abengoa and its commitment to developing innovative solutions in the realm of sustainability. Although this kind of technology is currently less mature than solar or wind power, it promises much for the future.



Ocean energy



# 07

## Abengoa and innovation

In addition to the company's own projects, the ocean energy business line is involved in R&D ventures through Spanish and European consortiums, including:

### Unique Strategic Ocean Energy Project (PSE-Mar)

Electromechanical design of specific underwater connectors for wave power devices.

### Cenit TEcoAgua project: "Sustainable Technologies for the Integral Water Cycle"

Managing knowledge, processes and technologies for the integral water cycle.

### ORECCA project: "Offshore Renewable Energy Conversion Platforms – Coordinated Action"

Research aimed at developing future marine platforms to generate energy from wind and marine resources in tandem.

### SOWFIA project: "Streamlining of Ocean Wave Farms Impact Assessment"

Assessment of the environmental and socio-economic impact of ocean wave farms.

In addition to the R&D&I projects, Abengoa's ocean energy business line is actively involved in the following forums and platforms for promoting and driving forward innovation and the development of emerging technologies:

- WTE – Aenor's National Standardization Committee AEN/CTN 206/SC 114 on ocean energy (Vice-Presidency)
- WTE – Forum on the Marine Energy of the Spanish Maritime Technology Platform
- WTE – Marine Energy Group of the Spanish Maritime Cluster

## Hydrogen

Abengoa develops proprietary technology in the hydrogen sector, as an energy vector, and in fuel cells, as a gas means of use; in both cases, the company protects its know-how through patents, agreements and alliances.

To elaborate further, the company organizes and conducts business to produce electrical and thermal power through fuel cells (using the different technologies involved) and to generate hydrogen from renewable sources and clean and efficient hydrogen use (including transportation and storage).

### Major milestones of 2011

Highlight research and development activities within the hydrogen sector in 2011 include the following:

- Development of hydrogen storage systems based on hydrosilanes and aminoboranes and start-up of a borohydride-based system to power fuel cells. The aim is to create more secure and efficient systems (greater energy density in terms of volume and weight) for transporting the gas so that these systems can be integrated into different kinds of applications.
- Detail engineering of a solar reactor for hydrogen production through bioethanol reforming. This reactor employs catalysts and solar thermal energy to attain a current of hydrogen-rich gas from a mixture of ethanol and steam.
- Detail engineering of a solar reactor for water-to-hydrogen production through thermochemical cycles. In this case, only water is used as the raw material for producing hydrogen; nonetheless, to reduce the temperature needed to disassociate the hydrogen molecules, thermochemical cycles are used instead of direct thermolysis.



Hydrogen borohydrides

# 07

## Abengoa and innovation

Hydrogen-powered android



- Completion of studies for the use of fuel cell systems in different railroad applications. Abengoa has cooperated with manufacturers from the railroad sector in pursuit of more sustainable forms of rail transport that utilize hydrogen as the energy vector, analyzing both vehicle propulsion systems and the supply of auxiliary parts.
- Development of new portable systems for generating electrical power from fuel cells, including testing of these systems. Along these lines, Abengoa has been operating 20-50 W systems powered with polymer fuel cells (polymer electrolyte membrane, or PEM), integrating all the necessary elements to ensure they work properly, including hydrogen storage.
- Generation of electrical power via hydrogen combustion: analysis of alternative internal combustion engines, turbines and microturbines. This line of research, which was initiated only recently, aims to harness hydrogen in order to generate thermal, mechanical and electrical power under different engine and turbine set-ups for use in the stationary and transportation sectors.
- Application of fuel cell systems for powering robots. Abengoa has been collaborating with Rey Juan Carlos University to develop a power system for androids, employing hydrogen as the fuel source and polymer fuel cells. Development of new portable systems for generating electrical power from fuel cells, including testing of these systems.
- Study and analysis of the hydrogen life cycle. This covers the entire hydrogen production chain and use of the gas in fuel cells, factoring in the environmental concerns (chiefly CO<sub>2</sub> emissions) and economic considerations (associated costs) of the different processes for producing the gas.

