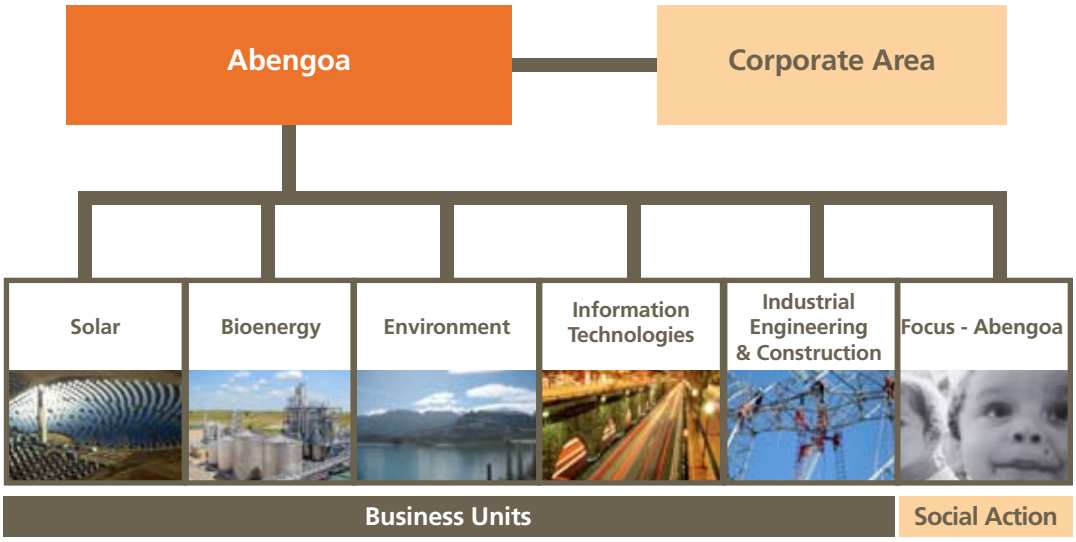
8 Abengoa and Innovation

Abengoa's Commitment to Innovation

Abengoa is a technology company whose five Business Units create innovative solutions for sustainable development in industries concerned with infrastructure, the environment and energy.



The global community is now in the process of mitigating and reversing humanity's past mistakes. We have overused the world's natural resources and treated the environment as a dumping-ground for industrial emissions and waste.

The economist Jeremy Rifkin has said that what is now sometimes called the "black" economy (opposed 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. We have raised the atmospheric concentration of co_2 year after year: In September 2009, the Keeling curve exhibited a co_2 concentration of 385 ppm. This poses a serious risk to the environment and to our way of 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 (Gross Domestic Product). This means the economy and society would be severely disrupted for the remainder of this century and beyond.

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 the only remaining question is how quickly we can get to a zero-emissions economy.

Against this backdrop of far-reaching change, Abengoa is determined to become a world benchmark in the development of innovative technological solutions for sustainable development. We hope to become a global leader 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.

Over the next ten years the United States will spend $150,000 M to promote second-generation biofuels (lignocellulosic bioethanol), support the electric and hybrid car market, encourage the commercial development of renewable energies and start the changeover to a new digital power grid.

And, in Spain, the Council of Ministers set its seal on the draft of a new Sustainable Economy Bill on November 27, 2009. Regarded as the centerpiece of the current legislative term, the new law is intended to bring about much-needed change in the Spanish economy by opening it up to innovation and renewal.

Abengoa, for its part, has worked 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. These new production processes call for a demanding schedule of investment, and that investment has served as Abengoa's engine in creating a new generation of jobs and a new array of benefits for the wider community.

Creating Value at Abengoa through Innovation

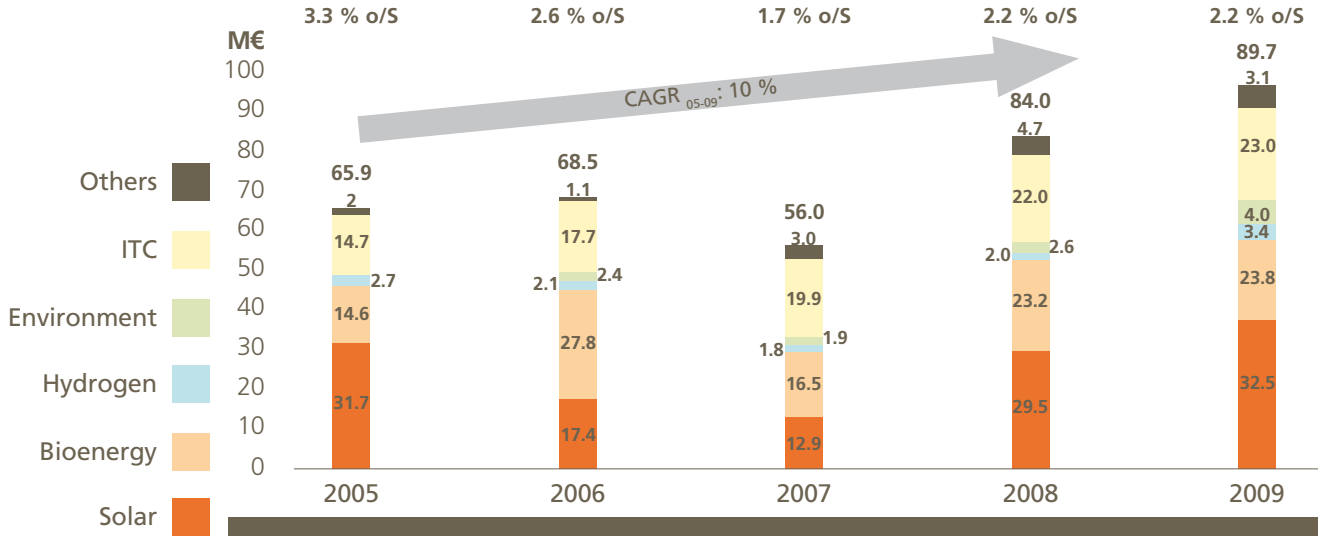
Abengoa's overarching goal, sustainable development, is achievable only through innovation. Hence Abengoa has become a leader in creating new technologies, processes and know-how designed to provide innovative solutions that help preserve the environment, create value over the long term and provide a competitive edge. Technological innovation is the key factor in evolving towards a sustainable world in which people and societies can enjoy a high standard of living. Experts agree that close to 80 % of an economy's long-term growth comes down to technological achievement.

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 2009, Abengoa's investment in R&D amounted to €89.7 M, 7 % up on the previous year and equivalent to about 2.2 % of its total sales. R&D investment has grown at an annual average of 8 % over the past few 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.

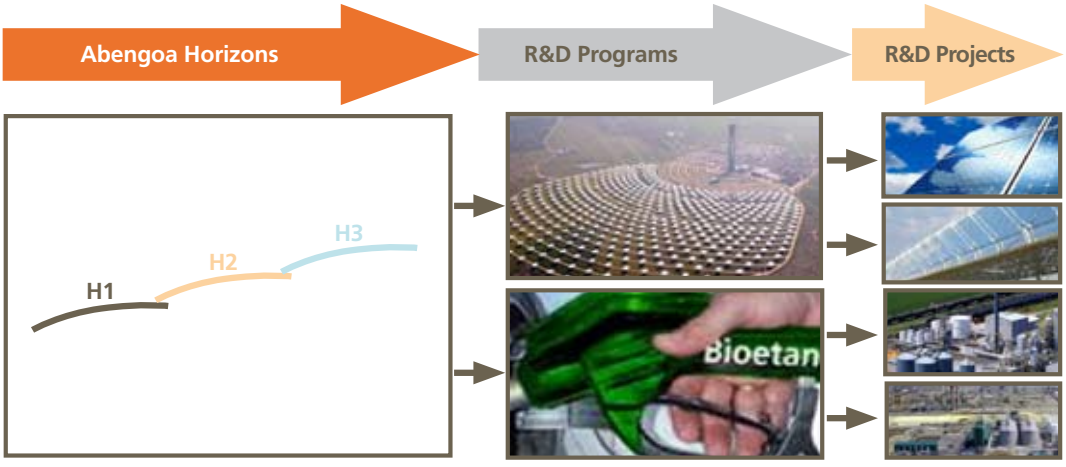
Investment in R&D by Activity



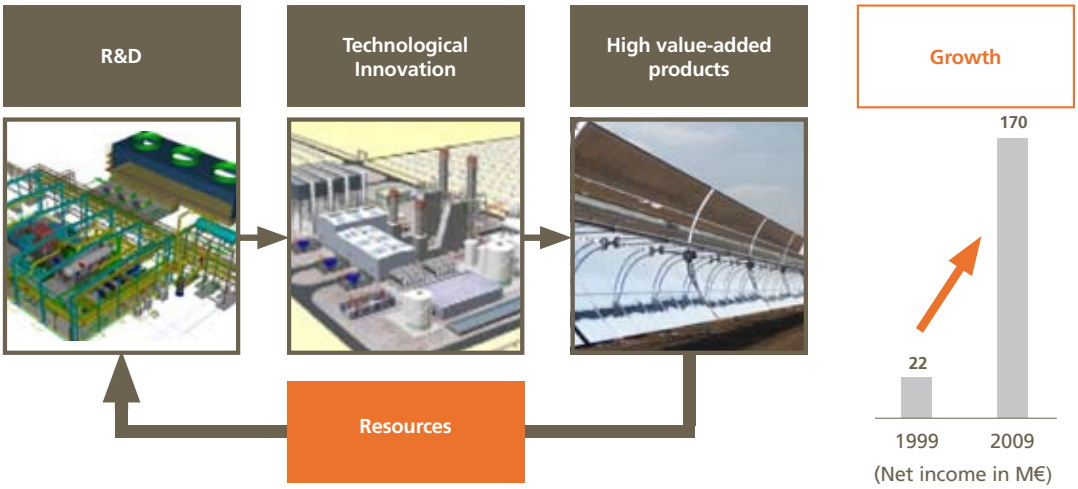
Innovation is a dynamic process that moves in step with an evolving society. It avails itself of all the resources offered by the knowledge, science and technology communities. In line with its calling as a leading company, Abengoa has adopted the "innovation ecosystem" approach: It works in partnership 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. It is through innovation alone that Abengoa is able to bring into being the necessary knowledge and provide responses and solutions to new challenges. The system of innovation embraces demonstration projects, research and development facilities in various countries and external suppliers. In 2009, two framework collaboration agreements were signed with the University of Seville. One concerned joint training for doctoral students while the other supported co-operation between the University and Abengoa.

