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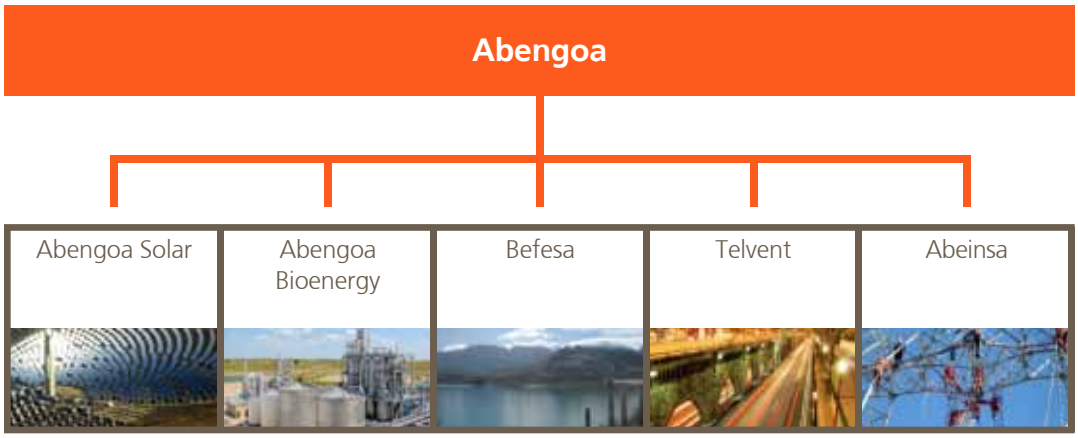
Introduction

Abengoa is a technology company that drives its business via innovation, defined as any knowledge-based change that creates value. This chapter primarily concerns technological innovation, and the research, development and creativity it entails. However, there are other key areas of business endeavor that, though not technology-driven, call for ongoing innovative effort. Innovation in all aspects of business is a value that must guide and engage everyone in the company. An innovative culture encourages people to explore new directions and take the risks this involves. Nevertheless, for Abengoa, innovation is not an end in itself but a means of transforming society towards a more sustainable world.

Innovation is one of the underpinnings of business competitiveness, but it demands strenuous and unceasing commitment and rigorously accurate business and financial management. Competitiveness needs to be sustained over time. One way of achieving this is to broaden the range of inputs to the productive process. But it cannot be a question of quantity alone. The quality of the company's inputs and, even more, its ability to make use of them can and does lead to higher output supported by higher performance. This is the variable measured by total factor productivity, TFP, the extent to which productivity increases beyond the mere sum of conventional factors such as capital and labor. The Nobel laureate economist Robert Solow, in his study on the growth of TFP in the United States over the first half of the twentieth century, concluded that close to 80 % of United States GDP growth was attributable to TFP. After Robert Solow, technological development is regarded as the variable most contributing to TFP. According to Solow, it is by increasing TFP that technology raises return on capital.

At Abengoa, technological development is a key factor for its infrastructure, environment and energy divisions, via its five business units, and plays a key role in the achievement of its strategic objectives.

Abengoa and its business units



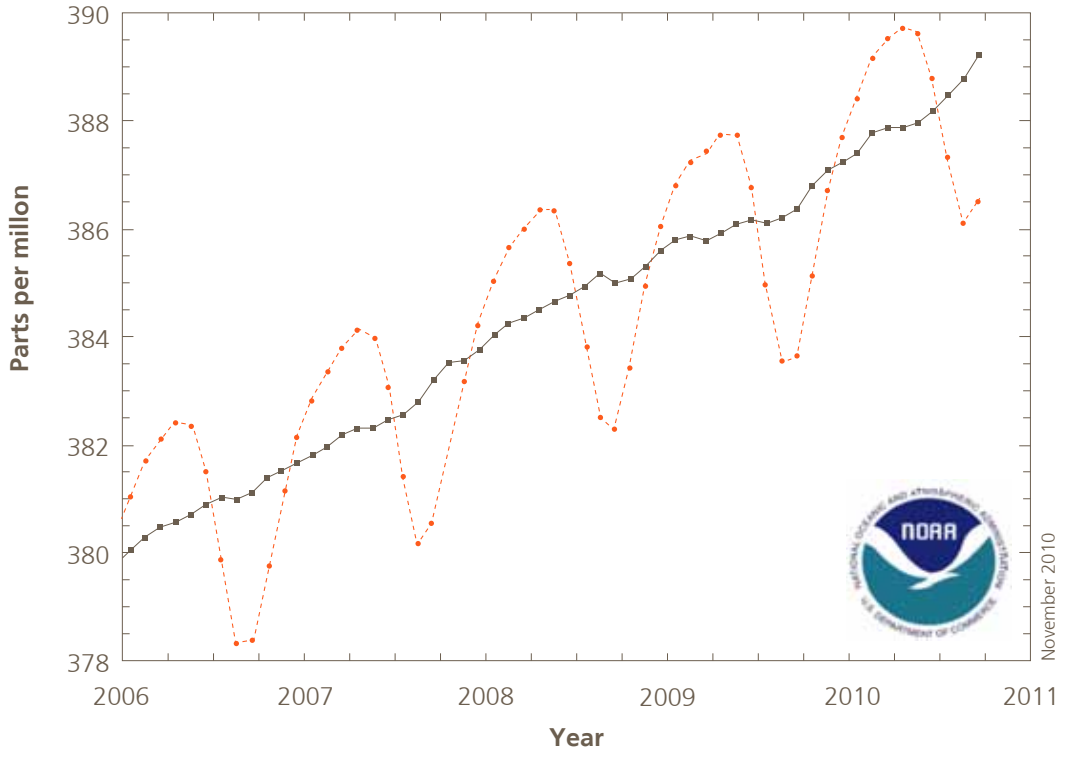
Abengoa has accordingly adopted the "innovation ecosystem" approach: The company works in partnership with universities, government agencies, public research institutes, technology centers and other private enterprises to support the creation of knowledge networks, with Abengoa as the driving force. This approach to innovation embraces demonstration projects, research and development facilities in various countries and alliances with third parties.

Sustainability. Abengoa's Business Metrics

The economist Jeremy Rifkin has said that what is now sometimes called the "black" economy (in contradistinction to the "green") - the industrial revolution driven by oil, cars and centralized energy production - peaked in the late twentieth century. Attempts to preserve the status quo only led to distortions, like the financial and property bubble that has recently burst. So it is now time to undertake a third industrial revolution: The Green Revolution.

Global warming is caused by human activity and year after year we have raised the atmospheric concentration of carbon dioxide: In November 2010, the Keeling curve exhibited a carbon dioxide concentration of 389 ppm. This poses a serious risk to the environment and to life. It is also set to deal a harsh blow to the world economy. According to the Stern Review on the Economics of Climate Change, global warming could throw the world into a slump involving a 20 % decline in global GDP. This means the economy and society would be severely disrupted for the remainder of this century and beyond.

Recent Global Monthly Mean CO_2



Keeling curve. Increase in carbon dioxide in the atmosphere measured in ppm (parts per million). (Dr. Pieter Tans, NOAA/ESRL www.esrl.noaa.gov/gmd/ccgg/trends)

The Stern Review estimates that an investment of 1 % of world GDP is needed to allay the effects of climate change. So far, however, decision-making processes have largely disregarded industry's harmful "externalities." Environmental and social considerations are thus rarely a factor in prevailing economic practice. But by this stage, according to the Stern Review's conclusions, the only remaining question is how quickly the world can get to a zero-emissions economy.

Against this backdrop of far-reaching change, Abengoa is today a world benchmark in the development of innovative technological solutions for sustainable development. Abengoa and its business units' policies and innovation strategies seek to make sustainable use of resources and raw materials so as to harness their entire life cycles. This is why Abengoa today is an international leader in many key areas of the Green Economy. The concept of "Green Economy" was coined in the midst of the present world economic crisis as part of the Global Green New Deal, the United Nations Environment Program mooted on October 22, 2008 to address the interdependence

between economic activity and natural ecosystems, more specifically, industry's harmful implications for climate change and global warming.

President Obama used the term "Green Economy" in his speech to the United States Congress on February 25, 2009 in connection with his ambitious program of energy reform. The new scheme, popularly known as "cap and trade," aims to lower greenhouse gas emissions by 80 % by 2050 and to create millions of new, "green" jobs.

In Spain, the Council of Ministers set its seal on the new Sustainable Economy Bill on March 19, 2010. Regarded as the centerpiece of the current legislative term, the new law is intended to bring about much-needed change in the Spanish economy over the next ten years by basing it on higher value-added industries: This calls for enhanced innovation and competitiveness.

Abengoa, for its part, has been working on the challenge posed by sustainability for the past twenty years. It has honed its capacity for technological innovation as the right tool for this paradigm shift. Abengoa has invested in research, development and innovation, recruited and developed the necessary talent, and disseminated the most promising technologies on a global scale.

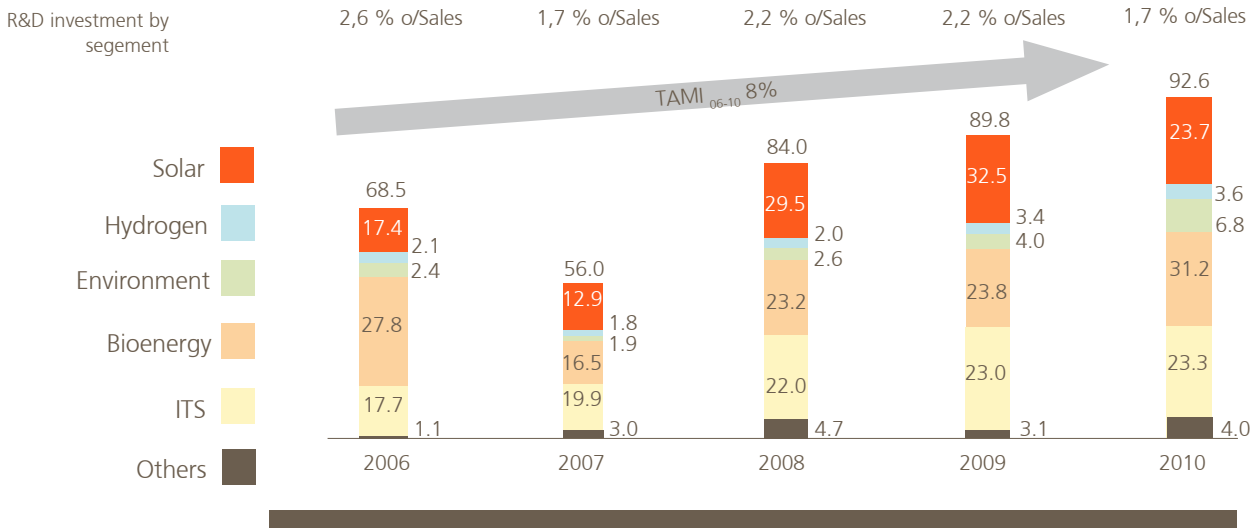
Creating Value at Abengoa through Innovation

Its ability to generate knowledge and extract value from it has made Abengoa a leader in creating new technologies, processes and know-how designed to provide innovative solutions that help preserve the environment, create value over the long term and provide a competitive edge.

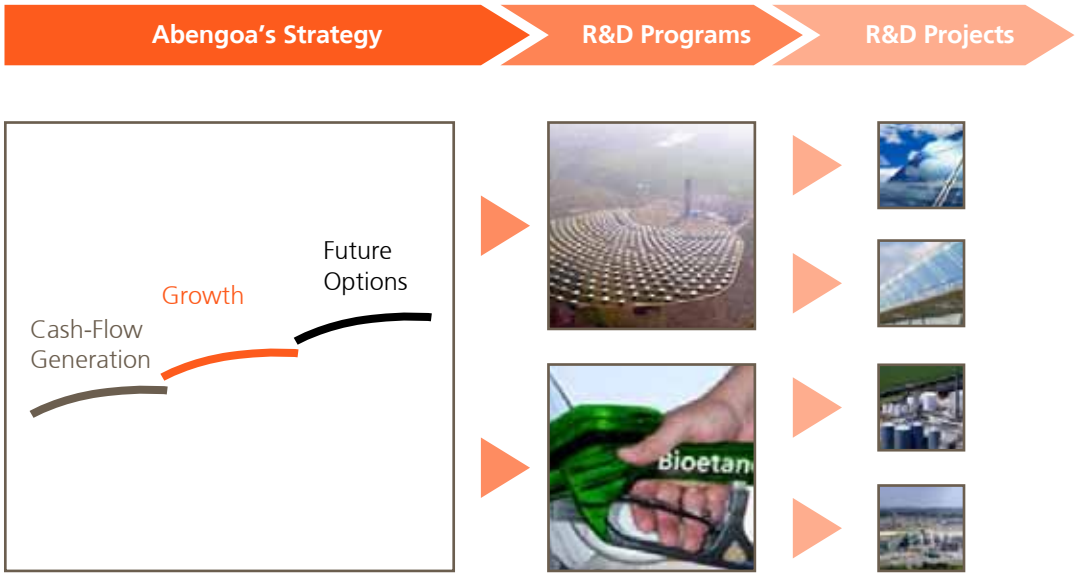
Investment in research and development makes technology the foundation of Abengoa's sustainable growth and plays a central role in its strategic objectives. Research and development is managed on business lines - result-oriented and closely aligned with strategy.

In 2010, Abengoa's investment in R&D amounted to €92.6 M, 3.2 % up on the previous year and equivalent to about 1.2 % of its total sales;meaning a 8 % annual growth rate in R&B investment during the last five years.This figure does not include 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.