With a view to optimizing its R&D activity, Abengoa has set up a Laboratory for Trials and Characterization of Fuel Cells and Advanced Hydrogen Technologies at its Campus Palmas Altas headquarters in Seville. The laboratory was designed by the company's technical team and features different technologies for producing hydrogen (reforming, electrolysis), conventional and experimental storage systems, and an area for testing fuel cells and developing their associated subsystems (particularly power electronics and control systems).

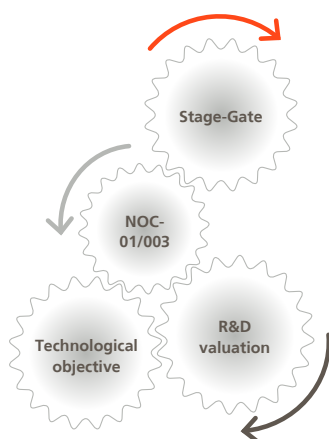
## Innovation management

Valuating R&D work, as an integral part of the many activities geared towards innovation management at Abengoa, its ultimate aim of this process is to help attain Abengoa's strategic objectives, while simultaneously minimizing the risks associated with investments in R&D&I projects.

In 2010, Abengoa took its first step towards rolling out its R&D assessment system by designing a process to quantify, in economic terms, the company's innovation "assets". This process allows the company to track investment in R&D from its origin to its actual implementation within a commercial process, measuring the improvements made by the research, in terms of profitability and efficiency, to the processes associated with technological innovation. The intangible nature of innovation can therefore be singled out and incorporated into the value generated by Abengoa.

Over the course of 2011, R&D was evaluated throughout the entire company. This common approach was used to assess the different programs of all lines of business, thus allowing Abengoa to obtain homogenous and therefore comparable results. The process has therefore provided the company with useful data with which to improve the quality of its strategic decisions relating to R&D&I investment, including qualitative and quantitative aspects, and allowing the company to weigh up all the different factors that should be taken into account when reaching a final decision.

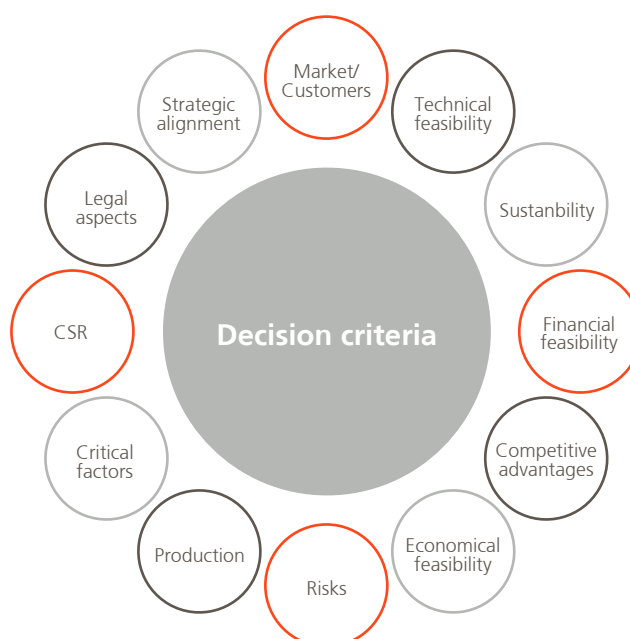
Innovation management instruments at Abengoa



# 07

## Abengoa and innovation

Criteria incorporated into the R&D evaluation process



The R&D valuation process follows the sequence described below:

- Description of the programs with a certain degree of detail and of their objectives and budgets. This requires us to align the program with the target market of our strategic objectives and subsequently allows us to compare the different programs.
- Qualitative valuation, studying how each R&D program fits in with Abengoa objectives, based on the criteria previously flagged as key to its strategy.
- Quantitative valuation, enabling us to estimate the value of the programs, including any uncertainties, and to identify any possible risk of the desired value not materializing. To such end, Abengoa prepares and studies technological and demand-related scenarios under different degrees of probability, which are then combined with the inputs associated with each program. The process is then repeated to obtain an average expected value of the portfolio of each R&D program with an associated risk.
- Lastly, the results are compared together to provide an overall picture of the portfolio, comparing its strategic suitability and maturity with its economic value.