Innovation management at Abengoa is a central part of the strategy implemented by each subsidiary or Business Unit. Innovation is regarded as having three aspects: new products, new processes and improvements to existing assets. Research and development programs are given a general scope, and each is linked to a given line of development.

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 innovation effort into practice.



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.



Sustainability. Abengoa's Business Metrics

Abengoa today is an international leader in many key areas of the Green Economy. This is where all its business units operate; all their policies and innovation strategies seek to make sustainable use of resources and raw materials so as to harness their entire life cycles. And it is to this end that each Abengoa business unit undertakes its own processes of technological innovation.

Abengoa has pioneered technological innovation in the field of renewable energy sources to offer high energy efficiency and low environmental impact. This realm of technological development, as part of the new Green Economy, leads to savings in greenhouse gas emissions. Furthermore, by decentralizing from conventional sources, renewable energy frees domestic economies from long-standing geopolitical constraints imposed by oil and gas states, and the shortfalls in security of supply that such sources sometimes imply.

The key areas of sustainable development being leaded by Abengoa include:

- Abengoa Solar, which produces energy using solar thermal or photovoltaic sources instead of conventional sources, and develops energy storage technologies. Abengoa owns the only two commercial concentrating solar power plants in the world that use tower technology, and is now developing several parabolic trough plants, including one of the world's largest in Arizona, USA. Abengoa has gained a clear world lead in this field. The key factor underpinning the company's leadership is its cooperation with the Almería Solar Platform and with CIEMAT as a whole.
- Abengoa Bioenergy, which produces first and second-generation biofuels to replace conventional fossil fuels. Using biomass as an energy source, Abengoa undertakes research and development projects that are set to mature into commercial enzymatic hydrolysis and biomass gasification facilities and hybrid biomass and concentrating solar power plants.
- Befesa Medio Ambiente provides solutions for the integrated water cycle and the integrated management of industrial wastes, creating new desalination and water treatment plants and new industrial processes for waste reuse.
- Telvent develops smart networks to optimize energy use and grid manageability. The company builds smart networks through research and development projects to create products which are then implemented in different countries around the world. Telvent's smart, efficient energy distribution networks play a leading role in this domain. Telvent is also developing highly competitive and sustainable agriculture with key support from new technologies. It supplies technology services to the world's leading farming sector: the United States agriculture.
- Abeinsa's "New Horizons" business unit comprises the companies Hynergreen and Zeroemissions. Hynergreen develops new systems to produce hydrogen from renewable sources and to use it in state-of-the-art fuel cells. Zeroemissions is a company providing global solutions for climate change through the promotion, development and sale of carbon credits, voluntary emissions set-off arrangements, and innovation in greenhouse gas reduction technologies. Abeinsa also implements energy efficiency improvements, carbon capture and storage programs and ongoing innovation schemes at industrial and energy plants, especially renewable energy facilities.

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 accordingly vital and solar energy plants still produce power at a higher cost than conventional plants. The development of the solar energy sector will depend on whether technology is able to bring down costs to a level equal to or even lower than the conventional energy sector. 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.

An increasingly competitive environment means that a company needs to innovate in order to survive and stay ahead of its competitors. Technology and innovation are tightly bound up with each other in a company's efforts to bolster its competitiveness. Abengoa must therefore create new technologies in a process of constant renewal that keeps the business at the forefront of the market.

Abengoa Solar's development of proprietary technology within its research and development department affords it at a competitive edge. This fact is particularly significant given the company's role at various different stages of the value chain: among other activities, it manufactures technological components and operates as a plant developer.

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 80 people at research sites across the world – Seville and Madrid in Spain; Denver in Colorado, USA.

- Abengoa Solar cooperates with leading institutions, such as Instituto de Energía Solar-UPM, Ciemat and many other universities in Spain; NREL, the University of Rochester and the University of California, Merced, in the United States; and DLR and Fraunhoufer ISE in Germany.
- The company's projects are funded by two income streams: Government aid and subsidies at the regional (IDEA, AAE, CTA), national (Cenit, CDTI, MICINN and MITyC in Spain; and the DOE in the USA) and European levels (Framework Programs, or FPs); and a large proportion of investment comes from the company itself. Major awards of public funds secured in 2009 included:
    - In Spain, the company continued the Cenit Consolida project into its second year. The total budget of €24 M is subsidized in a proportion approaching 50 %.
    - In Spain, three projects co-financed by European Union EFRD funds were secured through the CDTI (the Spanish center for industrial technology, an agency attached to the Ministry of Science and Innovation).
    - In the United States, Abengoa Solar secured two new R&D projects from the DOE.
    - In the field of photovoltaics, we worked as partners on the Cenit Sigmasoles project, aimed at developing concentrating photovoltaics (CPV) technology. The project is scheduled to be completed over a period of three years and has a total budget of €24 M. On a regional scale, Abengoa Solar has attracted significant funding from Andalusian public authorities for R&D projects in photovoltaic energy, such as the PV-Dish and Tejasol projects.

Abengoa Solar Innovation Highlights of 2009

In 2009, the research and development 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.

2009 saw the commissioning of several demonstration plants that corroborate Abengoa Solar's strategy in the field of new technologies: To develop and test technology using small-scale facilities (pilot plants) with a view to subsequent application at large commercial sites.

Abengoa Solar's research and development encompasses four stages. 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, etc. At the third 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.

These pilot plants enable Abengoa Solar to deal with the associated technological challenges successfully. The issues fall into two wide branches or different areas: enhancing the efficiency of solar energy conversion into electricity while lowering costs.

- 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 as and when desired. 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 transfer fluids, such as water, for direct generation of steam, thus avoiding the need for expensive heat exchangers or molten salts to achieve higher operating temperatures.
- Improvements in plant control and operation to enhance efficiency and reliability.

In response to these challenges, the company has set in motion several pilot plants as part of the Solúcar Platform over the course of 2009. 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, with temperatures reaching 550° C. The plant was commissioned in early 2009.
- Water certified as an alternative to oil in parabolic trough loops. Our direct steam generation plant, also commissioned early in 2009, has validated the control system developed by Abengoa Solar, thus meeting one of the main challenges of this technology.
- Validation of thermal storage. The setting in motion of a molten salts demonstration plant in 2009 reinforced Abengoa Solar's know-how 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.

Just like solar thermal technology, photovoltaic technology faces the challenge of developing systems that generate power at a cost that can compete with both other renewables and conventional sources.

The development of the photovoltaic market has meant that, holding geographical location constant, this technology now achieves costs comparable to those of high-temperature concentrating solar power plants. The versatility of photovoltaic technology makes it a strong candidate for use in virtually all regions of the planet – its efficiency and performance may differ, but it will be fully operational everywhere.

The market's learning curve and growth trend raise hopes for costs to be lowered with respect to other sources. Finally, the convenient modularity of photovoltaics makes them suitable for existing infrastructure and a wide variety of buildings, opening up special markets such as distributed generation (at a small scale) for industrial and residential areas.

This is why developing and operating efficient photovoltaic technologies has become a core goal for Abengoa Solar. The company is now working with flat panel systems, with and without concentration, and on high-concentration photovoltaics. Over the course of 2009, Abengoa Solar conducted a comparative survey of the power output of various available technologies and of newly emerging concepts in research and development: thin film, high-concentration photovoltaics and others.

The company has considered using high-concentration designs involving large area reflecting dishes and point focus approaches. Abengoa Solar has continued its research program to develop the concentration systems of the future, based on high-efficiency multi-band cells. A highlight here was the commissioning of one of the world's largest CPV plants, which now forms part of the Casaquemada facility (Sanlúcar la Mayor, Seville, Spain).

R&D Programs

The R&D program in the Solar Business Unit rests on five 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 2009, besides commissioning 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.

Running in parallel to the manufacture of the prototype and construction of the plant, the Resolve project – in partnership with leading Spanish research centers – developed a software application that simulates the thermal and fluid dynamics behavior in solar receivers of saturated and superheated steam. This work is embedded within the Cenit Consolida project and will accordingly run for a further three years, during which real-time observational data will be used to validate and improve the software.

In the field of tower technology, our 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 CDTI, involves the engineering and manufacture of a tower solar receiver prototype in which the heat transfer 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 Solugás project (co-financed by the European Seventh Framework Program), started in 2008, is intended to demonstrate the functioning of tower technology at higher temperatures, employing air as the heat transfer fluid and a gas cycle instead of steam.