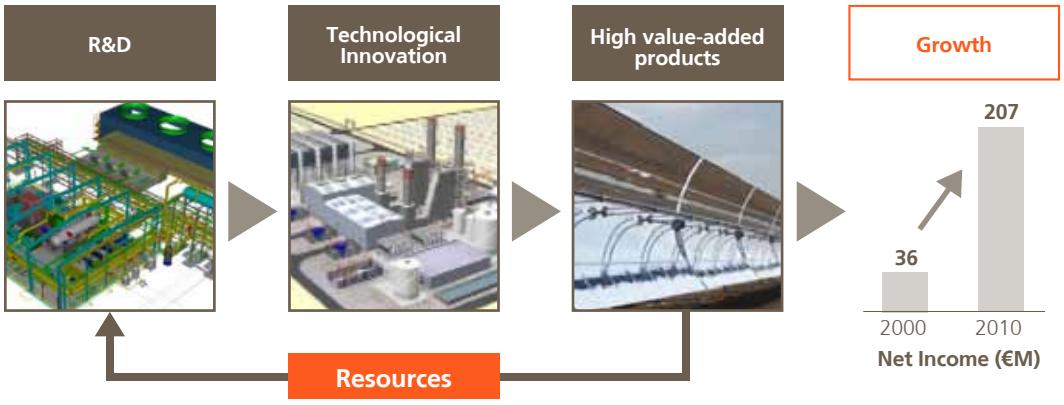


Innovation management at Abengoa is a central part of the strategy implemented by each business unit. Innovation is regarded as having three aspects: New products, new processes and improvements to existing assets. R&D&I programs are general in scope, and are tied to strategic lines of development.



Abengoa's R&D&I programs and projects are aligned with its strategy

Research and development programs take a long-term view (up to 30 years) and are undertaken as phased programs (each covering a ten-year period) and as specific projects (3-4 years). It is these specific projects that put Abengoa's research, development and innovation (R&D&I) effort into practice. At Abengoa, most R&D&I investment is channeled into applied research and the development of technological innovation geared towards the achievement of strategic sustainability goals and new products.



Research, development and innovation directed to value creation

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 the company's research and development activities over the coming years, setting out precisely defined targets for technological advance in terms of specific subject matter and timeframes, tied to McKinsey's "Three Horizons".
- R&D&I evaluation: Economic appraisal of research and development so as to oversee profitability and traceability.
- High-caliber research and development staff capable of living up to these new demands, with mechanisms being designed to ensure the success of their career entry and professional development.
- Major increase in the research and development budget, with funds being set aside for highly innovative projects.

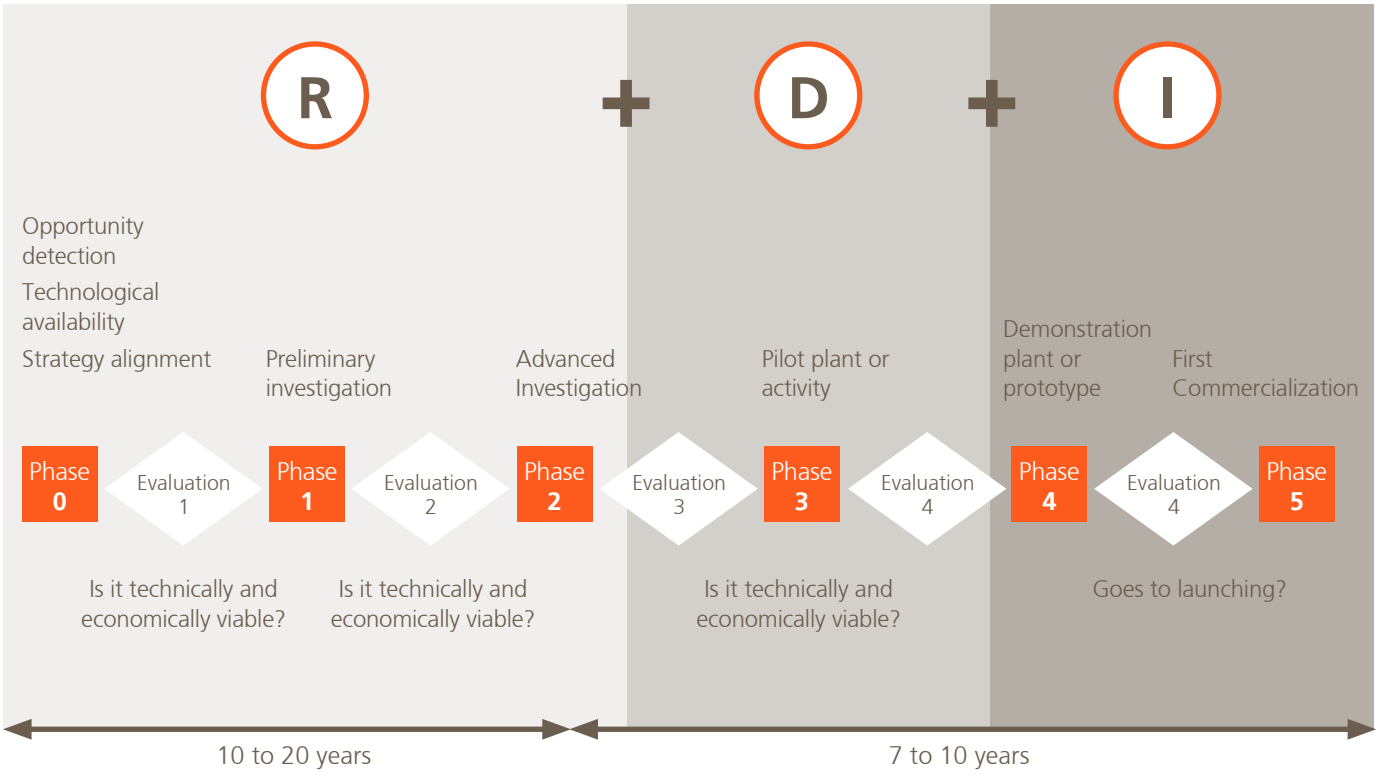
Key Milestones in Innovation Management at Abengoa in 2010

At Abengoa, most research and development investment goes towards applied research and the development of technological innovation towards the achievement of strategic sustainability goals and new products.

In recent years, Abengoa has sought to create an environment in which research, development and innovation all move forward in harmony. In 2010, the Stage-Gate-based application first introduced in 2009 became a fully fledged system to manage research and development projects within an overarching framework of excellence, in alignment with Abengoa's strategic objectives.

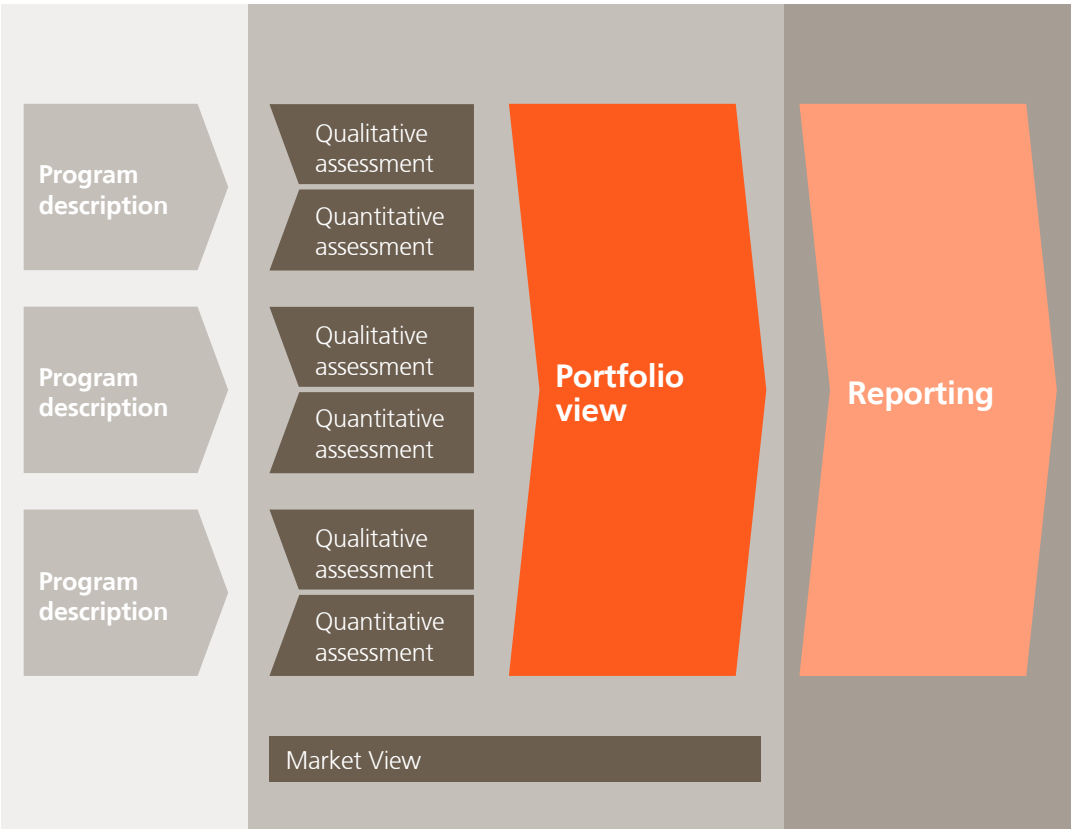
The Stage-Gate methodology specifies key actions to be taken in preparing and implementing a research and development project within Abengoa business units' project portfolio. This ensures a standard approach to research and development projects using a common methodology to define processes and maximize the value contributed by research and development projects to Abengoa's businesses, while minimizing the risks.

Stages of an integral R&D&I project



R&D Valuation

In 2010, research and development management has taken a further step by implementing a project to evaluate research and development efforts in both qualitative and quantitative terms, in parallel with the introduction of an application for managing Abengoa's research and development portfolio of research and development programs. The research and development assessment methodology tracks research and development investment from its source to its final implementation in a commercial process; this approach measures the improvements contributed by research in terms of profitability and efficiency to Abengoa's processes in the field of technological innovation. Evaluating research and development is a vital step in setting priorities within the process of innovation decision-making in accordance with corporate strategy.



R&D valuation methodology

The implementation of a common evaluation methodology underpins the whole of Abengoa's research and development strategy so as to enable a global overview of how the various programs are progressing.

Abengoa Solar

Abengoa Solar and Innovation

For Abengoa Solar, innovation and the development of new technologies are key priorities. The company's goal is to offer technologies that generate clean energy at a cost that can compete with fossil fuels.

The solar energy sector is a relatively young and highly technology-dependent industry. Innovation is therefore a key factor, enabling the emergence of better technologies capable of competing with fossil fuels on price (taking account of carbon dioxide emission costs). Two main drivers will combine to lower costs: increased market volume and more efficient new technologies. This is precisely where innovation has a vital role to play.

Abengoa Solar's development of proprietary technology within its research and development department affords it a 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 assets, inter alia.

Abengoa Solar's unflinching commitment to research, development and innovation is thus characterized by:

- A global presence: The company employs a team of more than 100 people at research sites across the world - Seville and Madrid in Spain; Denver in Colorado, USA.
- Abengoa Solar cooperates with leading institutions, such as Ciemat in Spain; NREL, the University of Rochester and the University of California, Merced, in the United States; and DLR and Fraunhoufer ISE in Germany.

- Programs are funded by two distinct yet complementary sources. The company itself makes a major investment effort; in addition, it seeks public subsidies in Spain, the European Union and the United States. Major awards of public funds secured in 2010 under innovation support schemes included:
  - In Spain, the company continued the Cenit Consolida project into its third year, with a total budget of €24 M. Moreover, in photovoltaic technology the company is involved in the Cenit Sigmasoles and the Cenit Liquion projects.
  - In Spain, work has continued on three projects funded by the CDTI.
  - In the United States, Abengoa Solar has won a new research and development project awarded by the Department of Energy to develop a new solar power technology. Work is also continuing on four other contracts for the same department.

Abengoa Solar Innovation Highlights of 2010

In 2010, the R&D&I team continued to grow, further honing its capabilities in its core research areas and building pilot facilities to put new technologies to the test at a small scale but under real operating conditions.

Abengoa Solar operated several demonstration plants over the year to showcase its strategy in the field of new technologies. The company develops and tests its technologies at small-scale pilot plants with a view to subsequent application using large commercial facilities.

Abengoa Solar develops its technology research and innovation via the Stage-Gate methodology so as to achieve excellence in project development and management, and to bring its efforts into alignment with the organization's strategic goals. Under this R&D&I management procedure, projects evolve by consecutive stages (Stages), subject to assessment milestones (Gates) at which the company assesses the extent to which it has achieved its objectives and overall project potential.

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 includes searching for suppliers, signing cooperation agreements, and so on. At the next stage, a prototype or demonstration plant is built and brought into operation. The final stage consists of analyzing the pilot plant's operational data in order to validate the demonstrated system with a view to undertaking large-scale commercial development.

Pilot plants help Abengoa Solar to face emerging technological challenges, which can currently be described as (i) raising the efficiency of converting solar energy into electricity, and (ii) bringing down costs. Specifically, pilot plants enable the company to test the following features:

- Higher operational temperatures. The key benefit is to increase the efficiency of solar energy conversion into electricity by enhancing the performance of the power cycle.
- New materials to withstand the high temperatures and steep temperature gradients involved in each operating cycle. Such materials are either insufficiently developed or would be too expensive for commercial use under present conditions.
- New thermal storage systems to facilitate energy supply management so as to deliver power to the grid over the desired periods. This is one of the key advantages of solar thermal technology - other renewable energy sources are not manageable in this way. A storage system raises the availability and capacity of the plant and makes for fewer turbine start-ups and shutdowns.
- Use of new heat-carrying 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.
- Integrating photovoltaic solutions with buildings and distributed generation centers.

- Power storage that brings photovoltaic generation into balance with electricity use, so improving the integration of photovoltaic power with the grid.

Parabolic trough demonstration plant hybridized with a coal-fired thermal plant in Colorado, USA

In response to these challenges, the company has continued to operate several pilot plants as part of the Solucar platform (Sanlucar la Mayor, Seville, Spain) over the course of 2010. The projects have validated a range of key innovative concepts:

- Operation of a tower plant at higher temperatures. Unlike the PS10 and PS20 models, the Eureka tower operates with superheated steam generated in a second receiver and reaching temperatures in excess of 500° C. The plant was commissioned in early 2009.
- In 2010, Abengoa moved forward with the engineering of new concepts for third-generation central receiver plants, with a view to starting to build pilot plants in 2011.
- Water certified as an alternative to oil in parabolic trough loops. The company's direct steam generation plant, also commissioned early in 2009, is validating the control system developed by Abengoa Solar, thus meeting one of the main challenges of this technology.
- Validation of thermal storage. The operation of a molten salts demonstration plant in 2009 provided invaluable experience in the use of this fluid to store energy in the form of sensible heat and to quantify the overall performance of this storage mode.

As with CSP technology, PV technology faces the challenge of developing systems that generate power at a cost that can compete with both other renewables and conventional sources.