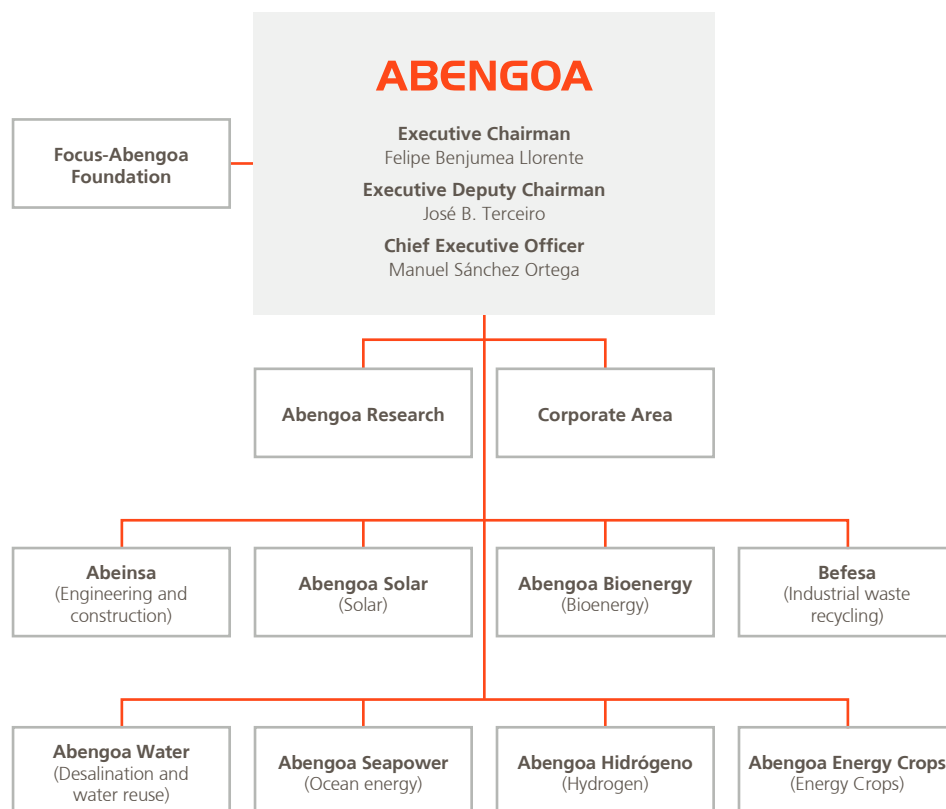
The process is essentially intended to add valuable information on issues that are essential to R&D&I management, on our R&D&I strategy, on the suitability of our programs to this strategy, on the alignment of projects to programs, on risk diversification, etc. It also allows us to forge solid links between the projects/programs and the viability of different lines of business, with associated costs and returns considered globally.

The ultimate aim is therefore to identify the impact of R&D on Abengoa's current results and on its short-, medium- and long-term projected results.





## Abengoa organizational structure



	Engineering and construction	Concession-type infrastructures	Industrial production
Abeinsa	×	×	
Abengoa Solar		×	×
Abengoa Bioenergy			×
Befesa			×
Abengoa Water		×	
Abengoa Seapower			×
Abengoa Hidrógeno			×
Abengoa Energy Crops			×

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## Organizational structure & management team