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 Repow PS10, an experimental loop comprising four collectors and using thermal oil as the heat transfer fluid. Potential optical and thermal improvements have been assessed and all the key components of the technology have now been identified. This unique test bench has earned us a practical familiarity with the functioning of the plant at smaller than commercial scale, and the know-how acquired has been passed on to commercial plants now in the process of construction.

2009 also saw the commissioning of the direct steam generation plant. Formed by three loops carrying saturated steam, the design of this technology removes the need for an oil-steam exchanger and accordingly raises the overall efficiency of the site. 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 Cenit Consolida project also involves research on improving components and transfer fluids. Here, the sought-after qualities are maximum durability and minimum environmental impact.

Storage Technologies

The technology underlying concentrating solar power plants is now reaching a state of maturity that positions solar power as a strong candidate to supersede conventional thermal plants. Some of the 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; levels of available sunlight and energy reserves at a given time impose severe strictures on operational planning.

The size of the energy storage system attached to a solar plant is determined by the plant's main transfer fluid – steam or thermal oil. Steam stores heat in latent form, while oil stores it in sensible form.

In the case of thermal oil, thermal storage at combined cycle plants is implemented in the form of sensible heat. A hot body (e.g., a heat transfer fluid) is brought into contact with a cooler liquid, solid or gaseous medium in which the heat is to be stored. As a result, the storage medium heats up. Using the sensible heat of the material, the medium stores energy as and when its temperature rises.

This technology was tested in 2009 at the TES PS10 facility, connected to the Repow PS10 oil loop. The experience provided a highly valuable lesson in operation and optimization for the construction of forthcoming commercial solar plants with attached storage systems.

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 taken part in several past research projects relating to storage with a change of phase. For example, the Distor project led to a prototype that underwent trials at the Almería Solar Platform.

In partnership with a wide range of research centers and universities, we are now working on a definition and full specification of innovative mixtures of materials.

As part of the Cenit Consolida project, we are also beginning to conduct research on another mode of storage: thermochemical storage.

Photovoltaic Technology

Concentrating Photovoltaics (CPV)

In partnership with NREL and several North American universities and colleges, the company is developing new concentrating photovoltaic concepts. Highlights include a new generation of Fresnel lens photovoltaic concentrators, a semi-static low-concentrating system, quantum dots, light guides 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, thus widening the feasibility of renewable energy to embrace scenarios where incentives are not needed for the business to flourish.

The company has made a major effort to develop solar trackers for concentrating photovoltaic applications. Building on the knowledge amassed on this kind of system for concentrating solar power plants, the Photovoltaic Technology division is adapting and optimizing trackers for the markets and their new requirements. Several CPV technology devices have been successfully installed at a 100 kW plant at the Instituto de Sistemas Fotovoltaicos de Concentración (ISFOC) at Puertollano (Ciudad Real, Spain). The move unveiled a potential new line of business that may well valorize the research and development efforts of recent years and garner attractive returns in the short or medium term.

Thin Film Technology

One of the company's most ambitious projects is to build an R&D technology center in Huelva 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.

The technology center will employ a large team of researchers and undertake its programs in partnership with leading Spanish and international research institutions. It will be endowed with a large budget so that it can acquire and use the latest techniques to characterize and deposit new materials.

One of the center's key goals is to become a world benchmark in applied research on advanced materials with photovoltaic applications.

Photovoltaics Laboratory

The photovoltaics laboratory built in 2008 has tested and measured the performance of a wide range of photovoltaic systems under real operating conditions and using various monitoring methods. Based on the data thus gathered, the laboratory has developed an experimental software application to analyze the cost of generating energy using different technologies and configurations, prevent or solve problems arising over the lifetime of photovoltaic systems, and identify the optimal technology and configuration for various kinds of facility. The company's photovoltaics laboratory, installed at the Solúcar Platform, is equipped to measure and characterize photovoltaic devices and systems. It serves as a powerful auxiliary for the requirements of the various

research and development projects now underway – solving and preventing difficulties at existing photovoltaic plants and troubleshooting the design of future plants.

Emerging Technologies

Stirling Dish Technology

Abengoa Solar's research and development also embraces Stirling dish technologies. Abengoa Solar has an eight-unit demonstration plant at the Solúcar Platform. Based on the experience thus gained, a number of projects are in progress to design and manufacture prototypes for new concepts of Stirling engines and similar concentrating structures. Stirling dishes have been shown to be by far the most efficient existing technology, with a heat-to-power yield in excess of 30 %. It is hoped that further advances will make it competitive in terms of cost with respect to other concentrating thermo-electrical technologies, such as parabolic troughs and central receiver plants. Being modular, Stirling dishes are suitable for fields that have hitherto been catered to only by photovoltaic technologies (distributed energy generation).

Their scalability means that they can also be used to build large plants offering tens of MW.

Renewable Hydrogen Production

In an ongoing partnership with Hynergreen, Abengoa Solar has undertaken numerous projects to produce hydrogen using thermal and photovoltaic solar power. As part of the integrated Cenit Consolida project, the company is working to single out the most suitable thermochemical cycle for combination with thermal energy produced by solar concentration. In late 2009, Abengoa Solar was awarded the tender for a project funded by the Spanish Ministry of Science and Innovation (MICINN) to implement a hydrogen receiver-reactor prototype at a tower plant.

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 co-products.

ABNT's team of engineers and scientists, in cooperation with research and development centers, universities and industrial partners, develops innovative processes to raise the performance of bioethanol through dry mill technologies, improve co-product quality, develop new co-products and develop biomass technology for bioethanol and co-product production. ABNT's business strategy involves developing and registering the intellectual property rights to provide technology to third parties under management agreements.

Abengoa Bioenergy Innovation Highlights of 2009

Abengoa Bioenergía Nuevas Tecnologías' mission is to engage in scientific and innovative endeavor to develop and demonstrate 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 co-products and develop new co-products.
- To improve on current dry mill technologies.
- 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 micro-algae.

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 at York, Nebraska. Having acquainted itself with the process and operating procedures, Abengoa Bioenergía Nuevas Tecnologías has set in motion a second-generation 5 ML BCyL bioethanol demonstration facility. 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 DOE.

In the field of gasification and catalysis, over the course of 2009 the company continued its ambitious program to develop heterogeneous catalysts for converting synthesis gas into bioethanol. The company has filed applications for two Spanish patents over groundbreaking catalysts that have improved on the prior art. We have 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.

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

Abengoa Bioenergy has also worked on the development, evaluation and validation of new processes to valorize the co-products of cereal-based bioethanol production, with a special focus on improving co-product consistency, enhancing the digestibility and concentration of proteins, and developing pig and free-range poultry feeds.

According to data produced 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 lines of research 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 the sustainability of raw materials used; 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 programs demonstrating potential new applications of bioethanol as an end product have focused on captive fleets of heavy vehicles – buses and construction machinery. Fuel analysis has been guided by a strategic focus on blend stability, engine performance and engine part durability when using e-diesel. 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 oxides emissions.

Another concept that has attracted our research team is bio-refining, the process of obtaining marketable products 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 bioethanol production has led the company to dedicate a specific line of research to developing optimized enzymes that more effectively reduce consumption and thus mitigate economic impact. We are 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.

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.

R&D Programs

The most significant projects are outlined below.

I+DEA Project

Abengoa Bioenergía Nuevas Tecnologías (ABNT) is leading this multidisciplinary consortium towards the goal of generating knowledge for the use of bioethanol as a fuel.

The specific objectives of the project include:

- Developing the right energy crops for both existing and second-generation technologies.
- Developing enzyme mixtures for the enzymatic hydrolysis process so as to reduce the impact of this stage on the overall cost of manufacture.
- Making significant progress with bioethanol synthesis catalysts.
- Undertaking complex process design and in-depth analyses.
- Conducting analyses on blend stability, engine performance and engine part durability.
- Demonstrating the use of e-diesel in bus and machinery fleets and developing on-board emissions measurement.
- Developing new applications for bioethanol: specific industrial bioethanol burners, use of bioethanol in marine engines, high-load engines and motorcycles (in modified and unmodified motors).
- Developing standards for tank design and soil restoration after bioethanol spills.

Biosynergy

The Biosynergy project researches the use of biomass to synthesize bioproducts: chemicals or materials with the production of secondary energy carriers; and fuels for transport, energy and/or CHP through the development of bio-refining. The company's research focuses on advanced and innovative development of breakdown

and conversion processes, combining biochemical and thermochemical aspects and developing the process from the laboratory scale to the pilot plant scale.

Abengoa Bioenergy's goal is to generate the data required to weigh up the various options for the physical or chemical breakdown of pre-treated forage and post-treated materials. This data is needed to configure the process while it remains in development and to select the right equipment for bio-refining facilities. It will also aid the development of the conceptual plan for a bio-refining plant that turns energy crop wastes into bioethanol and high-value-added co-products.

Major milestones achieved:

- Evaluation of a range of bio-refining concepts under technical, economic and environmental criteria.
- Analysis of the main bioproducts that can be produced from the various fractions of biomass.
- Technical and economic analysis of various pre-treatment options.
- Technical and economic analysis of various concepts involving combinations of biochemical and thermochemical processes.

PSE ("unique strategic project") for Energy Crops

Abengoa Bioenergy, Ecoagrícola and ABNT are partners in this project funded by the Spanish government to develop energy crops for a range of different applications – heat, electricity and biofuels. With Ciemat playing a coordinating role, the consortium includes Abengoa Bioenergy, Ecoagrícola, Acciona Energía, Acciona Biocombustibles, Guascor, Ciemat, CSIC, INIA, Taim, Circe, the University of Comillas and Valoriza.