Aerial view of the Solucar platform (Seville, Spain), with some of the R&D&I facilities visible

Developing and operating certain efficient PV technologies represent an important goal for Abengoa Solar. In 2010, the company carried out the following projects:

- Development of a new high-concentration PV module that achieves very high efficiency at lower cost.
- Development of groundbreaking PV technology in terms of new materials at the Seville R&D center.
- Development of an experimental application to analyze the power generation cost associated with various technologies and configurations..

As a result of this R&D&I work, Abengoa Solar now owns patent-protected proprietary technology. The company owns rights to exploit a number of major inventions in the solar industry, making for 25 patent applications in 2010.

R&D Programs

The research and development program in the Solar's business unit rests on four main pillars:

Central Receiver and Tower Technology

Abengoa Solar's research focus on central receiver and tower technology is what sets it apart from its competitors.

One of the internationally recognized hallmarks of Abengoa Solar is to use tower and heliostat technologies in its quest for efficiency, particularly in the solar component of the plant.

In 2010, besides operating the Eureka plant for the production of superheated steam, the company undertook research and development relating to one of the main components of a solar plant: The receiver.

The Eureka project was intended to address new challenges in tower technology, now that the start-up of PS20 has amply confirmed its reliability. This second-generation solar tower achieves higher temperatures by producing superheated steam, thus enhancing the overall efficiency of the steam cycle. The plant consists of 35 heliostats and a 50 m tower mounting the experimental superheating receiver. The approximate power of the plant is 3 MWth.

In the field of tower technology, the company's research and development was not confined to steam. Two new projects were initiated in 2009 to focus on two very different fluids: Molten salts and air.

The CRS Molten Salt project, co-financed by the Spanish CDTI, involves the engineering and manufacture of a tower solar receiver prototype in which the heat-carrying fluid is a mixture of molten salts. The purpose of the exercise is to appraise the technical and economic viability of a large-scale plant based on this technology.

In addition, the Solugas project (co-financed by the European Union's Seventh Framework Program), got underway in 2008 and is intended to demonstrate the functioning of tower technology at higher temperatures, employing air as the heat-carrying fluid and a gas cycle instead of steam.

The engineering phase has been taken forward in both projects, with a view to starting construction of demonstration facilities in the near future.

In 2010, the company has developed a new heliostat that is set to reduce costs by almost 30 %.

Eureka, a high temperature tower technology pilot plant which has been operational since 2009 at the Solucar platform, Seville

Parabolic Troughs

Parabolic trough technology offers great potential for improvement in a wide range of its components, including its structure, mirror-fixing methods, tubing and interconnections. Abengoa Solar is researching all of these components. At its prototype facilities at the Solucar platform, it tries out many different configurations in an ongoing search for an optimum that secures 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-carrying fluid. Potential optical and thermal improvements have been assessed and all the key components of the technology have now been identified. This unique test bench has afforded the company a practical familiarity with the functioning of the plant, and the know-how acquired has been passed on to commercial plants now in the process of construction and operation.

2010 also saw continued operation of the direct steam generation plant. This plant comprises three loops and uses steam as the heat-carrying fluid. By removing the need for an oil-steam exchanger, the technology enhances 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.

The company is also developing two new types of collector using different materials so as to sidestep commodity price risk.

The Cenit Consolida project is also continuing its research into improving components and transfer fluids. Here, the sought-after qualities are maximum durability and minimum environmental impact.

Trough at the parabolic trough direct steam generation pilot plant, which has been operational since 2009 at the Solucar platform, Seville

Storage Technologies

The technology underlying CSP plants is now reaching a state of maturity that positions solar power as a strong candidate to supersede conventional thermal plants. However, some major issues still have to be resolved, however. One difficulty is the seasonality of the energy source, meaning sunlight. This means that energy has to be stored in large accumulator systems;

Depending on the type of heat transfer fluid, oil or steam, the energy storage system will be designed accordingly to latent or sensible heat storage.

Steam stores heat in latent form, while oil stores it in sensible form. A hot body (e.g., a heat-carrying 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 has continued to be tested in 2010 at an experimental plant. The experience provided a highly valuable lesson in operation and optimization for the construction of forthcoming commercial solar plants with attached storage systems, such as the 280 MW Solana plant to be built in Phoenix, Arizona.

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 mixture of materials. This technology is at a very early stage, but Abengoa Solar has already taken part in several research projects relating to storage with a change of phase. For example, the Distor project led to a prototype that underwent trials at the Almeria Solar Platform.

Abengoa Solar has also undertaken numerous projects to produce hydrogen using thermal and photovoltaic solar power, which can be used as an energy storage medium.

Molten salt storage pilot plant, operational since 2009 at the Solucar platform, Seville

Photovoltaic Technology

Concentrating Photovoltaics (CPV)

In partnership with NREL and several North American universities, the company is developing new concentrating photovoltaic concepts. Highlights include a new generation of Fresnel lens photovoltaic concentrators, a semi-static low-concentrating system and other innovative technologies. These concepts are expected to become, in the medium term, the drivers of new photovoltaic systems capable of generating power at a competitive cost.

The company has made a major effort to develop solar trackers for concentrating photovoltaic applications. It has successfully installed several CPV devices at a 400 kW plant at ISFOC (Instituto de Sistemas Fotovoltaicos de Concentración), Ciudad Real, Spain.

New Materials Technologies

Abengoa Solar is planning to build an R&D&I technology center in Seville province, Spain. The center will be the setting for applied research on new materials, photovoltaic cells, and thin-film photovoltaic prototypes and technologies. The knowledge thus generated will lead to proprietary and competitive technologies in support of Abengoa Solar's future industrialization projects.

PV Laboratory

The PV laboratory built in 2008 has tested and measured the performance of a wide range of PV systems under real operating. 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.

Different photovoltaic systems in the R&D&I area of the Solucar platform, Seville

Abengoa Bioenergy

Abengoa Bioenergy and Innovation

Abengoa Bioenergía Nuevas Tecnologías (ABNT) was formed in early 2003 with the goal of positioning Abengoa Bioenergy as an innovative leader in the bioenergy industry. ABNT's mission is to develop innovative technological processes to produce bioethanol and its coproducts.

ABNT engineers and scientists, in cooperation with research and development centers, universities and industrial partners, develop innovative processes to raise the performance of bioethanol via dry mill technologies, improve coproduct quantity, develop new coproducts, and evolve technology to convert biomass into ethanol and improve its coproducts. In addition, the team leads conceptual design and regulatory oversight as regards sustainability throughout Abengoa Bioenergy's three territories.

ABNT's business strategy involves developing and registering intellectual property rights to provide technology to third parties under management agreements.

Abengoa Bioenergy Innovation Highlights of 2010

Abengoa Bioenergy New Technologies's mission is to engage in scientific and innovative endeavor to develop and demonstrate sustainable technological solutions that fulfill the aims of Abengoa Bioenergy's strategic plan:

- To develop biomass technologies and bring them to the market at competitive prices.
- To raise the value-added of existing coproducts and develop new coproducts.
- To improve on current dry mill technologies.
- To define management systems (procedures and technological solutions) that assure compliance with biofuel sustainability requirements.
- To encourage the development of energy crops.
- To develop the biomass market.
- To develop biofuel end-use programs.
- To develop and improve new enzymes for cellulose breakdown.
- To develop carbon capture technologies using microalgae.

For the use of new raw materials as sources of carbon, the company's efforts focus on enzymatic hydrolysis, gasification and catalysis processes.

The company has conducted extensive research on enzymatic hydrolysis at its pilot plant in York, Nebraska. Having acquainted itself with the process and operating procedures, Abengoa Bioenergy New Technologies has set in motion a second-generation 1.3 Mgal (5ML) ethanol demonstration facility at Babilafuente (BCyL). The data thus collected is critical for developing the design of the first industrial facility using this technology, now being implemented as part of a project funded by the United States Department of Energy.

In the field of gasification and catalysis, over the course of 2010 the company continued its ambitious program to develop heterogeneous catalysts for converting synthesis gas into ethanol. The company has filed applications for two Spanish patents over groundbreaking catalysts that have improved on the prior art. It has continued to develop technical and economic models and analyses for various configurations of thermochemical conversion of biomass, and to explore the different options for introducing biomass gasification technologies.

The company's pilot plants are constantly evolving. It has introduced improvements to the starch-based production process so as to raise the performance of ethanol/grain conversion, and is also experimenting with new enzymes to assess potential improvements to performance and reductions in impact. Major progress has thus been made in output performance as measured by liters of ethanol per ton of grain.

Abengoa Bioenergy has also worked on the development, evaluation and validation of new processes to recover value from the coproducts of cereal-based bioethanol production, with special emphasis placed on improving coproduct consistency, enhancing protein digestibility and concentration, and developing pig and free-range poultry feed.

In the sustainability and strategic consultancy area, a highlight has been the design, development, and subsequent application for approval from the European Commission, of Abengoa Bioenergy's

own voluntary scheme (RBSA) by which to demonstrate compliance with statutory requirements under 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.

According to data compiled by the Joint Research Center (JRC), raw materials account for 60 to 70 % of the production cost of biofuels, and 30 to 40 % of greenhouse gas emissions over biofuel life cycles. Abengoa Bioenergy is working on four distinct projects in the field of raw materials: Analyzing and identifying the most sustainable raw materials at the global scale; assessing potential local supply of biomass to Abengoa Bioenergy's facilities in Europe; developing software to track and assign greenhouse gas emissions and monitor the additional sustainability indicators for the raw materials used in the biofuel production process; and selecting the most suitable species for both first- and second-generation technologies.

Fully aware of the environmental benefits of using biofuels, the company is undertaking e85 and e95 demonstration programs and research aimed at developing stable ethanol-diesel blends to satisfy the requirements of gasoline and diesel engines. These demonstration programs for new applications of ethanol as the end product have focused on implementing the use of ethanol diesel blends (or e-diesel) in captive fleets of heavy vehicles: Buses and worksite machinery. Fuel analysis has focused strategically on obtaining knowledge on the stability of blends, performances on engine bench and durability of the engine components when e-diesel is utilized. The various studies and demonstrations using e-diesel have shown a reduction of up to 70 % in visible smoke, up to 40 % in particulate matter, and up to 30 % and 6 %, respectively, in carbon monoxide and nitrogen oxide emissions.

Another concept the company's efforts are focusing on is biorefining, through which products with market value will be obtained from biomass. The company is developing integrated concepts that combine first- and second-generation technologies to identify and select high value-added products that can be derived from biomass and to integrate enzyme production and microalgae-based carbon capture facilities within bioethanol production plants.

The significance of biocatalysts - or enzymes - in the biochemical route to biomass-based ethanol production has led the company to dedicate a specific line of research to developing optimized enzymes more effective at reducing consumption and thus cutting costs. The company is working on isolating and achieving the expression of the genes underlying enzymatic activities, isolating and improving producer microorganisms, characterizing and optimizing enzymatic mixtures, optimizing operating conditions and raising productivity. These lines of research are all geared towards lowering production costs and reducing enzyme dosage. The enzymes now in development are achieving outstanding performance and offering the lowest costs on the market per liter of ethanol output.

After preliminary assessment of the potential for using microalgae cultures to capture the carbon dioxide generated by prevailing production processes, the company set in motion an ambitious development program to isolate, improve and select carbon capture and biofuel production microorganisms, develop laboratory-scale techniques to cultivate and process these microorganisms 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. The company has already started up the first operational pilot reactor at its Cartagena plant.

Most significant projects

Cenit I+DEA

Abengoa Bioenergía Nuevas Tecnologías is leading the I+DEA (Spanish "Investigación y Desarrollo de Etanol para Automoción") initiative, funded by the CDTI as a Cenit project.

The goal of this project is to position Spanish industry as a leader in the production, use and technology of bioethanol as a biofuel. As a result, the company will seek to introduce bioethanol into the Spanish fuels market as a key step towards compliance with the objectives set by the European Commission in Directive 2003/30/EC of 8 May 2003, and later in the Renewable Energies Directive.

The project brings together 25 companies and 27 research centers and has a total budget of €28.2 M. Group players were selected on the basis of scientific excellence, multidisciplinary range and multi-regionality. Members are drawn from agriculture and seed production, biotechnology, energy, automobiles and transportation. The researchers and research centers involved are located across Spanish territory, and constitute a network of scientific and technological excellence.

Cenit SOST-CO_2

The SOST-CO_2 project, funded by the CDTI's Cenit program, aims to develop sustainable industrial applications to harness the carbon dioxide generated by industry. The solutions being worked on range across the full spectrum of today's industry: Chemicals, energy, renewable energy, food, services, etc.

Under the leadership of Carburos Metálicos and the public-private hybrid center Matgas (partnering Carburos Metálicos, CSIC, UAB), the project involves a consortium of 16 companies, including some of the leading Spanish players, such as Repsol, Iberdrola, Agbar and Ros Roca, and a number of technology-based SMEs. The number of research teams in play amounts to 28, while the total budget stands at €26 M.

Urban bus using bioethanol in Madrid, Spain

Abengoa Bioenergy's role in the SOST-CO_2 project focuses on two key efforts that aim to transform carbon dioxide generated by fermentation processes: To develop technologies to produce bioethanol from carbon dioxide in various catalytic processes; and to transform carbon dioxide biomimetically in microalgae so as to produce biofuels and other value-added products.

FP6 Biosynergy

The Biosynergy project is an integrated project funded by the European Union's Sixth Framework Program, and focuses on utilizing biomass for synthesis of bioproducts - chemical and/or material - together with the production of secondary energy carriers - transport fuels, energy and/or CHP - through development of biorefining. The research is focused on advanced and innovative development of fractionation and conversion processes, combining biochemical and thermochemical pathways, and development of the process from laboratory scale to pilot plant scale.

The project coordinator is ECN, and the consortium comprises companies such as Dow Europe, VTT, biorefinery.de, CRES, the Universities of Aston and Delft, among others.

ABNT's role is to develop the concept design for a bio-refinery plant to convert lignocellulosic biomass into ethanol and high value-added coproducts, based on the biomass ethanol plant that Abengoa Bioenergy is already operating in Salamanca (BCyL). The company is also in the process of producing the necessary data to evaluate various options for biomass fractionation by physical or chemical means.