Board Structure	Head	Address	Phone & Fax
Executive Chairman	Felipe Benjumea Llorente	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. + 34 95 4937005
Executive Deputy Chairman	José B. Terceiro	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. + 34 95 4937005
Chief Executive Officer	Manuel Sánchez Ortega	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 4937005
Institutional Relations, Chairman's Advisor	Germán Bejarano García	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 91 4486564
Technical General Secretary	José Domínguez Abascal	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
General Secretary	Miguel Ángel Jiménez-Velasco Mazarío	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Vicesecretary	José Fernando Cerro Redondo	Gral. Martínez Campos, 15-7º 28010 Madrid (Spain)	P. +34 95 4937111 F. + 34 91 4484025
Legal Counsel	Maarten Hoogstraate	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Communication	Patricia Malo de Molina Meléndez	Gral. Martínez Campos, 15-7º 28010 Madrid (Spain)	P. +34 95 4937111 F. + 34 91 4484025
Risk Management	Rogelio Bautista Guardado	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Corporate Social Responsibility	Carlos Bousoño Crespo	Gral. Martínez Campos, 15-7º 28010 Madrid (Spain)	P. +34 95 4937111 F. + 34 91 4484025
Economics & Finance	Vicente Jorro de Inza	Gral. Martínez Campos, 15-6º 28010 Madrid (Spain)	P. +34 95 4937111 F. + 34 91 4487820
Corporate Finance	Jesús Ángel García-Quílez Gómez	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Structured Finance	María Olimpia Montero Sánchez	Gral. Martínez Campos, 15-6º 28010 Madrid (Spain)	P. +34 95 4937111 F. + 34 91 4487820
Concessions	Eduard Soler Babot	Gral. Martínez Campos, 15-7º 28010 Madrid (Spain)	P. +34 95 4937111 F. + 34 91 4484025
Investor Relations & Reporting	Bárbara Zubiría Furest	Gral. Martínez Campos, 15-7º 28010 Madrid (Spain)	P. +34 95 4937111 F. + 34 91 4484025
Consolidation	Enrique Borrajo Lovera	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Internal Audit	L. Enrique Pizarro Maqueda	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Strategic Development	Javier Camacho Donézar	Gral. Martínez Campos, 15-5º 28010 Madrid (Spain)	P. +34 95 4937111 F. + 34 91 4484025
Planning & Control	Juan Carlos Jiménez Lora	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Appointments & Remuneration	José Marcos Romero	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Human Resources	Álvaro Polo Guerrero	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Information Systems	Enrique Aroca Moreno	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413373
Organization, Quality & Budgets	Luis Fernández Mateo	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Management Abengoa Research	Enrique Moreno Benítez	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Scientific Director Abengoa Research	Manuel Doblaré Castellano	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Engineering and Construction	Alfonso González Domínguez	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 4937005
Solar	Santiago Seage	Paseo de la Castellana, 31-5º, 28046 Madrid (Spain)	P. +34 95 4937111 F. +34 91 3196677

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## Organizational structure & management team

Board Structure	Head	Address	Phone & Fax
Bioenergy	Javier Salgado Leirado	16150 Main Circle Drive, Suite 300 Chesterfield, St. Louis, MO 63017-4689 (USA)	P. +1 636 728 0508 F. +1 636 728 1148
Industrial waste recycling	Javier Molina Montes	Paseo de la Castellana, 31-3º, 28046 Madrid (Spain)	P. +34 95 4937111 F. +34 91 3105039
Desalination and water reuse	Carlos Cosín Fernández	C/ Ombú 3, Edificio Torre Urbis, 28045 Madrid (Spain)	P. +34 95 4937111 F. +34 91 5284317
Ocean energy	Javier Camacho Donézar	Gral. Martínez Campos, 15-5º 28010 Madrid (Spain)	P. +34 95 4937111 F. + 34 91 4484025
Hydrogen	Javier Brey Sánchez	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413373
Energy Crops	Guillermo Rucks Lombardi	Avenida Uruguay, 1283, 11100 Montevideo (Uruguay)	P. +59 82 902 2120 F. +59 82 902 0919

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## Organizational structure & management team



Board Structure	Head	Address	Phone & Fax
President	Felipe Benjumea Llorente	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 4937005
President	José B. Terceiro	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 4937005
Vice President	Juan Antonio Carrillo Salcedo	Plaza de los Venerables, 8 41004 Seville (Spain)	P. +34 95 4562696 F. +34 95 4564595
Secretary	Miguel Ángel Jiménez-Velasco Mazarío	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
Manager	Juan Carlos Jiménez Lora	Campus Palmas Altas, Energía Solar, 1 (Palmas Altas) 41014 Seville (Spain)	P. +34 95 4937111 F. +34 95 5413371
General Manager	Anabel Morillo León	Plaza de los Venerables, 8 41004 Seville (Spain)	P. +34 95 4937111 F. +34 95 4564595