Milestones achieved:

- Externalities associated with the use of cereals as an energy crop.
- Development of a software application to identify the cereal used at bioethanol production plants in relation to greenhouse gas emissions along the production and supply chain.
- Selection of the first batch of cereal varieties optimized for bioethanol production.
- Agricultural engineering of Jerusalem artichoke and sweet sorghum (cultivation techniques, harvest periods and techniques, sugar yield, etc).

Híbrido Project

Abengoa Bioenergía Nuevas Tecnologías is leading the implementation of this initiative. The goal is to design, build and operate a commercial hybrid biomass and starch plant with a capacity of 380 ML.

The specific objectives of the project include:

- Demonstrating the commercial viability of the process of converting biomass into bioethanol.
- Confirming that the technologies developed can be adapted to existing and future plants.

Abengoa's ABNT subsidiary has been selected to design, build and operate the US DOE's large demonstration bio-refinery. The project is partly funded by a DOE subsidy.

The bio-refinery will be adjacent to a starch bioethanol plant, thereby forming a hybrid complex at Hugoton, Kansas, USA.

The bio-refinery will boast a processing capacity of at least 700 t/day, and will comprise two sections – an enzymatic hydrolysis (EH) section and a gasification section. The EH section will convert biomass (400 t/day) into bioethanol, 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.
- Obtained pro-forma approval for the hybrid starch/biomass 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.

Bioref-integ Project

The Bioref-integ project studies and develops bio-refining concepts based on existing industrial fuel production complexes in order to enhance their competitiveness with co-production 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.

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

- Identify and characterize bioethanol-producing plants in Europe.
- Model and evaluate the integrated process of grain-based bioethanol production and assess its co-products.

Sost-CO_2

This project is funded by the Cenit program (Spanish Ministry of Science and Innovation, or MICINN) and coordinated by Carburos Metálicos (Air Products Group).

Overall objective: To develop sustainable technologies for the use of CO_2. ABNT will work in partnership with Universidad Politécnica de Valencia, the University of Seville, Cener and Inabensa.

ABNT's specific objectives for the project include:

- Developing carbon dioxide hydrogenation selective catalysts for bioethanol synthesis.

- Developing the process for producing bioethanol from CO_2 and renewable hydrogen.
- Developing the process of converting fermentation CO_2 and processes for converting microalgae biomass into co-products.
- Evaluating the life cycles of the proposed alternatives and their impact on the life cycle of existing grain-based bioethanol production technology.

Milestones achieved:

- Proposal and technical and economic analysis of various configurations of catalytic processes to turn CO_2 into bioethanol.
- Development of catalyst evaluation from the laboratory scale to the test bench scale.
- Conceptual design and technical and economic evaluation of the process of carbon capture using microalgae cultures.
- Development of a methodology to analyze, pre-treat and ferment algae biomass.
- Development of laboratory procedures for converting microalgae into biofuels.

New Projects

LED Project

Recently awarded as part of the European Seventh Framework Program, the LED project is currently in the process of being negotiated. The objective of the Lignocellulosic Ethanol Demonstration (LED) project is to design, build and operate a plant producing 50 ML annually of bioethanol using lignocellulosic biomass. This four-partner project is led by Abengoa Bioenergía Nuevas Tecnologías.

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 field 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, S. L., with a view to bringing organizational structure in line with the new model,

expand the various lines of activity and widen and improve our 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 along with ongoing change in environmental law. The company prioritizes its management methods based on a hierarchy headed by reuse, recycling and valorization as against merely eliminative treatment. We are 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. The company has also engaged in cooperation with Spanish government bodies in the form of subsidies or partnerships with the Spanish Ministry of Industry, Tourism and Trade (MITyC), the Andalusia devolved regional Department of Innovation, Science and Enterprise, CDTI, Inasmet, University of Valladolid, Programa para el Fomento de la Investigación Técnica (PROFIT), Corporación Tecnológica de Andalucía, Laboratorio Inatec, Insesca and Alcan, among others.

In 2009, Befesa set in motion a new research and development center to centralize R&D activities and bring to bear the necessary equipment and means to undertake valuable research. Located in Dos Hermanas, Seville province, Spain, construction work on the new research center got underway in April 2008.

Befesa Innovation Highlights of 2009

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 valorization 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 news services and extending the range of treatable wastes, while diversifying into new environmental markets.

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

- Production of waste-based fuels as alternatives to fossil fuels.
- Acquisition of substitute raw materials for industry.
- Development of the best available technologies for treating wastes and contaminated soils.
- Development of technologies to diversify into new markets and opportunities.

Befesa Agua's strategic research and development plan pursues the goals of leading the way in desalination, becoming technologically competitive in potabilization and urban and industrial wastewater treatment and reuse, and underscoring its leading position in hydraulic infrastructure and water resource management models and systems.

Befesa Agua's strategic R&D plan relies on four main vectors of advance:

- In-house resources, such as the R&D department and Befesa's research and development center.
- R&D aid and subsidies awarded by a range of public authorities.
- Collaboration agreements with universities.
- Technology partnership agreements.

R&D Programs

Befesa's R&D is structured into two core research and development programs: the Industrial Waste Recycling Program and the Water Program.

Industrial Waste Recycling R&D Program

The Industrial Waste Treatment Program is structured into three strategic lines of action:

- Steel and galvanic waste recycling.
- Aluminum waste and salt slag recycling.
- Industrial waste recycling.

Some of the highlights of our research and development in 2009 are outlined below.

Treatment and Preparation of Raw Materials

This project is aimed at managing and finding uses for the co-products of treating spent pot lining (SPL) from the electrolytic cells used for primary aluminum production. The research will widen Befesa's recycling market.

Development of Products and Applications

One of the company's main goals is to demonstrate the potential uses of the alloys produced at its facilities and their applications in various fields. Secondary aluminum alloys can be used to replace primary aluminum to manufacture sand-

cast parts called on to bear high mechanical responsibility. Alloys commonly used for aluminum injection can be alloyed by up to 1.8 % without impairment. A new modifier can be created for the structural phases of iron present in the alloys, which makes them brittle.

New Applications of Paval/BFA/Serox

The company has developed a Paval+polyester component that fulfills the innovation requirements for a range of urban architecture and street furniture projects. The invention now needs to be followed through with its final touches: specifications of the production process; color schemes; development in polystyrene casts and complex forms; introduction of fibers, etc. The trademark has been registered in the name of ONN, a company that uses Paval® (a trademarked form of aluminum dross residue) to make architectural and street furniture.

Production Process Improvements

This innovation project enhances the equipment itself as part of the production process in both aluminum smelting and in molten salt recycling, so as to optimize the process and lower costs. A highlight of equipment enhancement is to develop a new refractory inner lining for rotary kilns. Salt recycling has been improved by lowering the humidity of the molten salts at the crystallization exit, making savings in the natural gas required to produce steam, and enhancing the process of drying the salts and Paval, and further conditioning the Paval on its exit from the production line.

Introduction of the Greenhouse Gas Emissions Inventory

Over the course of 2009, the company advised on the introduction of the new greenhouse gas emissions inventory in all companies within this business unit in accordance with Abengoa's internal rules and regulations. The move involves setting objectives and framing plans and specific measures to reduce carbon dioxide emissions across the group's various facilities.

Design of New Dust Recycling and Waelz Oxide Lixiviation Plants

The company has undertaken engineering projects and services for the design of two new plants. One will serve as the central purification unit for unwashed Waelz oxide produced by the common steel waste recycling division, while the other, currently installed in southern Europe, is intended to accommodate expanded capacity for the treatment and valorization of steel mill dust by means of the Waelz process. We have located the ideal site for each project and filed applications for the required administrative permits for implementing our plans.

Improving Existing Processes and Products

The company is assessing a range of innovative processes for enhancing the quality of our products. We are searching for economically viable applications for a Waelz process co-product called Ferrosita®, which has been tested successfully as an input material for making various kinds of bricks and concrete counterweights for elevator systems. In addition, the galvanic waste recycling division has conducted research to produce a commercial quality zinc oxide through valorizing low-zinc-content concentrates.

Development of Oxygenated Additives Derived from Glycerin for use in Liquid Fuels

The aim of the project is to use excess crude glycerin from biodiesel production plants to make high-value-added products. A specific area of interest is to synthesize glycerin esters for use as oxygenated additives for diesel fuels. Finding a use for the large surpluses of crude glycerin – for which there is no market in Spain at the moment – will improve the life cycle of biodiesel, support sustainable development and mitigate adverse environmental impacts. Befesa Gestión de Residuos Industriales' (BGRI's) research and development department is working on this project in partnership with the Fundación de Investigación Tekniker and the thermal machinery and engine research team of the University of Seville.

The project has attracted funding from the Spanish Ministry of Industry, Tourism and Trade (MITyC), the CDTI, the Department of Innovation, Science and Enterprise of the devolved regional government of Andalusia (Agencia IDEA) and Corporación Tecnológica de Andalucía (CTA).

New Construction Materials Made from Recycled Waste

This project is concerned with stabilizing inorganic wastes which can then be used as construction materials – bricks, mortar, sound and heat insulation, etc. The company hopes to validate techniques for stabilizing inorganic industrial wastes in silicon matrices using gentle hydrothermal processes that do not require high energies. Project partners include the solid-state chemistry research team of the University of Seville and the private enterprises Cerámicas Malpesa and Cementos Barrero S. A..