PSE ("Unique Strategic Project")

ABNT researchs on new uses of biomass

Fast-growing energy crops are used to produce biofuels or energy in various forms, such as heat and electricity. Abengoa Bioenergy intends to produce ethanol from energy crops grown in Spain, including high-starch alternative raw materials and other lignocellulosic biomass types.

ABNT is thus working on cooperation projects to develop energy crops, including a number of "Unique Strategic Projects" (Spanish "PSEs") funded by the Ministry of Science and Innovation via the European Regional Development Fund.

This project involves cooperation on producing and characterizing energy crop biomass and the logistics of biomass supply and certification, in particular, traceability and certification of biomass for producing second-generation bioethanol.

Projects such as this provide a strong boost to new energy crops, optimize the use of conventional crops for bioethanol production, and develop the energy crop market in a sustainable way.

Hybrid Project

Abengoa Bioenergía Nuevas Tecnologías is leading the implementation of this initiative. The main objective is to design, construct and operate a 380 ML commercial biomass and starch hybrid plant.

The specific objectives of the project include:

- Demonstrating the commercial feasibility of the biomass-to-ethanol conversion process.
- Confirming that the technologies developed can be adapted to existing and future plants.

The subsidiary ABNT has been selected to design, construct and operate the US DOE's large pilot biorefinery. A grant from the DOE will partially fund the project. The biorefinery will adjoin a starch ethanol plant, forming a hybrid complex in Hugoton, Kansas, USA.

The bio-refinery will boast a processing capacity of at least 700 t per day, and will comprise two sections - an enzymatic hydrolysis (EH) section and a gasification section. The EH process will convert biomass (400 t/day) into ethanol, lignin, and livestock feed, whereas the gasification section will convert 300 t of biomass per day into syngas, which will be burned to generate steam. The steam will be used internally within the biomass plant, with any surplus being sold to the adjacent starch plant.

Milestones Achieved:

- Secured a DOE grant worth $38 M for the phase 1 contract.
- Hired staff and rented offices for the project.
- Signed property management and water supply agreements.
- Pro forma approval secured for the starch/biomass hybrid plant.
- Obtained approval for pre-construction of the project and the EPC program.
- Completed the enzymatic hydrolysis and gasification simulation model.
- Selected the starch technology.
- Selected and engaged architecture and engineering consultancy firms.
- Completed the engineering phase of the project.

FP7 Bioref-integ

The Bioref-integ project, funded by the European Union's Seventh Framework Program, studies and develops bio-refining concepts based on existing industrial fuel production complexes in order to enhance their competitiveness with coproduction of new products. The project addresses various sectors of the market: Bioethanol, biodiesel, pulp/paper, oil refining, energy production, the food industry and the farming sector. The bio-refining concepts developed as part of the project are then assessed in terms of their technology, economic features and emissions profile.

The project coordinator is ECN, and the consortium comprises companies and institutions such as AFSG, VTT, ETC, Repsol, the University of Kent and the University of Aston.

Abengoa Bioenergy's goal is to help identify existing industrial complexes in the bioethanol sector and potential coproducts, while developing bio-refining simulation models for integration within the bioethanol sector.

The project, which was successfully completed in June 2010, identified new opportunities for developing ethanol in the field of bio-refining.

PlanE DemoE2

The overall goal of the project is to lay the foundations for the transition to second-generation ethanol production technologies at the demonstration plant located at Babilafuente, near Salamanca in Spain, which has the capacity to produce 1.3 Mgal (5ML) of bioethanol annually from wheat and barley straw.

Specifically, the project pursues the following technological objectives:

- Demonstrating the technology to produce lignocellulosic ethanol at a commercial scale.
- Producing enzymes at an industrial scale for use at the ethanol plant.
- Undertaking technological development activities in connection with the process implemented at the Babilafuente plant (Salamanca, Spain) so as to reduce the operating and capital costs of the process, via:

2nd ethanol demonstration plant at Babilafuente, Salamanca

- Optimizing the enzymatic hydrolysis stage.
- Reducing the severity of the thermochemical treatment of biomass by wholly or partly replacing it with biological treatment.
- Developing a microorganism that co-ferments C5 and C6 sugars so as to eliminate some of the fractionation stages.

New Projects

FP7 LED

The Lignocellulosic Ethanol Demonstration (LED) project, funded by the European Union's Seventh Framework Program, embraces the design and construction of a bio-refinery plant to produce second-generation bioethanol using cereal-crop straw for use in public vehicle fleets, enhance the enzymes involved in cellulose hydrolysis, and utilize the lignin contained in the raw materials to make high value-added products.

Led by Abengoa Bioenergía Nuevas Tecnologías, the project involves four other companies from different countries: Green Value, from Switzerland, TNO, from the Netherlands, Communauté d'Agglomération de Pau-Pyrenées (CDAPP) and Communauté de communes de Lacq (CCL) from France.

The LED project lends the necessary continuity to the technological development required for raising the industrial production of second-generation ethanol to a commercial standard. In this endeavor, Abengoa Bioenergy has successfully completed major milestones, such as building a demonstration plant with the capacity to produce 5 ML/year at Babilafuente, near Salamanca in Spain, with the support of the European Union within its Fifth Framework Program.

The objective of the LED project is to design, build and operate a plant producing 50 ML annually of ethanol using lignocellulosic biomass. This four-partner project is led by Abengoa Bioenergía Nuevas Tecnologías.

Cenit BioSos

The Cenit BioSos (Biorefinería Sostenible) project aims to cover the biomass value chain end to end, from generation of the resource to marketable end products, with particular focus on undertaking studies and developing tools to ensure that the proposed solutions are sustainable.

Funded by the CDTI's Cenit program, Cenit BioSos has a total budget of €27.6 M and is divided into five activity areas: Raw materials, sugar- and gas-based transformation processes, bio-product production, and horizontal sustainability analysis.

The aim is to develop a technology able to support the design of innovative, integrated bio-refining processes for energy production and bio-product synthesis, while an ancillary activity is to analyze the economic, environmental and social impact of the proposed solutions.

Abengoa Bioenergía Nuevas Tecnologías is partnered by major companies such as Ecocarburantes Españoles, Acciona, Azvi, Guascor, Green Source (Sniace), Carburos Metálicos, and Técnicas Reunidas, and small technology-based or highly specialized firms such as Neuron, Solintel, Biópolis, Gairesa, Industrias Omar and Krafft, which contribute high-caliber expertise to the project team.

FP7 BIOFAT

Recently awarded as part of the European Union's Seventh Framework Program, the BIOfuel From Algae Technology (BIOFAT) project is currently in the process of being negotiated. The aim of BIOFAT is to demonstrate the industrial viability (at a scale of 10 ha) of algae-based biofuel

production. The bio-refining concept will be used to recover value from algae biomass fractions such as biodiesel and bioethanol. This eight-partner project is led by Abengoa Bioenergía Nuevas Tecnologías.

PlanE BIOCAT2ndOL

The project titled "High-Efficiency Bio Catalysts for Second-Generation Bioethanol (BIOCAT2ndOL)" aims to develop high-efficiency biocatalysts for lignocellulosic biomass hydrolysis in order to optimize the second-generation bioethanol production process. Specifically, the target is to reduce the cost impact of the biocatalyst from the current €0.40 per liter of ethanol to a figure in the vicinity of €0.10 per liter.

BIOCAT2ndOL is to be completed during the timeframe 2010-2011 via three main research areas:

- Biocatalyst development.
- Production with biocatalyst development.
- Enzymatic hydrolysis and ethanol production.

The project involves the cooperation of several research centers and businesses, led by ABNT. Partners include ICP-CSIC, CIB-CSIC, Biópolis SL, and Neurón Biopharma.

PlanE SorgoSweet

The project titled SorgoSweet ("Initiative for the Development of Sweet Sorghum Cultivation for Bioenergy Purposes") aims to evaluate the potential of sweet sorghum (Sorghum bicolor (L.) Monech) as an energy crop in farming areas in the environs of the Ecocarburantes Españoles plant near Cartagena, Murcia province, Spain. A detailed study will be undertaken on the potential for adapting the crop to the agricultural and climatic features of the area and optimizing pre-fermentation extraction techniques.

This partnership brings together two companies and two research centers, led by ABNT, spread out across various locations in Spain, thus supporting local job creation and economic development.

PlanE ECOALGA

The project entitled ECOALGA ("Initiative for the Development of Microalgae Cultivation Systems for Bioenergy and Carbon Dioxide Capture") involves the design and construction of a pilot plant to evaluate technologies for growing microalgae and cyanobacteria as raw materials for producing biofuels and animal feed and for sequestering carbon dioxide generated by fermentation in the bioethanol production process.

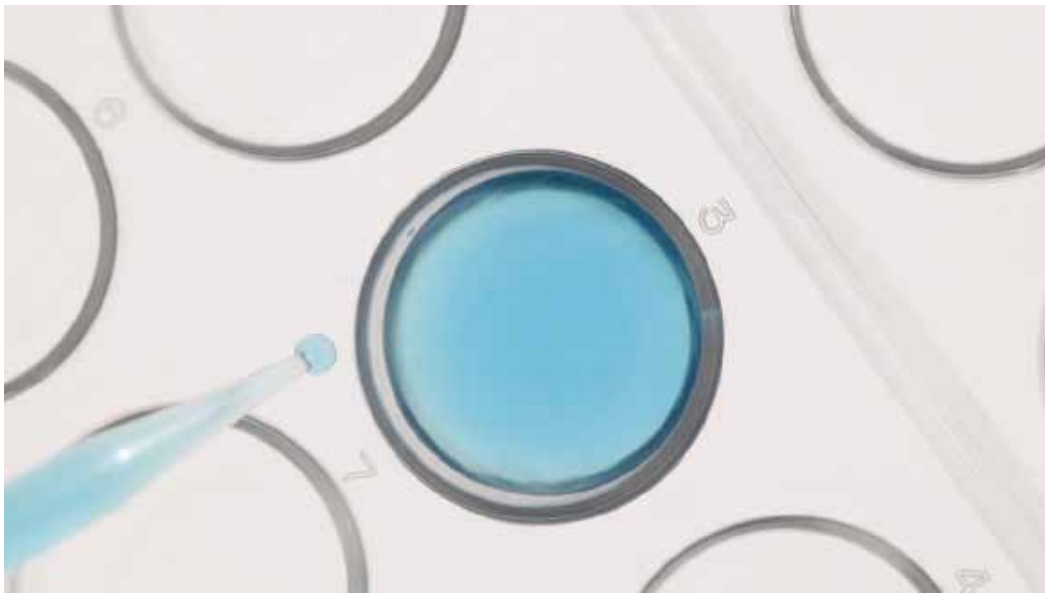
The project will be conducted on a lot owned by Ecocarburantes Españoles adjoining its ethanol plant. Carbon dioxide generated by grain fermentation for ethanol production will be the carbon source for algae cultivation.

The project involves several research centers and universities:

- The Biomass Department of the National Renewable Energy Center ("Centro Nacional de Energías Renovables").
- The Chemical and Environmental Engineering Department of the Polytechnic University of Cartagena.
- The Animal Production Department of the Veterinary Surgery Faculty of the University of Murcia.

The ECOALGA (2010-2011) project is now at the engineering stage. Construction and commissioning are scheduled for 2011.

Microalgaes offer a solution for the capture of CO_2 as well as for the biofuels production



Befesa

Befesa and Innovation

Befesa's research and development strategy is geared towards results and value creation by proposing new technologies in alignment with sustainable development.

Befesa's strategic research and development plan pursues the following objectives:

- To become a technologically competitive leader in aluminum and galvanized steel waste recycling.
- To develop new technologies for industrial waste management.
- To lead the field in desalination technology and become technologically competitive in wastewater treatment and reuse.

Research in the realm of aluminum waste recycling seeks to improve performance in the recovery of aluminum raw materials and waste, optimize operating procedures and product quality, and develop new, improved technologies in aid of sustainable development.

The steel and galvanic wastes recycling area has recently formed a new company, Befesa Steel R&D&I, SL, with a view to bringing organizational structure in line with the new model, expand the various lines of activity and widen and improve the company's range of services so as to exceed market expectations and enhance both delivered and customer-perceived value.

The industrial waste integrated management area is developing new technologies in step with ongoing change in environmental law. The company prioritizes its management methods based on a hierarchy headed by reuse, recycling and value recovery as against merely eliminative treatment. It is also diversifying into new environmental markets and widening the range of treatable wastes.

In the water area, the company's goal is to lead the desalination field, become technologically competitive in potabilization and urban and industrial wastewater treatment and reuse, and entrench its leading position in hydraulic infrastructure and water resource management models and systems.

One of the main vectors of Befesa's research and development strategy is to enter into external partnerships with institutions and universities. Major partners include the Fundación Euskoiker and the Escuela Técnica Superior de Ingenieros Industriales de Bilbao, as part of the activities conducted by the Aula Befesa higher education unit in training and research.

Befesa collaborates closely with a large number of research teams based at various universities and public research institutions, including Seville University, Cadiz University, Valladolid University, Granada University, Malaga University, Castilla La Mancha University, Polytechnic University of Seville, Gerona University, Higher Council for Scientific Research (CSIC), Energy and Environment Research Center (Ciemat), Solar Energy Research Center (Ciesol), Inasmet, Laboratorio Inatec, Insesca and Alcan, among others.

The company has also engaged in cooperation with Spanish government bodies in the form of subsidies or partnerships with the Ministry of Science and Innovation, the Ministry of Industry, Tourism and Trade (MITyC), the Ministry of Environment and Rural and Marine Affairs, CDTI (Spanish, Centro para el Desarrollo Tecnológico Industrial), the Ministry of Education PROFIT Program (Spanish, Programa para el Fomento de la Investigación Técnica), the Andalusia regional Department of Innovation Science and Enterprise (Agencia IDEA), and CTA (Spanish, Corporación Tecnológica de Andalucía).

To achieve its research, development and innovation goals, Befesa has built its own research and development center in Seville. Equipped with state-of-the-art, sustainable facilities, the center has the scientific and technological resources to position Befesa at the technological forefront of its chosen fields. The center aspires to become an international benchmark in integrated water cycle management - desalination and reuse especially - and in industrial waste treatment. The facilities, which can house 70 researchers, have a total of 3,000 m^2 of floor space, used primarily for testing, laboratories, workshop, offices, control room, exhibition room and multi-use room.

Befesa R&D&I Center

Befesa Innovation Highlights of 2010

2010 was a year of entrenchment and further growth for Befesa's research and development capability. The company's total research and development outlay in 2010 came to €4 M. The firm employs a staff of 40 full-time researchers.

The highlights of 2010 for Befesa were:

Cenit TEcoAgua

In late 2009, Spain's Ministry of Science and Innovation notified Befesa of the approval of the project titled TEcoAgua, "Sustainable Technologies for the Integrated Water Cycle", an initiative headed by Befesa Agua, in the context of the fifth annual selection round of the Cenit-E program, a government scheme in support of technological development. The TEcoAgua project, led by Befesa Agua, is backed by a total budget of €18 M. Over a timeframe of four years, the project will be completed by a partnership of ten consortium members, four of which are SMEs, and twenty-one universities, selected on the basis of scientific excellence and industrial and regional diversity.

The prime goal of the Cenit-funded TEcoAgua project is to develop sustainable technologies to generate alternative water resources. The team has integrated advanced water resource recovery technologies with regeneration and reuse of wastewater and new desalination processes, inter alia. The TEcoAgua project is one of Spain's leading research initiatives in the water sector.

Seawater pretreatment pilot plant using membranes

Technology Funds and European Projects

In 2010, Befesa filed bids for awards under the Technology Fund Inter-Entrepreneurial Program in respect of three major projects in the field of industrial waste and aluminum recycling, with an aggregate budget of €6.8 M and involving eight partners. One of the projects aims to valorize waste and by-products as fuel and input materials in the cement industry (ValoRes); a second project involves using waste to produce biodegradable plastics (Bioplástica); while a third project aims to manufacture safety parts for the automobile industry using recycled aluminum having an iron content ranging from 0.3 to 0.4 % (Alesbap).

Within the framework of the Technology Fund and the Individual Research and Development Projects Program (Spanish "PID"), Befesa secured funding awards in 2010 for four projects with an eligible budget of €3.8 M in the fields of aluminum recycling, waste treatment and water.

2010 also saw the award of a Eureka seal to a research and development project for the application of new desalination technologies to industrial processes. The project is being taken forward as a cooperative effort between Befesa Agua and a Dutch partner, with a total budget of €2.7 M.

MBR pilot plant

Technological Development

Following on from work performed over the past few years, 2010 witnessed the construction and commissioning of a total of six demonstration plants designed to validate technological developments in water desalination and purification and waste treatment and recycling.

At Qingdao, China, Befesa has set in motion a pilot desalination plant using membrane technology for desalination pretreatment and reverse osmosis, boasting treatment capacity of 10 m^3 of seawater per hour.

In the wastewater reuse field, in 2010 further progress was made in building two pilot MBR plants (membrane bioreactors), equipped with MF (microfiltration) membranes and having a treatment capacity of 1 m^3 of wastewater per hour.

Befesa has built a pilot plant for the etherification of crude glycerol to obtain oxygenated additives for diesel fuels. This pilot plant has a total batch reaction capacity of 120 L. At the same strategy of valorization crude glycerol, Befesa has also built another pilot plant which goal is the steam reforming through a catalytic process to obtain more than 500 NL of hydrogen per hour.

Glycerin etherification pilot plant

In 2010, Befesa's plastics recycling business saw the construction of a demonstration plant producing fiberglass-reinforced plastics, with a capacity of 1,000 kg/h.

Fiberglass-reinforced plastic demonstration plant

This technological development has brought Befesa six new patents in 2010 at various stages of registration in Spain and via the PCT route.

Befesa's Technological Strategy

R&D&I has a key role in the Befesa's technological strategy

Aluminum Waste Recycling

Befesa Reciclaje de Residuos de Aluminio's research and development efforts primarily seek to preserve the company's competitive edge over other market players. Befesa's research capability operates in four distinct areas:

- Ongoing search for technically and economically viable processes to recycle all types of waste generated by aluminum manufacturing, such as red sludge, casting mold resins, or the recent success story involving SPL recycling.
- The company is diversifying the range of aluminum-content input materials that its technology is capable of processing. Up to 25 % of all manufactured aluminum goes into compound domestic and urban products, which at present are only marginally recyclable.
- Ongoing improvement of internal process technologies. Befesa is working to raise the yield obtained from input materials, minimize aluminum loss, minimize and optimize salt consumption, minimize salt slag generation, lower energy consumption and achieve energy autonomy.
- Product development. Befesa's aim is to bring the mechanical performance of secondary aluminum alloys up to the standard of primary alloys so as to gain entry to new markets. The company is also developing new applications for Paval to establish it as a valid value-added product in construction and civil engineering, metal manufacturing, the rubber and ceramic sectors, and elsewhere..

A key element of Befesa's strategy is to dedicate 300 m² of its Valladolid plant to research and development exclusively. This lot adjoins a facility operated by Befesa Escorias Salinas and Befesa Aluminio's works. The availability of operating R&D&I staff and the proximity of industrial facilities producing input materials and Befesa Escorias Salinas' analysis lab - the Befesa Reciclaje de Residuos de Aluminio group's biggest - make this the ideal location for centralizing and reinforcing research and development in the chosen fields.

The R&D&I facility's starting equipment will comprise a rotary furnace having 1 t of loading capacity and fitted with a gas treatment system and an aluminum and salt slag evacuation system. Other features will be an innovative eddy current pilot plant to enrich aluminum fines and extra fines, a small impact mill and a blade mill, and a conventional eddy current separator. The project is backed by an initial budget of €60,000 and is expected to be operational by early February 2011.

Rotary furnace with 1 t of capacity to be installed at Valladolid

Industrial Waste Management

Befesa Gestión de Residuos Industriales' strategic research and development plan seeks to entrench the company's leadership in waste management and adapt to ongoing changes in environmental law. Specific objectives include:

- Gradually replacing elimination treatments with recovery and energy value recovery approaches.
- Reinforcing technological leadership in industrial waste management by developing environmentally safe and energy-efficient treatments.
- Widening the scope of the market by offering industry new services and extending the range of treatable wastes, while diversifying into new environmental markets.

The strategic plan develops technologies that offer environmentally friendly and sustainable treatment alternatives to prevailing practices in waste management, by using the material and energy resources of wastes through recycling and value recovery processes. The technology activities associated with the strategic plan include:

- Technologies supporting the production of waste-based fuels as alternatives to fossil fuels, and obtaining substitute input materials for industry.
- Developing the best available technologies for thermal waste treatment.
- Developing technologies to diversify into new markets and seize new opportunities via new recycling processes and obtaining high value-added products.

Water

Befesa Agua has an ambitious R&D&I strategic plan that aims to generate the technological know-how required to secure resource availability and quality and create sustainable solutions for the integrated water cycle.

The goals of the plan can be summarized as:

- Optimizing the energy efficiency of reverse osmosis desalination; minimizing costs and enhancing sustainability while mitigating the environmental impact of the brine and moving towards the use of renewable energy to power the desalination process.
- Developing wastewater reuse by extending the boundaries of urban and industrial wastewater treatment technology, optimizing it on a case-by-case basis for each specific reuse type.
- Optimizing hydraulic infrastructure under sustainability criteria for the integrated water cycle and developing water management models that allocate natural, generated and regenerated resources with due regard to floods, drought processes and water quality.

Befesa Agua's strategic research and development plan drives forward along four main vectors of advance: (i) In-house resources, such as the research and development department and Befesa's research and development center; (ii) research and development aid and subsidies awarded by a range of public authorities; (iii) collaboration agreements with universities; and (iv) technology partnership agreements.

R&D&I Programs

Befesa's research and development is structured into seven core research and development programs focusing on industrial waste recycling and integrated water management. The research and development programs and their highlight projects are summarized below.

Aluminum Waste Recycling Program

Befesa Aluminio's R&D&I is implemented as a single program primarily directed to fulfill targets set by the company's afore-mentioned R&D&I strategic plan.

Some of the highlights of its research and development within this program in 2010 are outlined below.

Obtaining Second-Meltdown Aluminum Alloys for Use in Safety Components

This project, conducted in partnership with Edertek, Fagor Automoción's technology center, and Cofundi, an SME that manufacturers die-cast parts, applies research findings to use recycled aluminum to make safety parts for the automobile and rail sectors, such as car hubs and hub carriers, still produced to-date using low-iron primary aluminum. Taking a global approach to the issue of secondary aluminum's high iron content, the project processes the melt with chemical alloying agents, liquid-state thermal and mechanical treatment, further thermal treatment, new part-manufacturing processes, etc.

Obtaining Secondary Aluminum through a Solid-State Process

This project lies halfway between the line of research concerned with processing new raw materials and the research area focusing on processing technology. The company is looking at integrated enhancement of fines processing in the 1-5 mm range across the various processing lines operated by the unit's facilities. Input materials are derived from aluminum slag, compound scrap or other companies' recycling processes sold on the market, such as white-goods fines. A pilot plant is processing 1-4 t per day of fines for subsequent briquette manufacture at Bostlan, a company running trials at the 200-500 kg scale in a pilot rotary furnace and pot at the Inasmet technology center operated by the Fundación Tecnalia.

As a long-term goal, the company is working on the potential for raising the aluminum content of fines to a level that makes them marketable to part manufacturers as briquettes of a standard composition in accord with the desired alloying, thus avoiding the need for meltdown at an aluminum refinery.

Waste Treatment and Value Recovery Program

The aim of the program is to develop thermal waste treatment technologies and transform wastes into fuels and input materials usable in energy value recovery and recycling processes.

Some of the highlights of the company's research and development within this program in 2010 are outlined below.

Extracting Value from Materials through Catalytic Oxidation

The goal of the project is to design an industrial waste pretreatment process to make waste usable as a direct fuel for an industrial catalytic oxidation facility. Applied research must be brought to bear to create a thermal waste treatment technology that, marking Europe's first radical departure from conventional methods, achieves a high degree of catalysis so as to lower the flashpoint, speed up isothermal oxidation, and enable combustion gases to remain in the oxidative chamber over extended periods. The novel features of this technology allow for exhaustive control of gas emissions and ensure that slags will be inert, while achieving energy recovery via electricity production.

One of the key issues in developing this technology is to pre-treat wastes to create uniform physical and chemical conditions at the process entry point. Funded by CDTI in the amount of €1.4 M, the project is being undertaken in partnership with the Tekniker technology center.

Producing Fiberglass-Reinforced Polypropylene

Befesa Plástico is developing an innovative technology to produce fiberglass-reinforced plastic. Recycled polypropylene and fiberglass waste is utilized to produce material that improves the mechanical performance of recycled plastics. The project involves building a demonstration plant capable of producing 1,000 kg/h per line. Domestic and European funding have made for a total budget of €5 M. The technology lowers carbon dioxide emissions by 60 % versus new raw materials.

Alternative Treatments and New Markets Program

The goal here is to create and develop emerging, sustainable technologies that enable the company to diversify into new environmental markets and broaden the range of processable wastes.

Some of the highlights of its research and development within this program in 2010 are outlined below.

Producing Biodegradable Plastics from Industrial Waste (Bioplastics)

One of the overarching concerns of the project is to utilize petrochemical plastic wastes, sewage sludge and other wastes to obtain medium-chain polyhydroxyalkanoates (mclPHA), a high value-added biodegradable plastic.

The scope of the project embraces the construction, commissioning and operation of the first pilot plant to produce biodegradable plastics from wastes, on the basis of the lab research completed by Bioplastech, a spin-off company based in Ireland.

The project is funded at "CDTI Technology Fund Inter-Entrepreneurial Program", and is developing in collaboration with Idesa, an Asturias-based equipment manufacturer, and Enia, an Asturias-based SME specializing in automation and control equipment. Successful completion of the project

will result in a new waste recycling technology enabling the company to broaden the range of "processable" wastes and diversify its business by entering new markets, such as bioplastics.

The overall project goal is closely aligned with Abengoa's core strategy of sustainable development by restricting raw material consumption, recycling waste, and creating biodegradable, environment-friendly products.

Viability Study for Application of Advanced Oxidation Techniques to Liquid Effluents with High DQO (Photocatalysis)

The project is focused on the evaluation of the solar treatment techniques to detoxify the landfill's leachates and other effluents. Specifically, the goal is to assess the ability to detoxify using advanced oxidation processes, in particular, Foto-Fenton, a process that destroys the total organic load (DQO) of a liquid via oxidation with hydroxyl groups (OH) formed by exposing hydrogen peroxide to sunlight.

The study encompasses lab tests of various effluents, and trials at a pilot plant at the Almeria Solar Platform. The company has partnered with the Ciesol (Spanish, Centro de Investigaciones de Energia Solar), a solar energy research center attached to Almeria University and the project is funded by the CTA (Spanish, Corporación Tecnologica de Andalucía) and the IDEA agency.

Desalination Program

This research and development program focuses on improving the efficiency of the reverse osmosis process and lowering its investment, operation and maintenance costs by reducing the cost per cubic meter of desalinated water.

Some of the highlights of the research and development department within this program in 2010 are outlined below.

Seawater Pretreatment System using MF/UF Membranes

This project aims to develop an advanced seawater pretreatment system using membrane technology. The company has conducted real-site tests on seawater at the pilot plant scale to evaluate the performance of commercially available micro- and ultra-filtering systems in comparison to one another and to conventional schemes. The results have then been used to design a proprietary system based on MF/UF membranes.

The project has secured grants from the Department of Innovation, Science and Enterprise of the regional government of Andalusia and from the Spanish Ministry of Environment and Rural and Marine Affairs.

Desalination Plant Remote Monitoring Project (CRIBA)

The purpose of this particular project is to develop a remote control system affording real-time vision of the state of operation of Befesa's desalination plants across the world. If successful, the system will be a key tool for optimizing the operation and maintenance of Befesa Agua's plants. The company has created an IT platform for remote control and monitoring, a communications system, an information management system and a control room. Now in its demonstration phase, the platform is being tested with data from one of Befesa Agua's desalination plants.

The project is funded by subsidies from the Department of Innovation, Science and Enterprise of the regional government of Andalusia and from the Spanish Ministry of Industry, Tourism and Trade's PROFIT scheme.

Potabilization-Purification-Reuse program

This program seeks to optimize membrane-based water treatment processes so as to save energy, produce less sludge, develop sludge treatment and elimination technologies and

undertake research on supercritical oxidation.