The project has attracted grants from the Spanish Ministry of Education and Science (MICINN) and the Department of Innovation, Science and Enterprise of the devolved regional government of Andalusia (Agencia IDEA).

Restoration of Contaminated Soils using Non-Hazardous Wastes and other Byproducts

The project is intended to validate remedial techniques for metal and hydrocarbon contamination. The proposed methods involve fixing the contaminants using non-hazardous industrial gypsum wastes and other byproducts, such as modified or organic clays. The arrival of a new regulatory framework on contaminated soils management has prompted the development of techniques that prioritize on-site treatment of the terrain as against techniques requiring mass displacement of soils. Research partners include the CSIC (the Spanish national research council), the IRNA (the Spanish Institute of Natural and Agro-biological Resources), the ICMS (the Seville Materials Science Institute) and the University of Barcelona.

The project has attracted a subsidy funded by the Spanish Ministries of Education and Science (MICINN) and of Environment (MARM).

Water R&D Program

Befesa Agua's strategic R&D plan is structured into three areas: desalination, potabilization-purification-reuse and water cycle sustainability.

The Desalination area focuses on improving the efficiency of the reverse osmosis process and lowering its investment, operation and maintenance costs.

The Potabilization Purification Reuse area seeks to optimize membrane-based water treatment processes so as to save energy and produce less sludge, develop sludge treatment and elimination technologies and undertake research on supercritical oxidation.

The Water Cycle Sustainability area 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 our research and development in 2009 are outlined below.

Pilot Plant for High-Efficiency Desalination

The aim of the project is to lower energy use for desalination purposes to less than 2.5 kWh per cubic meter of water output. Befesa Agua has researched and developed reverse osmosis membranes and energy recovery systems and implemented process improvements to minimize energy use. The project is now at the pilot phase in that a high-efficiency pilot plant has been built and experimental campaigns are being conducted.

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

Seawater Pretreatment System using MF/UF Membranes

This project is directed to developing 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 won grants from the Department of Innovation, Science and Enterprise of the devolved regional government of Andalusia and from the Spanish Ministry of Environment.

Desalination Plant Remote Control and Monitoring System (Beftel-CRIBA)

This project is aimed at developing 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 devolved regional government of Andalusia and from the Spanish Ministry of Industry's PROFIT scheme.

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 biological membrane reactors and micro- and ultra-filtering systems. The project is now at the stage where a pilot plant is under construction and experimental campaigns are scheduled for 2010. The company is awaiting a decision on its application for funding from the CDTI technology program.

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 wastewater treatment plant sludge. A pilot plant has now been designed and built, experiments are already underway, and by 2010 tests will be extended to other types of sludge.

The project is funded by subsidies from the Department of Innovation, Science and Enterprise of the devolved regional government of Andalusia, the Corporación Tecnológica de Andalucía and the Spanish Ministry of Environment.

Telvent

Telvent and Innovation

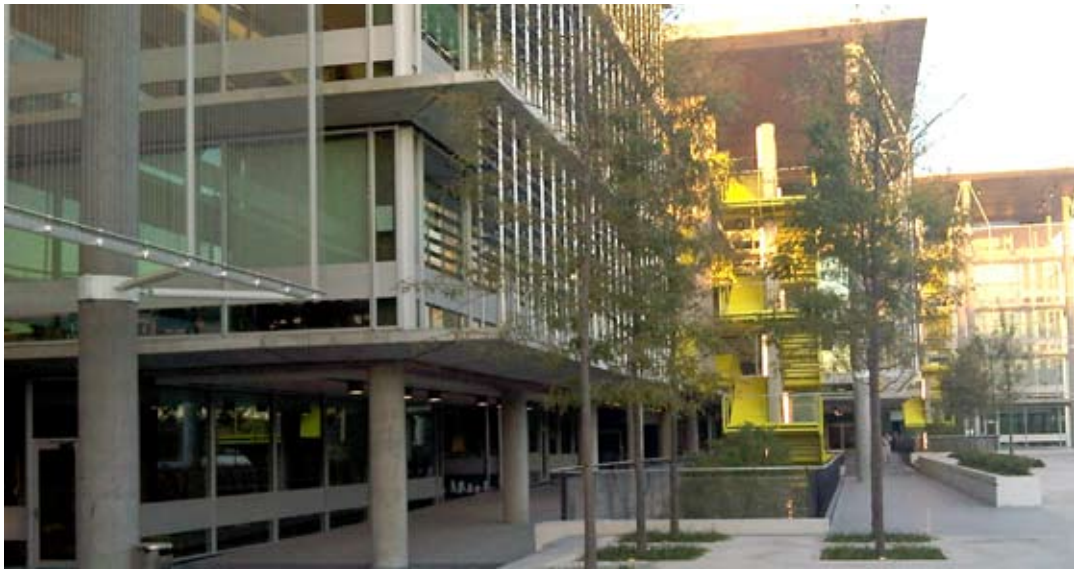
One of the mainstays of Telvent's strategy is to invest in R&D&I so as to offer our clients innovative solutions providing technological support for sustainability, security and safety. Our goal is that our clients should be able to benefit from all the advantages of technological applications and solutions without having to become involved in the

increasingly complex issues surrounding technological decision-making. They should be confident that the ongoing evolution and improvement of Telvent's systems will enable them to manage their processes efficiently and securely and gain high value-added information for their operational, business and environmental decisions.

One of Telvent's strengths is its global presence. The company has accordingly achieved a high standard of competence in a very wide range of technological domains. The company's business is organized under a distributed scheme of Product and Competency Centers. Product centers create the technologies that afford the underpinnings for Telvent's range of solutions. Sometimes sold as freestanding packages in their own right, these technologies are utilized by our competency centers to develop high-value-added system architectures and advanced applications specifically aimed at each given industry.

Across Telvent's network of centers, a research staff of close to 400 implements our global research and development programs to create and evolve over 75 technology products and solutions. In 2009, Telvent's R&D&I highlights included:

- Smart Grid Solutions (SGS). This program encompasses Telvent's technological strategy for the utilities sector. Taking a global, integrated approach, research ranges over three key areas – Smart Network, Smart Operations and Smart Metering – to develop solutions built on the foundations of Telvent's proprietary technologies. SGS focuses on technology and process innovation to offer value-added to our clients through tightly cohesive integration of advanced applications with underlying platforms. SGS conceives of the power supply grid as a network of two-way services and information, supported by smart automation at an exceptional standard. The advantages of this concept are that our clients can get from now on unavailable demand management tools, adapt their grid to new and alternative forms of power generation, help consumers self-manage the service using real-time information, enhance energy efficiency across the grid, and boost quality of service.
- Smart Mobility. This concept is concerned with sustainable mobility, and addresses the issue from two angles: The efficiency issue, by implementing smart information technology systems to manage and enhance existing infrastructure capabilities, assure security, safety and sustainability, and free up traffic flows; and the information issue, by offering the public accurate information to enable users to combine different modes of transport ("intermodality"), facilitate access to public transport, and allow for journeys to be planned in advance in aid of improved efficiency.



Research and Development Highlights of 2009 at the Product and Competency Centers

Key products and successes are outlined below, by product and competency center.

SCADA and Information Management

Our product center at Calgary, Canada, develops and maintains OASyS DNA (Dynamic Network of Applications). OASyS DNA is Telvent's main applications platform. It is the technology foundation for a wide range of solutions directed at the energy, transport and environment sectors. Its robust security and wide flexibility make it ideal to accommodate technological progress in the critical industries where Telvent operates.

- 2009 witnessed the completion of the second stage of our 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 research is concerned with the security of critical infrastructure. OASyS DNA was selected on the strength of its leading position in the market for intrinsically secure platforms. INL is now continuing its trials with OASyS DNA to validate secure information transactions in the setting of a full SCADA system comprising equipment from a variety of suppliers.
- OASyS DNA technology is embedded in several Telvent products, which thus benefit from a high-performance, high-security foundation. In addition to its long-standing use in SCADA solutions, OASyS DNA is also the platform for Responder, the outage management system, and for DMS, the next generation of the power distribution management system.
- To satisfy the demanding requirements of DMS and of its role in Telvent's proprietary Smart Grid system, in 2009 the functionalities of OASyS DNA were given a major boost. When the project reaches completion, the volume of data that OASyS DNA can handle will have increased tenfold.

Geographic Information Systems (GIS)

Based at Fort Collins, Colorado, USA, this product center leads the field of GIS applications for utility companies with its ArcFM suite. ArcFM helps power, gas, water and telecommunications utilities manage their assets, work and operations to enhance quality of service and lower costs. Since 1987, this product center has operated a highly successful technological cooperation agreement with ESRI, the leading software developer for Geographic Information Systems.

- Telvent continued to develop its ArcFM solutions with the April 2009 release of version 9.3 Rev2 of the package. Certified for use with ArcGIS® 9.3.1 and ArcGIS 9.3.1 SP1 developed by ESRI, this version of the ArcFM suite offers a wide range of new functionalities and improvements that have been introduced to meet emerging market needs.

Data Capture Subsystems

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 2009 the company continued to develop its Cross Domain Platform (CDP). Telvent 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 our 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 (the Spanish acronym for "embedded systems for critical infrastructure"), supported by MITyC, Spain's Ministry of Industry, Tourism and Trade.