Some of the highlights of the research and development within this program in 2010 are outlined below.

Advanced Wastewater Treatment for Reuse (TRASOS)

The ability to reuse wastewater stands to be a key factor in sustainable development, and offers high potential as an alternative source of water. The goal of this project is to optimize wastewater treatment processes by taking account of the specific type of wastewater concerned and its intended future use. The company is researching membrane technologies such as membrane bioreactors (MBRs) and micro- and ultra-filtering systems. It has also built two pilot MBR plants equipped with microfiltration membranes, and is now developing mathematical models to describe their behavior. Experimental campaigns are scheduled for 2011.

Wastewater Treatment Plant Sludge Removal using Supercritical Oxidation

With Befesa Agua acting as coordinator, this project has been undertaken in partnership with Emasesa. The goal is to demonstrate the technical and economic viability of supercritical oxidation technology for eliminating sludge at wastewater treatment plants. The project is now at the final experimentation phase.

The project is being subsidized by the Department of Innovation, Science and Enterprise of the regional government of Andalusia, the Technology Corporation of Andalusia, and the Ministry of Environment and Rural and Marine Affairs.

Sustainability Program

This program seeks to optimize energy use in water infrastructure, develop hydro power and marine energy capabilities, create sustainable water management models, and develop and apply sustainability criteria in the design of the company's solutions.

Some of the highlights of the research and development within this program in 2010 are outlined below.

Integrated and Sustainable Water Resource Management Model (MAISA)

The aim of the project is to develop a platform to manage water resources at the hydrographic basin level, taking account of factors such as water quantity, quality and energy value. Progress has been made in designing the platform and data management modules, a hydrological simulation system and demand management for irrigation zones.

The project is funded by CDTI via the Cenit TEcoAgua project, within the framework of the Cenit-E program.

Filtration Membranes Program

Filtration membranes have become a strategic technology for water treatment processes, and are increasingly in use for wastewater potabilization and regeneration and desalination pretreatment. The aim of this program is to develop water treatment filtration membranes.

Water Treatment Filtration Membranes Development Project

This project is concerned with developing a high-performance ultra-filtration membrane (pore size and distribution, permeability, strength, etc.) having applications in water treatment processes (potabilization, reuse, desalination).

The initiative is funded by CDTI via its research and development projects program (PID).

Telvent

Research, Development and Innovation 2010

Telvent's strategy focuses on developing information and communication technology-based solutions and services as a way of dealing with today's sustainability challenges. The company seeks out efficient and effective ways of managing core resources such as energy, transport, water and food, using smart networks and infrastructure.

Telvent's sustainability-oriented solutions




	Energy	Transportation	Environment	Agriculture
Real-time Operations	Smart Grid & Pipelines	Smart Mobility	Water Management	
Supply Chain	Fuel & Gas Distribution	Interoperability & Payment	Integrated Water C	Grain Distribution
Information Services	Market Pricing Load Forecasting	Traveler Information	Weather Services	Market Pricing & Risk Analysis

Telvent's sustainability-oriented solutions are divided into three main areas:

- Real-time operations. Telvent's systems are equipped with highly specialized software and hardware enabling efficient and effective management of geographically distributed critical infrastructures.
- Management systems. Telvent develops solutions that add value to the production chain in its chosen fields, aiming to integrate all stakeholders involved.
- Information services. Telvent develops and offers highly accurate information services to enhance its clients' decision-making, operations and supply chain systems.

Telvent invests in developing its SAAS (software as a service) model, in which it has a track record of over eight years in developing cloud computing components to make these solutions a reality. Telvent is confident that the SAAS model is an effective and attractive platform for many of its solutions, and is accordingly investing in planning, research and development so as to widen the range of services offered under this approach.

Telvent's ongoing bid to undertake research and development of new products and services has kept it at the international forefront of the energy, transportation, environment and agriculture markets. The company has moved on from a systems integration and outsourcing strategy to selling high value-added information services in support of operational, business and environmental decision-making.

One of Telvent's strengths is its global presence via several product and competency centers, employing over 450 technical specialists. Having invested across nine research and development

programs, co-funded by Spanish and international public authorities, Telvent has successfully achieved its technical and business targets.

Competency and Product Centers

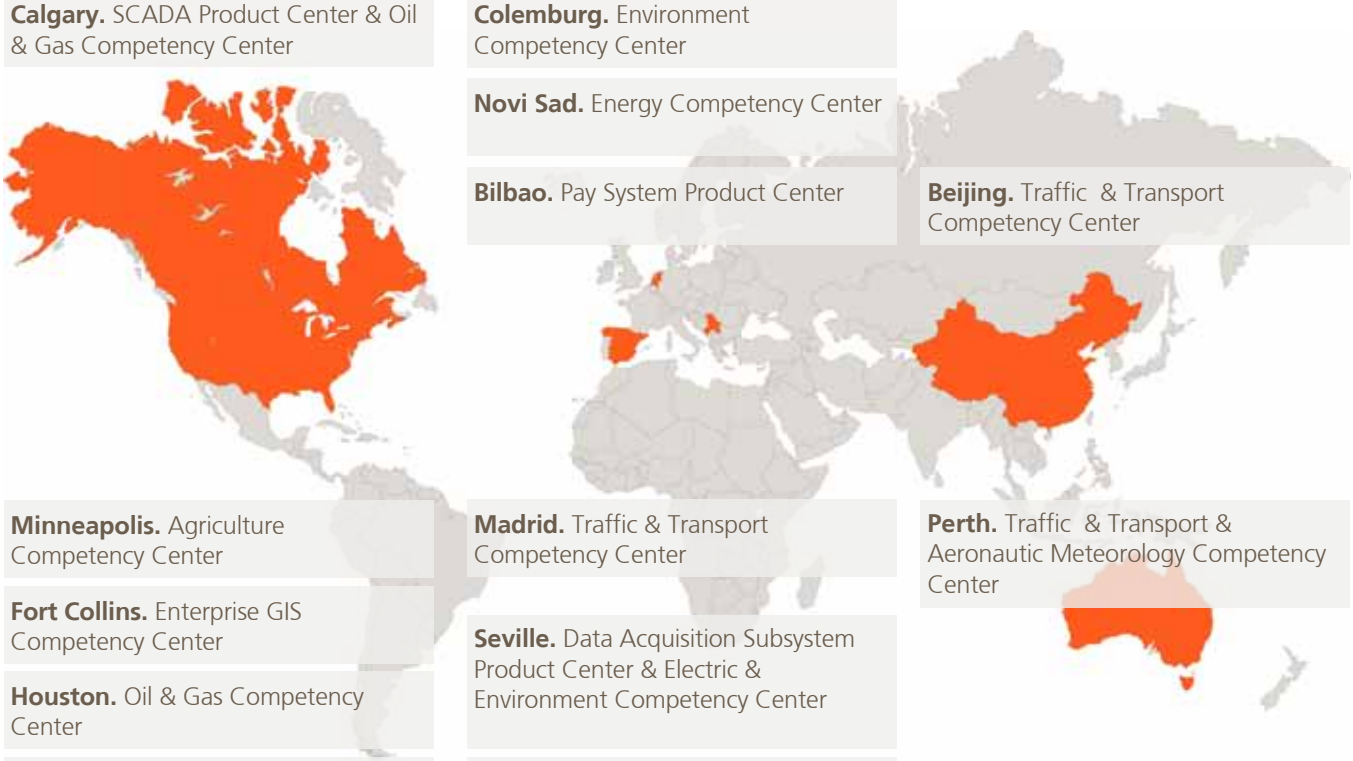
Calgary. SCADA Product Center & Oil & Gas Competency Center

Colemburg. Environment Competency Center

Novi Sad. Energy Competency Center

Bilbao. Pay System Product Center

Beijing. Traffic & Transport Competency Center



Minneapolis. Agriculture Competency Center

Madrid. Traffic & Transport Competency Center

Perth. Traffic & Transport & Aeronautic Meteorology Competency Center

Fort Collins. Enterprise GIS Competency Center

Seville. Data Acquisition Subsystem Product Center & Electric & Environment Competency Center

Houston. Oil & Gas Competency Center

Rockville. Mist Product Center & Traffic Competency Center

Barcelona. Traffic & Transport Competency Center

Key R&D&I Programs in 2010

Telvent conducts its research and development at geographically distributed competency and product centers. These centers provide the technology and product infrastructure that underpin Telvent's solutions. Sometimes marketed as freestanding packages in their own right, these technologies are utilized by the company's centers to develop high value-added system architectures and advanced applications specifically aimed at each given industry.

2010 was a good year for Telvent's research and development, with highlights including:

Energy

In the energy sector, Telvent continued to implement the following research and development programs at its Electricity Sector Competency Center, its Data Capture Subsystems Product Center and OASyS, Enterprise GIS and Refined Fuels.

Smart Grid

The Smart Grid program embodies Telvent's strategy for smart energy grid management, from generation to distribution, so as to turn the power grid into a two-way information and services network. These features mean that the system can be handled largely by smart automation: Usage can be managed, operated and metered to enhance energy efficiency across the grid and raise the standard of service to users, via the following technologies:

Smart management of energy grids

Data Capture Systems

The Data Capture Subsystems Product Center operates sites in Seville, Spain, and Houston, USA. Its core business is to develop Remote Terminal Units (RTUs), especially Saitel and its two auxiliary packages, the gasCAT gas flow calculator and the subCAT power substation remote controller. Our range of remote control solutions is completed by RTU SAGE. Developed in and for the North American market, this suite has earned widespread acceptance and a broad base of installations.

In 2010, Telvent completed development of its Cross Domain Platform (CDP). The company has brought to bear the experience it has amassed in recent years in its target sectors. The project thus benefits from the latest technologies, and ranges over the whole family of equipment for real-time data capture, embracing both present and emerging trends. This means that its customers will get a highly flexible solution that they can tailor to their configuration and technology needs. As always, security is a key issue that has been considered at all stages of design and development. Some of the research areas within this project have attracted public funding, such as SEPIC (Spanish acronym for "embedded systems for critical infrastructure") and PROTECT-IC (cyber security for critical infrastructure), supported by MITyC, Spain's Ministry of Industry, Tourism and Trade.

Power Industry Solutions

Our competency centers for the electricity industry are located in Seville, Spain, Fort Collins, Colorado, Houston, Texas, and Novi Sad, Serbia. These sites develop comprehensive solutions for smart management of power generation, transmission and distribution networks, based on standards that are readily compatible and scalable with existing infrastructure.

Our solutions are designed to provide effective support for smart planning, design and operation of power grids, ranging from real-time data capture to network planning, economic analysis and evaluation of management solution options.

In 2010, highlights included:

- Telvent developed version 3.0 of DMS (Distribution Management System) at its Novi Sad site, offering scalability and high security, based on its OASyS SCADA (supervisory control and data acquisition) system.

- Integrating Telvent's AMI infrastructure with its OMS (Outage Management System) Responder, passing interoperability tests and so obtaining CIM certification from the United States National Institute of Standards and Technology.
- Work continued on the S2G (Substation to Grid) project to build a pilot facility to test the deployment of wireless smart sensors at high- and medium-voltage substations and explore the benefits of a predictive maintenance system.
- Telvent continued its SmartCity initiative, a project undertaken in partnership with and led by Endesa, to study the planning of an operations center from which to manage the public lighting system, to be operated by Telvent. The aim is to analyze the development of a sustainable and energy-secure city from the standpoint of electricity distribution. The project will be conducted in Malaga, Spain.

Geographic Information System

Based at Fort Collins, Colorado, USA, this product center's ArcFM suite leads the field of GIS applications for energy companies around the world.

ArcFM helps power, gas and water utilities manage their assets, work and operations to enhance quality of service and lower costs. ArcFM also supports the development and management of integrated network models, a capability increasingly recognized as the core element of automating the distribution of Smart Grid applications. With this product, Telvent has a privileged relationship with ESRI, the leading GIS software developer.

In February of 2010, Telvent launched a new version of ArcFM, with an additional service pack released in May. These versions offer the following innovative features:

- Designer Express, a design application enabling users to develop more flexible and scalable workflows.
- Staker Designer, a new application to design field work flows.

Oil and Gas

Telvent offers industry-leading solutions for the efficient, secure and reliable operation of oil and gas pipelines. The company also develops management solutions enabling effective coordination among refining companies, oil pipeline operators, suppliers, fuel terminals, distributors and end-users, embracing the following initiatives:

Oil and gas ducts management

The Oil and Gas Competency Center is spread out across two sites, at Calgary, Canada, and Baltimore, Maryland. The center develops advanced measurement systems and business solutions for the hydrocarbon production, transportation and distribution needs of leading energy companies. Based on the OASyS DNA platform, the applications provide a centralized operating environment.

In 2010, major improvements were achieved:

- The Liquid Suite product provides pipeline operators with the tools they need to minimize the operating cost of their facilities while ensuring timely fuel supply. Telvent created an employee training simulator that enables customers to simulate system operation and predict various operating scenarios.
- A wholly revamped version of Gas Suite HMI has been launched under the name Sightline. The new suite is easily configurable and based on industry standards.

Refined Fuels

This product center operates sites in Omaha, Nebraska, and Allen, Texas. As a leading provider of supply chain solutions, advanced information services and oil supply management solutions, its applications range over transaction management, business intelligence solutions, and advanced infrastructure for fuel suppliers, terminals, wholesale and retail end-users, and renewable energy producers.

Milestone projects carried out in 2010 include:

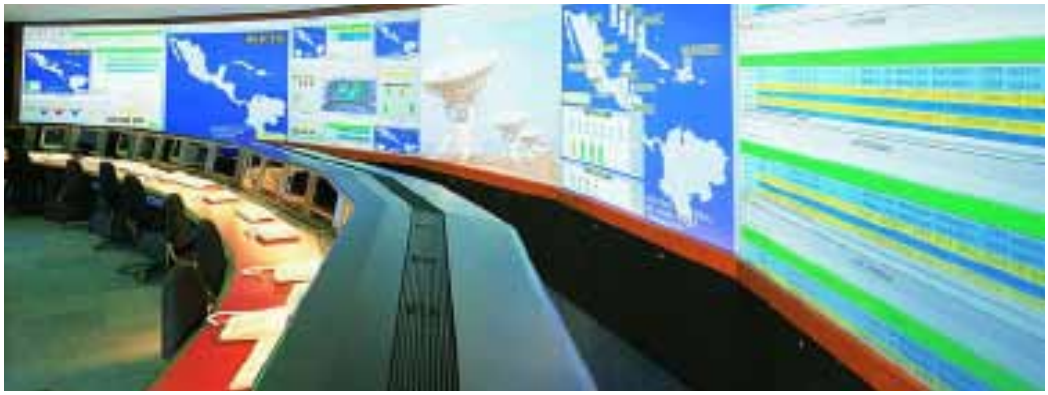
- An improved version of DTN TABS®, optimizing fuel supply and demand so as to afford suppliers higher product management security and efficiency.
- Launch of DTN Fuel Seller™, an SAAS advanced solution for defining fuel sale prices, drawing on accurate real-time data to optimize sales margins and volume.
- DTN Fuel Buyer™, a sophisticated application used by fuel wholesalers for their daily buying needs and optimizing logistics.
- DTN Guardian3® System, a centralized solution for terminal control. The tool has been further integrated with OASyS DNA SCADA.

SCADA and Information Management

The OASyS Product Center at Calgary, Canada, develops and maintains OASyS DNA (Dynamic Network of Applications), Telvent's main applications platform. This product is the underlying technology platform for a wide range of real-time solutions for energy, transportation and the environment. In 2010, highlight initiatives included:

- Improvements to OASyS DNA for use by major oil and gas industry customers and integration with Telvent's Smart Grid suite. In addition, the project team made further progress in adapting the solution to other Telvent markets, such as transportation and water management.
- Results were presented for the second stage of Telvent's joint research project with the Idaho National Laboratory (INL). Commissioned as part of the United States Department of Energy's National SCADA Test Bed Program, this project is concerned with researching critical infrastructure. OASyS DNA was selected for assessment at a wide range of facilities in the United States.

Pemex control center



Transportation

The main research and development programs in the transportation sector in 2010 were SmartMobility - focusing on sustainable mobility - and SmartInformation, an advanced transportation information system.

As part of those programs, the Transportation Competency Center, with sites at Madrid and Barcelona in Spain, Rockville in Maryland (USA) and Beijing, China, develops solutions for urban and interurban road and rail traffic, including: Traffic control systems (MIST), with extensions for adaptive centralized and distributed control (Itaca, OPAC); traffic regulators; centralized railway traffic control systems (OASyS-based CTC); and traffic information systems (SmartNET).

At its development sites in Bilbao, Spain, and Austin, Texas, the company creates solutions for toll, ticketing and parking lot management. Highlights include: Toll network management systems (SmartToll), ticketing management (Mobifast) for rail and underground rail networks, ticketing management (Valtick) for road transport, and parking lot control management systems (Web.Park).

SmartMobility

With this sustainable mobility program, Telvent meets the need for more efficient and safer use of mass transit systems: This calls for optimizing facilities and developing and managing valid data and predictions on infrastructure usage. Telvent has made highly meaningful progress in integrating intermodal transportation data in high-density cities throughout Asia, the Americas, Europe and the Middle East, achieving the following technology milestones:

- The technology upgrade completed in 2009 for high-end traffic light controllers was extended in 2010 to the entire range of traffic regulators. Telvent was the first developer to certify in compliance with the Barcelona Protocol, Spain's most advanced standard, and has also certified to NTCIP, a United States standard widely accepted internationally.
- In addition, the company has developed a mobility lab based on micro- and meso-scopic traffic simulation, integrated with Telvent's existing urban and inter-urban traffic control systems, so as to compare the performance of various regulation modes, such as time- or action-based schemes, under various regulation scenarios and traffic plans.
- 2010 also saw significant progress in the development of an integrated back-office platform for enforcement systems and transportation pay-per-use schemes (tolls and mass transit), thus offering a single overarching solution for managing customers, offenses, tags, pricing policy, collection management, and so forth.
- In the ticketing area, Telvent has opted to focus on light rail systems. In 2010, the company developed a new comprehensive solution embracing control and management applications and new onboard and station-based equipment.

SmartInformation

This program offers mobility services as part of the future "intelligent universe", in which users can use their cell phones to access multiple services and information sources in accordance with their preferences, context and roles.

- Key research was completed in Advanced Sustainable Mobility Services via projects such as mIO!, funded by the Spanish CDTI through the Cenit program, or Smart Urban Spaces, a Europe-wide project under the ITEA seal, also funded by the Ministry. These initiatives are closely aligned with the company's new strategic line in information sales and services, and will lead to highly innovative solutions in this field.
- Also within this program, work continued on "New Smart ITS Infrastructure", oriented to future cooperative systems and vehicle-infrastructure communications. Our projects have won the support of Spain's Ministry of Development, which provided public funds for the completion in 2010 of the ViaSens project and for continued work on the Bus-Direct initiative.

Environment

In the environment sector, the main research and development program in 2010 was Weather and Water Management Suite, a set of advanced weather prediction and data systems and hydrographic basin management applications.

Weather

The Environment Competency Center, with sites at Seville and Madrid in Spain, Culemborg in the Netherlands and Perth in Australia, searches for advanced IT solutions to address the risks currently blighting our planet, such as pollution, climate change, water management and natural disasters. The key initiatives in 2010 arising from the company's commitment to innovation and technological improvement were:

- Further offshoots of the Illion WeatherNet project: The development of a web-based weather service that provides users with state-of-the-art forecasts tailored to their requirements and geographical location co-funded by MITyC and the European Fund for Regional Development (EFRD).
- Work also got underway in 2010 on the Prometeo Project, involving the development of a weather information system specifically capable of handling forest fire scenarios: It offers critical high-quality weather data on fires as they unfold and real-time monitoring of firefighting aircraft. This is a project subsidized by the CDTI.

The Weather Product Center, with sites at Minneapolis, Minnesota, and Omaha, Nebraska, is the North American leader in meteorological systems for decision-making support in aviation, energy and transportation, and continuously explores new solutions to position the various US industries as market leaders.

One of the key achievements in 2010 was the successful extension of the company's weather prediction solution to other Telvent markets: This was particularly significant for the Smart Grid, Aviation and Transportation markets.

Water Management

This research area seeks solutions to rise to the challenges associated with the increasing scarcity of water: Minimizing leaks, improving energy management and optimizing water operations. A particular highlight project was:

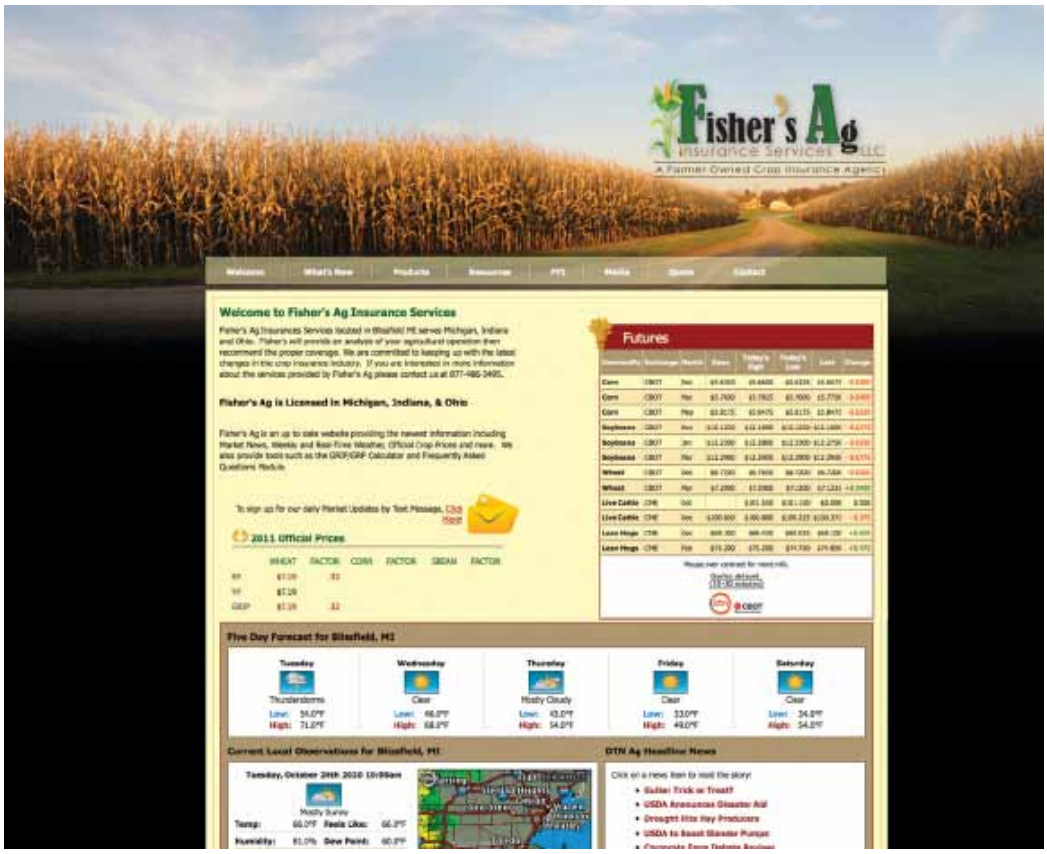
Water Management Suite (WMS). The company has started to develop a range of applications for sustainable water management in urban environments, so that water utilities can at all times assure the required service levels at each stage of the integrated water cycle, while optimizing their resources and infrastructure and lowering costs and greenhouse gas emissions.

Agriculture

The agriculture sector focuses on developing accurate information services in support of real-time decision-making via the company's agriculture information services research and development program.

The Agricultural Product Center, based at Minneapolis, Minnesota and Omaha, Nebraska, is the leading provider of agricultural information in the United States, particularly for corn, soybean and livestock.

Agricultural Information Services



Telvent/DTN''s agricultural information services

The overriding goal of this program is to offer advanced information services - accurate market and weather data in aid of more effective farming resource management. These services are a valuable aid to crop and livestock farmers in managing prices and costs while lowering market risk. Highlights in 2010 included:

- The Telvent Grain Portal, a data website offering a comprehensive range of information on cereal crops in the United States. In 2010, the company developed new modules for integration with other management systems widely used by farmers.
- The Ag online service is the leading online agricultural information provider for United States farmers. This year, the company made significant improvements, such as a new map viewer and a whole new generation of smart phone and Tablet PC apps.
- The Prophet X solution provides vital information to support over 4,500 farmers' decision-making on the cereal, livestock and biofuel markets.

Other R&D&I Programs

The Healthcare and Homeland Security Competency Center has its headquarters in Seville, Spain. Its research, development and innovation activity continues to focus on Homeland Security and eHealth. In 2010, the following lines of work were highlights:

Health Care and Homeland Security

- In 2010, Homeland Security research continued to build on its groundbreaking work in physical security, targeting immigration management and document verification.
- The second year of the Cenit Integra project, led by Telvent, was completed as planned; the venture aimed to develop innovative technologies towards an integrated system of immigration management (prevention, control and integration of migratory flows).

- In the Healthcare domain, research in 2010 continued to focus on telecare and the AmiVital project. The key aim was to create a telecare platform, a vital step towards meeting the demands of the incipient and increasingly promising telecare market, geared towards providing services and personal support for independent living, well-being and health.

Creating Value through Technology

In addition to the above R&D&I initiatives, Telvent is committed to developing technology that creates value for its customers and shareholders through products and solutions aligned with market strategy. Telvent's aims are to:

- Develop patentable technology.
- Apply best practices in software development. In 2010, Telvent achieved level 3 CMMI certification at every one of its Product and Competency Centers.

Abeinsa

Abeinsa and Innovation: Introduction and Overview

Abeinsa is the Abengoa group's industrial engineering and construction division. Research, development and innovation are naturally core capabilities in this field.

Innovation at Abeinsa focuses on energy and industrial facilities. The company undertakes the bulk of its projects in Spain, Europe and Latin America. Major activities include designing and developing solar plants - particularly solar thermal - and biofuel production plants, improving conventional plants and railway facilities, designing substations and containers, and stringing major power transmission lines.

Abeinsa's research and development capability ranges over three major areas:

- Abeinsa Nuevas Tecnologías is a business-oriented R&D&I concern; it operates within each Abeinsa company, with a focus on the specific business at hand. The main lines of work conducted by Abeinsa Nuevas Tecnologías are CO_2 capture and valorization, energy efficiency consultancy and research, electric car development, ocean energy, and telecommunications.
- Abeinsa Nuevos Horizontes embraces companies like Hynergreen (hydrogen and fuel-cell technology) and Zeroemissions (carbon dioxide and other greenhouse gas management), independently managed businesses which concentrate on specific technologies tightly linked to research and development.
- Abengoa Research encompasses high-end innovative research and development activities and operates as an ideas nursery for Abeinsa and Abengoa, generating new research horizons. Its interests include materials, nanotechnology, fluid mechanics, solid mechanics, structures, thermal engineering, process engineering, biotechnology and power networks.

Abeinsa's research and development efforts are undertaken in partnership with numerous research institutes and universities in Spain and elsewhere. Collaboration with these centers and the academic world is one of the pillars upholding the company's development strategy.

R&D&I Programs

The following is a list of Abeinsa's key research and development projects undertaken or completed over 2010 in each of the group's strategic lines of concern.

Hydrogen and Fuel Cell Technologies

This strategic line of research subdivides into: Production, storage and use of hydrogen from

renewable sources; and development of fuel-cell systems. In line with established practice, the main research milestones of the year have been patented, and the company's scientific achievements have been disseminated via conferences and published articles.

Renewable Hydrogen Production, Storage and Use

Hydrogen, a colorless, odorless gas, is both an energy vector requiring production and a form of energy storage. It is a fuel that can be produced using available resources and used as needed.

Hynergreen's hydrogen production research embraces bioethanol and biodiesel reforming at various scales and for different uses, electrolysis, and thermochemical cycle studies oriented to solar thermal energy use.

In the storage field, the year's highlights include work on metal hydrides, borohydrides, nanostructures and hydrosilanes, oriented to both portable and transportation applications and the stationary sector.

Hynergreen led the Hercules project, where a hydrogen station was installed; as well a car was adapted to use it in a fuel cell

Fuel Cells

Fuel cells are electrochemical devices that directly convert the chemical energy present in a hydrogen molecule (or a molecule containing hydrogen) into electricity and heat to a high degree of efficiency, while offering advantages such as modularity, a low failure rate and robustness.