Electricity Competency Center

The Electricity Competency Center, with sites at Seville in Spain, Fort Collins and Houston in the USA, and Novi Sad in Serbia, develops and integrates advanced applications to meet the global requirements of electric utilities in transmission, distribution, substation automation and network operation. This business unit's core package is Smart Grid, outlined in the introductory section of this chapter. Highlights relating to Smart Grid in 2009 included:

- In November 2009, Telvent released the first version of a new product that rounds off the long list of Smart Grid solutions: MDM (Meter Data Management). MDM is the starting-point for the configuration of an advanced metering infrastructure (AMI). The data identifying and tracking millions of consumers is processed into a body of information validated by a given set of rules; it can then be fed into the utility's corporate applications, such as billing or customer relationship management.
- The Novi Sad center in Serbia has continued to improve the DMS (distribution management system). This package provides a distribution network behavior model and makes power grid calculations as required for effective analysis, operation and control of the network. 2009 saw the start of the technological re-engineering of the product, based on the powerful and secure OASyS DNA platform. This will considerably enhance its scalability and its potential uses in large complex networks, both on the American and on the European pattern. The new version is particularly suited to the Common Information Model (CIM) exchange scheme, widely used under Smart Grid's international standards.
- Another key milestone has been the synergic connection of two previously separate systems: the Advanced Metering Infrastructure (AMI) and the outage management system (Responder OMS). This means that the electricity utility gets a previously unavailable real-time snapshot of the state of the grid.
- The company started its Substation to Grid or S2G project. This partnership project will 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.
- 2009 also saw the launch of SmartCity, a partnership project led by Endesa. 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 the city of Malaga, Spain.

- The first year has now been completed of a project in partnership with Consolida, led by Abengoa Solar, to research more efficient solar thermal technologies. Telvent's contribution involves its Electricity and Environment competency centers. The Electricity Competency Center contributes its experience in developing advanced remote control solutions for solar plants.

Oil and Gas Competency Center

The Oil and Gas Competency Center, located at Calgary, Canada, and Baltimore, USA, develops advanced operation, measurement and business solutions for the hydrocarbon production, transportation and distribution segments, aiming to meet the needs of the world's leading energy companies. Our products are developed on the basis of the OASyS DNA applications platform. They provide oil and gas companies with a centralized and highly automated operating environment, closely integrated with corporate business applications and shielded by the strongest available security safeguards.

- In 2009, the company significantly improved the user interface for the gas measurement accounting system (GMAS) product line. Dubbed "Sightline", the interface has been favorably received by the industry, and rated as an impressive tool with innovative functionalities that will considerably raise productivity.
- In our liquid fuels area, in 2009 the company completed stage 2 of its Power Optimization product. Oil pipeline operators are now in possession of the tools to minimize the cost of operating pumps while delivering fuel to deadline.

Transportation Competency Center

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 (RMY, RMB, RBY); centralized railway traffic control systems (OASyS-based CTC); and traffic information systems (SmartNET).

At its development sites in Bilbao, Spain, and Austin, Texas, USA, 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).

The core package is SmartMobility, outlined in the introductory section of this chapter. Highlights relating to SmartMobility in 2009 included:

- Technology upgrade of traffic light controllers to satisfy the most stringent technical requirements and thus gain access to new international markets. The controllers have been equipped with a new Cross Domain Platform CPU to accommodate new standards and protocols. The present controller has been ported to the new technology, and a controller has been developed to implement NTCIP (National Transportation Communications for ITS Protocol), the present standard communication protocol for American controllers and increasingly in demand in most other countries.
- The company's innovations in enforcement systems have garnered excellent results in recent years in terms of road accident reduction. In 2009, we continued

to make progress with new speeding offense detection systems such as En4Speed, a system that measures the average speed of a vehicle over a given stretch of road. In comparison with conventional speed radars, which detect speeding offenses only at very specific points of the network, En4Speed allows for great strides to be made in discipline enforcement throughout the entire road network.

- Our projects have again won the support of Spain's Ministry of Industry, Tourism and Trade (MITyC), which will provide public funds for the completion in 2009 of the mVía project. This year, the project focused on researching new platforms for the creation and provision of vehicle services, based on on-board equipment, satellite positioning and new vehicle-infrastructure communications networks. The available information can be supplied to drivers in transit. This solution has been validated in a range of different scenarios and test runs.
- The company has continued to work on the ViaSens project with the aim of bringing to bear a new approach to road-based information capture and processing. It is hoped that this new paradigm will enhance mobility and safety using non-intrusive sensors fully distributed throughout the entire road network.
- We have also successfully developed and field tested a new bus ticketing solution, ValTick. This development, which we began a number of years ago, posed a major design challenge that called for a combination of high performance and attractive design. The outcome is a tightly integrated piece of equipment.
- In transport ticketing, Telvent is focusing on introducing innovations to facilitate access to and use of public transit systems. In 2009, highlights included:
    - The development of a modular platform, SGIT, to manage integrated ticketing systems. This solution will facilitate the deployment of interoperable and intermodal transport networks and so encourage the use of public transit systems, thus supporting a more sustainable and environment-friendly transport model.
    - In our rail ticketing product line, Mobifast, we have completed the development of a new generation of devices, including the new MáquinaAutoventa Universal Accesible (accessible universal vending machine) and the new Paso, primarily intended to facilitate access to public transit systems to people with disabilities.
- A final highlight is the mIO! project aimed at researching new technologies to provide mobility services as part of the future intelligent universe, in which users can use their cell phones to access multiple services in accordance with their preferences and roles. The project is being undertaken in partnership with a wide range of leading Spanish companies, research centers and universities. It has attracted a large subsidy from the CDTI through the Cenit program and is scheduled for completion in December 2011.

Environment Competency Center

The Environment Competency Center, with sites at Seville 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.

- In 2009, as part of the Consolida initiative – mentioned above in the context of the Electricity Sector Competency Center – a partnership has been formed with Abengoa Solar New Technologies to create a meteorological prediction software platform for efficient and sustainable management of solar energy, garnering

higher functionality and accuracy in solar resource predictions by using adapted and integrated new technologies and information sources. This is a Cenit project subsidized by the CDTI.

- 2009 also witnessed the start, as an offshoot of the Illion WeatherNet project, of the development of a web-based weather service that provides users with state-of-the-art forecasts tailored to their requirements and geographical location. Users working in sectors as wide apart as farming or helicopter emergency services can get real-time information and forecasts aligned to their day-to-day operations, making for more effective decision-making. The project is financed by MITyC and the European Regional Development Fund (ERDF).
- In addition, as part of the Water Management Suite (WMS) project, we have developed a range of applications for sustainable water management. The package streamlines operating processes, raises quality of service, improves water quality, lowers costs and reduces greenhouse gas emissions – this is a feature of particular relevance to water utilities operating in urban environments.
- Finally, the launch of the MetDNA project provides a new information system for aeronautical meteorology applications. The suite offers new functionalities, satisfies the emerging safety and sustainability requirements of the aviation sector and is compliant with the guidelines and safety specifications of the United States Federal Aviation Administration (FAA) and the European Union's Eurocontrol.

Advanced Services for Agriculture Competency Center

This competency center, based at Minneapolis, Minnesota and Omaha, Nebraska, is the leading provider of agricultural information in the United States for corn, soybean and livestock feeds. In the face of increasing demand for new information services brought on by price volatility in commodity markets, this Competency Center is uniquely positioned to provide innovative solutions to executives in agricultural and plantation businesses. A reliable information source forms the basis for a very wide spectrum of solutions and services, such as a publishing business implemented in-house, weather forecasts and market reporting.

- In 2009, we created a whole new website (http://www.dtnprogressivefarmer.com) offering new capabilities and functions, including daily press room videos, digital advertising for cell phones, daily press releases and other features that are unique in the sector.
- AgHost is a website designed to help farming businesses contact their customers, encourage sales and foster a highly competitive market. In 2009, changes were made as required to host 500 new clients. AgHost now provides services to over 1,800 agricultural clients in North America.
- With over 16,000 customers, Ag Online is this Competency Center's flagship. It offers corn, soybean and wheat growers specific market data, low-altitude weather conditions in real time and farming business news. The intention is to help users get the best possible prices for their crops, save on supplies, manage key aspects of the business and face meteorological challenges. Significant improvements were made in 2009. Website users can now create specific commodity market price alerts, which are then sent to their cell phone or e-mail address, or make cash bids over the subscriber network.
- ProphetX solutions provide agricultural professionals with vital data that helps them find and complete the best deals. ProphetX offers real-time, individually itemized commodity market prices, analysis tools, market news,

expert commentary and even order execution. Specially adapted versions are also available for the livestock, grain sales and biofuel markets. In 2009, we introduced an option to make cash bids over the network of website subscribers, thus providing further value-added to our 3,000 members.

Government and Healthcare Competency Center

The Government and Healthcare Competency Center is based in Seville, Spain. Its research, development and innovation activity continues to focus on Homeland Security, eGovernment and eHealth.

- In 2009, Homeland Security research addressed physical security, targeting immigration management and document verification. Telvent played a leading role in the recently completed Globe project (European Global Border Environment) funded by the European Commission. This initiative has successfully responded to some of the main issues surrounding immigration in Europe, and will serve as the basis for Commission decision-making.
- Telvent also led the Cenit Integra project, which develops innovative technologies towards an integrated system of immigration management (prevention, control and integration of migratory flows).
- In the Healthcare domain, research in 2009 focused on telecare. We enhanced our understanding of how to manage multiple information sources, based on personal, environmental, positional and distributed location parameters. The information thus compiled can now be used to provide solutions to support the well-being and health of chronic and dependent adult patients. This activity has been chiefly based on AMIvital, one of the Cenit projects now in progress, which is aimed at developing a new generation of ICT technologies and tools for the modeling, design, implementation and operation of ambient intelligence (AmI) devices and systems designed to provide services and personal support for independent living, well-being and health.
- Our eFactura project in the realm of eGovernment is intended to identify standards, trends and technologies at the international scale. The first versions have now crystallized of an electronic billing platform that can be applied in both the private and public sectors.
- Finally, in 2009 the company shaped and reinforced several product lines as a result of evolving existing solutions or utilizing the results of fresh research. The core products now featured in the center's catalogue include:
    - TiCares: A comprehensive suite for clinical and health care management at sites providing healthcare services.
    - TiPacs: A multi-node system for medical image management at healthcare sites.
    - TiWorks: A comprehensive electronic administration solution.
    - TiPass: A biometric and document secure verification system.

ICT Platforms Competency Center

The Information and Communication Technologies Competency Center operates sites in Seville and Madrid, Spain.

- In 2009, the company made further progress with the Mobile Information System project. We have completed construction of a modular core to mobilize any app in a Blackberry device in record time and with functionalities already

tailored to the specific handset. We have also improved messaging performance and transmission and widened the scope of the project to encompass new applications like People Center or SAP. The new developments promise to improve employee mobility significantly.

- In 2009, Telvent developed the second version of its Greenhouse Gas Inventory application. Improvements have been made to indicators, to supplier data management and to the functionality for reporting to customers. Companies using this system can generate sustainability indicators based on data from multiple sources, effectively meaning that they can include a greenhouse gas emissions criterion in their supplier selection and procurement processes. This tool is key to achieving reductions in overall emissions, and thus provides high value-added to the wider community.

Other Key Projects

Alongside its research, development and innovation activity, Telvent is actively involved in international collaboration projects supported by mixed funding. Here, Telvent seeks out new foundational technologies that it can then apply in its solutions to create a competitive edge. Key projects other than those already mentioned above include:

- PROTEC-IC. Research on security and safety at critical facilities. Subsidized by the Spanish Ministry of Industry, Tourism and Trade (MITyC).
- TURTLE. A project aimed at bolstering the security of embedded electronic systems.
- ITEA R&D Roadmap 3. The ITEA (Information Technology for European Advancement) research and development roadmap is based on a vision of future technological development of software-intensive systems.
- Prometeo Technology Platform. Telvent is a founding member of the Prometeo distributed intelligence technology platform. This activity calls for building research and development cooperation networks among all relevant actors (academia, technology centers and industry) in those realms of endeavor where high importance attaches to new technologies for embedded and distributed intelligence systems.

- MoSIS. This project carries on the research focus of the CAFÉ and FAMILIES initiatives. The company is appraising system families so as to identify the most promising routes towards high-quality, highly adaptable products, while optimizing costs. The project is a response to industry's demand for increasingly complex products and services.
- OSAMI-Commons. As the natural next step after the COSI and OSIRIS projects, this research seeks to define architectural concepts and service-oriented common infrastructure using open source code, with the potential for being tailored to a wide spectrum of applications.

Abeinsa

Abeinsa and Innovation

Abeinsa is the Abengoa group's industrial engineering and construction Business Unit. R&D&I are of course 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 power plants – particularly concentrating solar power – and biofuel production plants, improving railway facilities, designing substations and containers, and stringing major power transmission lines.

The Abeinsa group's research and development capability is brought together under the umbrella of Abeinsa New Horizons, the common name for the six strategic areas addressed by various subsidiaries within the business unit:

- CO_2 and other greenhouse gas emissions management: The company Zeroemissions generates knowledge on new technologies to reduce greenhouse gases and develop new emission control methodologies.

- Hydrogen and fuel cell technologies: Hynergreen conducts research on the production, storage and use of sustainable hydrogen and power generation through fuel cells.
- Carbon capture and valorization. The subsidiary Inabensa develops solutions to convert CO_2 into a valuable co-pro duct: a biofuel or new raw material.
- Energy efficiency consultancy and research. Inabensa also creates technologies to raise the energy efficiency of industrial equipment and modes of transport, and develops efficient energy storage systems.
- Ocean energy. The Inabensa research and development department is evaluating the various options offered by marine currents, waves and tides with a view to finding uses for these new sources of renewable energy.
- Telecommunications. The Inabensa communications division develops infrastructure and technology with a special focus on medical and healthcare applications.

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

Abeinsa Innovation Highlights of 2009

2009 proved to be a tough year for new investment. However, Abeinsa increased its research and development budget to over €21 M, meaning that the Abeinsa group was able to continue all its strategic lines of research, development and innovation. Over the course of the year, close to 300 Abeinsa employees were involved on a day-to-day basis in R&D&I in close partnership with universities and research centers.

2009 saw the start of new projects both within Spain and abroad. Most of the international initiatives engaged Abeinsa in partnerships and alliances with leading industry players and research institutes.

Another highlight of the year was the successful move of a large number of employees and equipment involved in Abeinsa's R&D&I capability to the new Campus Palmas Altas, where our staff will be able to draw on enhanced material resources.

Abeinsa's R&D&I efforts will continue to be strongly supported in 2010, in which a further increase in investment is expected.

R&D Programs

The following is a list of Abeinsa's key R&D&I projects undertaken or completed over 2009 in each of the unit's strategic lines of concern.

CO_2 and Other Greenhouse Gas Emissions Management

New Cooling Systems

Conventional refrigeration is commonly based on technologies that involve greenhouse gas emissions. Our subsidiary Zeroemissions develops sustainable refrigeration alternatives, such as using CO_2 itself as a cooling agent or applying magnet-based solutions.

Hydrogen and Fuel Cell Technologies

S-80 Submarine AIP System

A conventional submarine is an electric-powered vehicle, in which the diesel engine is used solely to produce electricity. The electricity then drives an electric motor or is stored in batteries for later use.

This constrains the submarine's underwater autonomy. It can only stay underwater for as long as it has electricity stored in its batteries. The diesel engine will not work underwater, because it needs to exchange gases with the atmosphere.

Shipbuilding businesses therefore seek to develop Air Independent Propulsion (AIP) systems to lengthen the time that a submarine can stay underwater even beyond its battery capacity. One of the most promising technologies here is the fuel cell.

Since 2001, Abengoa has worked in partnership with the Spanish Ministry of Defense and the Spanish Navy on a prototype intended to equip the new Navantia S-80 class submarines with a novel form of AIP technology, in which hydrogen produced by bioethanol reforming is used in a fuel cell to produce electricity as and when required.

Over the course of 2009, Hynergreen completed the detail engineering for three major components of the AIP system for Navantia – the bioethanol processor, the power adjustment system and the control system. Construction has now begun, and the components are scheduled for delivery in 2010.

Hércules Project

This project is aimed at setting up a renewable (solar-generated) hydrogen service station at Sanlúcar la Mayor, Seville province, Spain. The supplied hydrogen will power the fuel cells used to propel electric vehicles – another of the company's developments.

The project, with an overall budget in excess of €9 M, has attracted funding from the Department of Innovation, Science and Enterprise of the devolved regional government of Andalusia (Agencia IDEA), Corporación Tecnológica de Andalucía (CTA), and the Spanish Ministry of Science and Innovation (MICINN), which has granted it PSE status ("unique strategic science/technology project").

The Hércules project is an Andalusian initiative promoted by eight partners under the overall coordination of Hynergreen. The consortium comprises five private enterprises, a government agency and two research institutions: Hynergreen, Abengoa Solar NT, Santana Motor, Carburos Metálicos, GreenPower, Agencia Andaluza de la Energía (the Andalusian Energy Agency), INTA and AICIA. Having started the project in January 2006, the consortium developed and built the prototypes over 2009. The service station was opened in the closing quarter.

Carbon Capture and Valorization

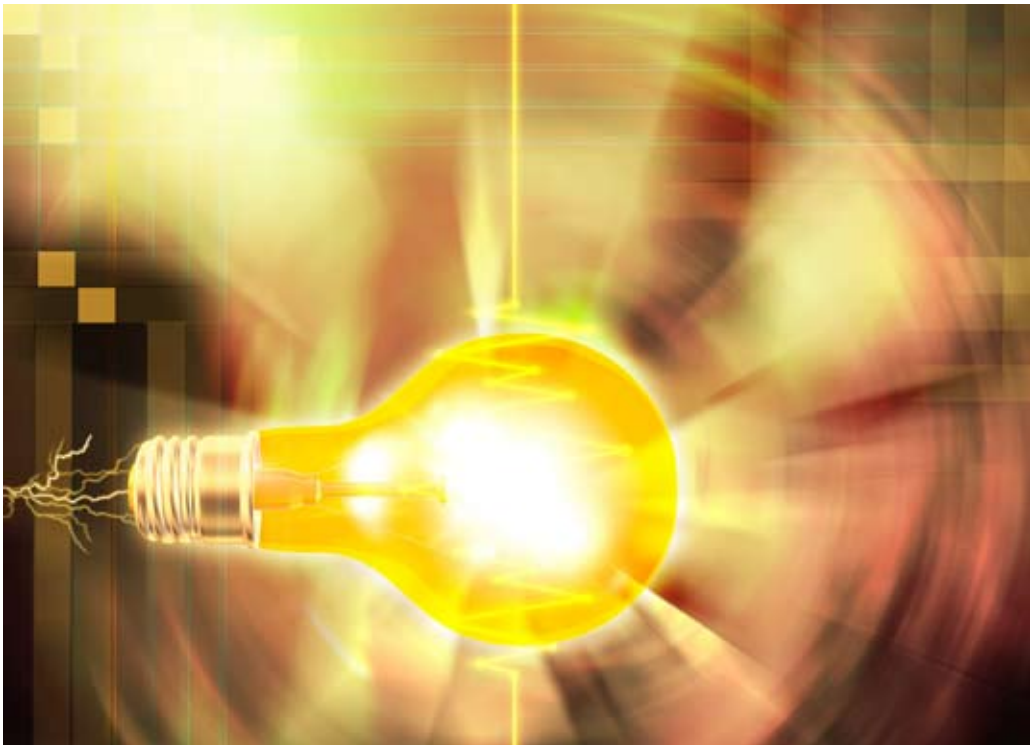
Sost-CO_2 (Carbon Capture and Use)

As part of the CDTI's Cenit program, and led by Carburos Metálicos, this project is directed at the entire chain of capture, transport and potential viable uses of carbon dioxide.