In 2010, Hynergreen worked on a range of different fuel-cell projects. Some of the key applications have been aimed at the portable sector, with units in the 20 W to 100 W range, and the transportation sector, with systems producing electricity for propulsion purposes in the range of 50 kW to 300 kW.

The company also worked on adapting and converting fuel cells' output capacity and on control systems and data capture networks associated with these technologies.

Projects tend to be based on polymer fuel cells (PEMFC), although the company has also worked in the high temperature sector.

Carbon Dioxide and Other Greenhouse Gas Emissions Management

Zeroemissions' new technologies division focuses on developing greenhouse gas emission reduction technologies and on studying the impact of these technologies on the environment via R&D&I projects. The division's research program bears the title "Development of Technologies and Know-How in Emissions Reduction Techniques and Evaluation of the Environmental Impact of Human Activities."

The program encompasses a range of different research projects. Progress made in 2010 is outlined below.

$RNCO_2$ Project

A study of new highly energy-efficient steam compression refrigeration plants using carbon dioxide as a natural cooling agent instead of HFC-type fluoride gases, thus achieving both direct and indirect emissions reductions in the field of refrigeration and climate control. ABNT is working in partnership with the Polytechnic University of Valencia and University Jaime I of Castellon.

In 2010, the company analyzed the lifecycle of different refrigeration techniques, comparing the production requirements of refrigeration equipment and gases, energy use throughout their useful lives, and emissions associated with leakage and end-of-life scenarios for equipment and gases.

The energy cost should take into consideration the emissions cost associated

Abanilla Project

This study monitors gases produced at the Abanilla landfill, evaluates the techniques used to purify biogas, and calculates the emissions prevented by the use of landfill biogas. The project is underway in partnership with Energía Sur de Europa and AICIA.

In 2010, the company installed a device to monitor the composition and quantity of biogas generated by the Abanilla landfill in Murcia, Spain. This ongoing monitoring supports calculations of the greenhouse gas emissions prevented by utilization for energy purposes of the biogas. The company also examined the cleaning capacity of various motor filters.

AEMEP Project

The aim of this project is to reduce, monitor and verify the reduction of total equivalent carbon dioxide emissions from livestock slurry via selection, installation and optimization of a livestock

waste treatment system capable of generating methane based on anaerobic digestion of slurry mixed with purification plant sludge and the organic fraction of urban waste for subsequent value recovery for energy purposes in the form of heat and/or electricity. The project is being undertaken in partnership with the University of Leon and Cogersa.

In 2010, the company developed a methodology to calculate the emissions prevented by co-digestion of wastes, based on methodologies and tools developed by the United Nations.

Upcoming Projects

Ventures now at the launch stage in the field of emissions reduction techniques and assessment of the environmental impact of human activities include the Bioglicer, Watersol and Biocar projects.

CO_2 Capture and Valorization

Over the course of 2010, the company made significant progress in key R&D&I initiatives relating to CO_2 capture and valorization.

Mineral Carbonation of CO_2: Wollastonite Project

Carbon sequestration by mineral carbonation is a technology that mimics the natural weathering of calcium- and magnesium-based rock that has taken place since the formation of planet Earth.
In a carbonation reaction, carbon dioxide reacts with materials (chiefly silicates) containing metallic oxides to form carbonate and silica. These minerals include olivine, serpentine and wollastonite.

The main advantage of mineral sequestration is that the products are mineral carbonates that remain unchanged over time (millions of years) - unaffected by the environment, they are even reusable as raw materials in various processes (e.g., cement manufacturing).

Mineral carbonation, though still at the research phase, has evolved along a variety of routes in terms of experimental protocols and results at the laboratory scale. Literature published to date expresses a number of caveats, but at present this appears to be the only carbon dioxide sequestration method free of the long-term risk of gas leakage, thus removing the need for post-storage leakage control and monitoring processes.

The Wollastonite project was begun in late 2009 and will run through 2011. Conducted in partnership with the University of Seville, it is funded by the Ministry of Science and Innovation and the Innovation, Science and Enterprise Department of the regional government of Andalusia.

The project analyzes the technical and economic viability of carbon dioxide carbonation processes using silica and calcium compounds such as wollastonite, and identifies the specifications required for the design of an integrated carbon dioxide capture and sequestration system as applied to an industrial facility generating large quantities of the gas (power plants, cement manufacturing plants). In addition, applications are being considered for carbonation by-products.

Oxy-Fuel Combustion Technologies: AvantO_2 Project

Oxy-fuel combustion is a new energy generation technology consisting in burning coal or natural gas in pure oxygen (instead of air), so creating a gas outflow chiefly comprising carbon dioxide and steam.

The technology requires a large oxygen input. As an estimate, a 500 MW oxy-fuel combustion plant would need approximately 10,000 t of oxygen per day; at present, this would be feasible only through cryogenic air separation. However, the technology carries a very high energy cost - a 500 MW plant operating for 8,000 h would necessitate an air separation unit consuming energy equivalent to 15 % of the plant's annual power output, making for a penalty of 10 % on the plant's overall efficiency.

Inabensa is exploring alternatives for mass oxygen production. The company is now focusing on oxygen transport membranes (OTMs), and hopes to lower the overall efficiency-loss of an oxy-fuel combustion plant to the level of 5 %. OTMs are ceramic membranes having the distinctive property of selectively allowing permeation by oxygen, thus creating a pure oxygen flow.

As part of the AvantO_2 project, conducted from 2008 to late 2009 with a subsidy awarded by the Ministry of Science and Innovation, Inabensa benefited from the expertise of the CSIC Chemical Technology Institute for the development of new ion-conducting ceramics to be applied in air-oxygen separation processes.

As a result, the team identified promising materials for efficient oxygen production. A second phase of the project has been launched to continue researching and improving these materials and find the best way to integrate the membranes thus developed with an oxy-fuel combustion plant.

Bio-Sequestration using Photosynthetic Microorganisms: Cenit SOST-CO_2 Project

This project has made considerable headway in carbon dioxide sequestration using photosynthetic microorganisms (microalgae and cyanobacteria) for energy purposes and as biomass. A promising strain has been selected, and knowledge has improved as to the optimal conditions for achieving the highest cultivation yield.

Abeinsa works in the development of liquid absorbing CO_2

Forward motion has also been achieved in designing and synthesizing ionic liquids for the specific purpose of absorbing carbon dioxide as a potentially viable and competitive alternative to existing commercially available amine-based absorbent agents.

Energy Efficiency Consultancy and Research

Product and Plant Reengineering; Energy Evaluations

Energy efficiency in equipment and facilities used not to be a design parameter, chiefly because energy was cheap and engineers sought to optimize individual performance elements rather than take an all-embracing approach.

Inabensa is redesigning several of its products by analyzing potential performance improvements over their useful lives. All design aspects - mechanical, thermal, electrical - and manufacturing features are considered in combination, and the energy performance of the whole ensemble is evaluated. For instance, an appraisal is made of the benefits of using a more efficient component (transformer, switch, frequency converter) that, though expensive initially, reduces losses and generates less heat. In turn, given the lower thermal load, the climate control system can be smaller, consume less, and thus lead to lower costs. Improvements of this kind pay for themselves very quickly and garner environmental benefits.

Developments in the efficinecy will help to reduce the primary energy consumption

Energy assessments are not confined to equipment; the company is also evaluating entire sites: Offices, facilities, manufacturing shops and energy plants.

Electricity Storage and Energy Management

Until recently electricity flowed from large power stations to consumers by a one-way route. This concept has now evolved, however, with the advent of renewable energy and distributed generation. Storage and management will be key issues in the emergence of a safer, more efficient and sustainable grid. In this arena, Inabensa is involved in the Sa2ve initiative, a Unique Strategic Project funded by the Spanish Ministry of Science and Innovation. The research develops storage technology via inertia wheels applied to a range of sectors, including railways. The Ferro Sa2ve sub-project stores the braking energy generated by a given train in an inertia wheel, and releases it as needed to another train, e.g., during acceleration, by returning the energy to the overhead contact line. Inabensa has designed and executed the renovation works for the power substation where the trials are being run, and has brought the various elements together: Inertia wheels, electric converters, protection systems, quality assurance, etc.

Alongside storage research, Inabensa is considering the possibility of transmitting brake energy to the power grid, thus turning substations into two-way systems.

Electric Car Alternatives

Abeinsa is firmly committed to making progress towards sustainable mobility, a concept that emerged in response to concern about the environmental and social issues surrounding the fact that, in the second half of the twentieth century, urban transportation became based predominantly on the use of private vehicles. The drawbacks of this model are atmospheric pollution, overuse of energy, traffic congestion, and harmful effects on health. Inabensa is accordingly determined to find alternatives that mitigate the adverse consequences and lead to a new, more sustainable model. Transportation accounts for one-fourth of greenhouse gas emissions and 36 % of energy use in Spain.

Keeping faith with this commitment, Inabensa's R&D&I department has launched a new line of research under the name "Electric Car Alternatives," with the ultimate aim of creating new business models. This line of research focuses on two areas:

- Energy storage. Inabensa R&D&I is confident that the key to successfully implementing a new, sustainable transportation model is to store energy in cells and make full use of the autonomy they are capable of providing.
- Smart Metering & Smart Grid concepts, and their integration with renewable sources of energy. The aim here is to dovetail the company's efforts with research conducted in this field by other Abengoa companies.

Ocean Energy

Abengoa is committed to developing technologies that harness renewable energy resources and so contribute to the planet's sustainable economic growth. This is why Abeinsa is involved in ongoing research towards these goals.

The ocean energy line pursued by Inabensa R&D&I is a prime example of this commitment. Ocean energy is a natural resource that, though harboring high potential, has so far been insufficiently explored.

Abeinsa has analyzed the sector so as to frame its business strategy within this incipient industry, with a view to diversifying its operational scope.

Several lines of activity are now in progress, embracing the main points identified to develop the company's business strategy:

- Wave energy: Applications for large-scale power generation.
- Market niches: Water desalination applications, other minor applications, etc.
- Auxiliary businesses.

This far-ranging analysis process has involved Inabensa in both domestic and European R&D&I projects. Exhaustive technological observation of the sector enables Abeinsa to operate at the forefront of development in an industry that is set to revolutionize the world energy scene and the marine industry.

The sea has a big energetic potential to be explored

Telecommunications

mIO! Project

The mIO! project, one of the ICT ventures in the mobility area, is funded for the 2008-2011 period by the CDTI's Cenit program. The objective of project mIO! (technologies for providing mobility services in the coming intelligent universe) is to realize technologies that allow ubiquitous services to be provided in an intelligent environment, adapted to each individual and to his/her context, using the mobile device as the base for interaction with both services provided by companies and with microservices created and provided by the mobility users themselves.

Taking forward the overall goals of the mIO! project calls for a technological leap that goes far beyond the present state of the art.

This leap will entail scientific and technological progress in fields as diverse as:

- Mobility service technologies created and provided by individuals: Service description models, mobile service delivery platforms, semantic technologies, advanced usability and graphical interface models, open operator, device or service APIs, advanced search technologies and proximity technologies and protocols, etc.

- Access interface technologies: Mobile devices as an advanced user interaction interface, new algorithms supporting higher device workloads, interface designs enabling immersive viewing, etc.
- Context and personalization management technologies: New mechanisms for modeling knowledge obtained from users, services and devices.
- Mobility service technologies created and provided by businesses: Integration of smart card and mobility technologies, integration of multiple smart devices with different features within a mobility environment, etc.
- Communication and connectivity technologies: Definition of communication and information exchange mechanisms among the mobile device, the user and his/her environment, support techniques for frequent transfers resulting from nomadism in an environment with intelligent infrastructures, new capacities and services deployment models via NGN and IMS architectures, etc.

Inredis Project

As one of the ICT projects geared towards social inclusiveness and independent living, Inredis secured funding for the 2007-2010 period from the CDTI's Cenit program.

The core goal of the Inredis project (INterfaces de RElación entre el entorno y las personas con DIScapacidad) is to develop fundamental technologies capable of supporting channels for communication and interaction between people with special needs and their environment.

The technological challenges that the Inredis project seeks to address are:

- Analyzing the technological environment and identifying the state of the art in emerging technologies applicable to the interaction between people with disabilities and information society applications and services.
- Analyzing the technical, semantic and organizational specifications relevant to the development of a communication protocol supporting interoperability among existing technologies.
- Analyzing human-machine interaction technologies that offer the potential for a qualitative leap in the relationship between people with disabilities and the information society (speech processing, psychophysiology, image processing, text processing, emotional technology, haptics and intelligent textiles).
- Researching the most innovative aspects of each technology and conducting validation and checks using an experimental platform.
- Integrating the interoperability protocol developed within the project with user devices and their respective Ubiquitous Technical Applications.
- Modeling a mobile system or device that can mesh with different communication protocols and be used by functionally diverse people in a safe and intuitive way.
- Producing a white paper on the design of accessible, interoperable technology.

Iza Project

Also within the field of social inclusiveness and independent living, the Iza project ("Intelligent System for Service Provision in a Residential Setting for People with Physical and/or Cognitive Disabilities") is funded by the Avanza R&D&I sub-program operated by MITyC (Spain's Ministry of Industry, Tourism and Trade) over the period 2008-2010.

The core goal of this project is to develop an intelligent system offering ad hoc services to carers of people with physical and/or cognitive disabilities residing in nursing homes.

The carer can use a personalized interface to monitor his/her users'/residents' activities in real time, establish standard behavioral patterns, identify deviations from preset models, and achieve early diagnosis and correction of diseases signaled by known behavioral patterns, with the ultimate aim of enhancing residents' quality of life and personal autonomy.

The project provides a service platform focusing on support for people with physical and/or cognitive disabilities and their carers, who may be family members or nursing home staff. The personalized interface removes the need for the user to interact with any device manually: The environment itself captures the data and takes steps accordingly.

A major step forward with respect to commercially available solutions is a combination of emerging technologies such as ZigBee, Wi-Fi-M2M, PLC and UWB to create a single intelligent system operating autonomously.

The challenge is to find comprehensive solutions that support carers dealing with the day-to-day activities of people with physical and/or cognitive disabilities.