Inabensa is involved in two clearly distinct areas. First, the company is developing new ionic-liquid-based chemical absorbents (using boron anions) as candidate competitors against amines – so far, the only commercial benchmark for carbon capture at industrial combustion sources. Secondly, we are researching carbon fixing by photosynthetic microorganisms (microalgae and cyanobacteria) and the potential production of biofuels. The company is working in conjunction with Carburos Metálicos and Abengoa Bioenergía Nuevas Tecnologías on each respective line of research, and has the support of leading units of the CSIC (the Spanish Higher Council for Scientific Research), such as ICMAB (Barcelona Institute of Materials Science) and IBVF (Plant Biochemistry and Photosynthesis Institute) in Seville.

The project was started in 2008 and is scheduled for completion in 2012. The budget allocated to Inabensa amounts to roughly €1.5 M.

Energy Efficiency Consultancy and Research



Perseo (Energy Efficiency)

The Perseo (Packaged Electrical System Efficiency Container) project concerns the redesign of one of the Inabensa Manufacturing division's leading products: turbine control containers for combined cycle and gas power plants. The redesign is intended to reduce power and heat requirements. Our research is focusing on the thermal loads generated and on evacuation by cooling in adverse weather conditions.

The project is essential to defining a comprehensive methodology for energy efficiency. This methodology must generate theoretical models, provide for model validation in the field, and lay out improvement plans that make consumption savings and allow us to cost the required investment accurately.

Perseo, which has gained the support of the Corporación Tecnológica de Andalucía (CTA – the Andalusian Technology Corporation), is being implemented to a schedule running through 2009 and 2010. The project will ultimately result in the creation of a multimedia app to facilitate further design for this new type of efficient equipment.

Kess Project (Energy Storage)

Kess (Kinetic Energy Storage Systems) is a project that aims to evaluate the viability of various energy storage systems – electric or flow batteries, flywheels, supercondensers, etc – for various applications in railway traction and renewable energies (solar photovoltaics and wind power).

The specific goal is to construct technical solutions for integrating a given system of flywheels with railway traction substations. The design is to be implemented at a facility that is among the first of its kind in Spain and Europe, located near Atocha station in Madrid.

Inabensa is thus one of the partners in Sa2Ve, a PSE-rated project (classed by the government as "unique and strategic"), led by Adif (the state-controlled railway track operator) and in partnership with a number of other technology players, Ellyt Energy, Ciemat and GreenPower.

The venture, with an overall budget in excess of €300,000, has attracted funding from Corporación Tecnológica de Andalucía (CTA), the Department of Innovation, Science and Enterprise of the devolved regional government of Andalusia (Agencia IDEA), and the Spanish Ministry of Science and Innovation (MICINN), for implementation in the period 2009-2010.

Ocean Energy

PSE-Mar (Marine Energy)

This is a PSE-rated science and technology project (dubbed by the government as "unique and strategic"), led by Tecnalia, also with EVE, as fellow technology partners. The initiative is the national benchmark in the emerging field of wave energy.

Inabensa is focusing on putting forward innovative constructive solutions for the electrical and communications infrastructure required to integrate these new renewable sources with the existing energy system.

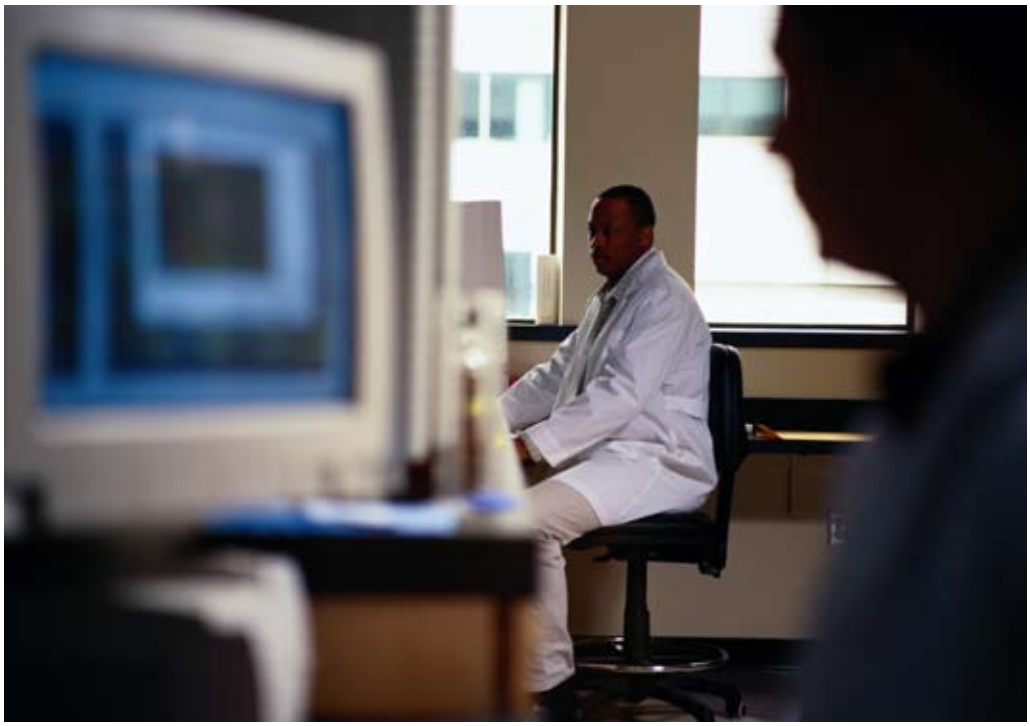
The project marks Inabensa's first foray into marine energy. It will serve as a source of knowledge and experience that can then be extrapolated to other needs in this field.

Having secured funds in 2008 from MICINN, the Spanish Ministry of Science and Innovation, the project is set to be completed in 2010.

Telecommunications

Elisa Project

Elisa (the Spanish acronym for "smart positioning environment for assisted services") is a project concerning the definition, design, implementation and deployment of new services in the context of technology platforms for research, with a special focus on positioning and accessibility/adaptability. Enlisting mobile and positioning technologies in both open and closed-ended environments, the services are intended to make a real difference for people with disabilities and general users.



The challenge here is to improve positioning-driven services in open and closed-ended environments by pushing forward the techniques and algorithms used in the positioning process.

In addition, the project is developing adaptation and profiling methods directed at mobile services linked to users and devices. Finally, we are creating a platform for generating services in real environments so as to adapt communications to the user profile on the basis of the possibilities offered by the device.

Elisa is a PSE-rated project (dubbed by the government as "unique and strategic") which has attracted funding in the framework of the Avanza I+D sub-program of the Spanish Ministry of Industry, Tourism and Trade (MITyC). The subsidy period runs from 2007 to 2009.

AmIE Project

The goal of the AmIE (Ambient Intelligence for the Elderly) project is to develop a smart distributed system that enhances the quality of life of people in need of assistance, such as the elderly, people with disabilities, etc. Such assistance consists of support for day-to-day activities provided both at home and in external settings. This support must be provided discreetly, respectfully and with all due attention to ethical and legal considerations. The package to be developed will also include tools for monitoring and following up users via a system of alerts managed by health professionals.

The system is equipped with cognitive functionalities so as to accommodate the specific features and needs of a given user at a given time, and thus make his or her life easier. Adaptation takes account of the user's characteristics (personality, behavior and even state of mind), his or her environment (time of day, weather conditions, unexpected events, etc) and his or her historic data on file in the system.

The research challenges of this project include the development of new technologies, applications and services that enhance the quality of life of social groups with highly specific requirements – the elderly, people with disabilities, etc. The developments must adapt to specific situations according to need, with the overarching goal of lengthening the period during which a user can continue to live independently in his or her own home and gain inclusion in the information society.

The project will develop equipment, applications and services to support care processes in the healthcare system and cater to both permanent and temporary situations. Remote monitoring, for example, embraces all information and communication technologies capable of tracking the patient's data (vital signs, activity, behavior) for the purposes of subsequent computer processing, sharing with specialist healthcare centers as needed, generating alerts in the event of anomalous circumstances, and positioning – locating the patient via a range of different devices.

The intelligent systems to be developed include cognitive and reactive models, user personalization and profiles, and ontologies and knowledge representation. These features are intended to ensure that the care provided is appropriate and autonomous and that healthcare predictions are accurate.

Our research has prompted us to design ambient intelligence involving a network of monitoring sensors for remote assistance purposes that are inconspicuous or not noticeable and respectful of the user's privacy.

AmIE is a European Eureka project funded by the Itea2 scheme in the framework of the Avanza I+D sub-program of the Spanish Ministry of Industry, Tourism and Trade (MITyC). The subsidy period spans 2008 and 2009.