

RDI



## Abengoa's proposal

- Commitment involving the public administration and technology companies to implement a ten-year Strategic Innovation Plan, clearly targeting priority sectors and defining the action required to ensure the full involvement of the public RDI system.
- Creation of long-term programmes to implement Relevant Demonstration Projects involving the public administration and each of the companies selected, establishing the technological assets and financial resources that each party undertakes to provide.
- Effective implementation of tax benefits to incentivise innovation, which innovating companies currently have great difficulty in applying.
- Effective coordination among public administrations.
- Guaranteed continuity of the plan, ensuring that it is not affected by changes of government or the ups and downs of the business cycle.

## Abengoa's innovation strategy

- Corporate structure
- Results oriented

Abengoa's policy is geared to creating and sustaining value. Its innovation efforts are results oriented and based on the pursuit of three tangible objectives:

- Diversification: new products and services
- Product differentiation: improvement and adaptation of existing products
- Process improvement

Intangible objectives include the acquisition of key competencies and, most importantly, the generation of future options, which is closely linked with the creation of value through growth prospects and the development of new business.

## How the strategy is implemented

Abengoa implements its innovation policy in various ways: in-house innovation aimed at providing specific solutions for individual customers and in-house developments; outsourced innovation based on collaboration agreements with universities, public research bodies and other third parties, in which case the work is usually shared; and in some cases technology is purchased. Another method much used in recent times is the acquisition of strategic financial interests in tech companies. In such cases, the move is usually a corporate initiative, although subsequent management is undertaken by the individual companies involved.

## The economics of innovation: financing

- External resources:
  - Tax benefits
  - Subsidies
  - Universities, public research bodies
  - Shared R&D
  - Customers
- In-house resources
  - Investment
  - Yearly expense item

## Innovative business segments and type of innovation

- Bioenergy: radical and differential innovation, mixed financing (US Department of Energy, Framework Programme).
- Solar and cells: radical and differential innovation, mixed financing (Framework Programme).
- Telvent: differential and radical innovation, mixed financing (Framework Programme).
- Befesa: differential, dispersed, internal financing, in-house implementation.



## Awards Abengoa

### 1993-2002

- Academiae Dilecta (first edition): in recognition of its track record in innovation. Spanish Academy of Engineering, December 2002.
- Andalucía Económica: for its extensive track record of achievements in the region of Andalusia and the influence it has had on its economy. Andalucía Económica magazine, Malaga, February 2002.
- AEC: for its RDI efforts aimed at environmental protection. Spanish Association of Scientists (AEC), Madrid, November 2001.
- Most valuable innovation: for the product Velflex developed by Sainco. European Wind Energy Conference, Copenhagen, June 2001.
- National Quality Award 2000: to Teyma Uruguay for its efforts and achievements in Quality Management. Government of Uruguay, February 2001.
- RENFE award: to Sainco for its contribution to improving and modernising safety facilities at RENFE Northwest Management Headquarters of the Maintenance and Infrastructure Unit. RENFE, León, November 2000.
- European Union award for the Best Industrial Renewable Energy Partnership: to Abengoa, Repsol-YPF and Cepsa for their bioethanol project, awarded by the Renewable Energy for Europe. Campaign for Take-Off. European Union, Toulouse, October 2000.
- Best Environmental Performance: to Sainco. Airtel, 1999.
- Sponsorship and patronage: to the Focus-Abengoa Foundation. Andalusian Business Confederation (CEA), Seville, November 1999.
- Export award. Madrid Chamber of Commerce and Industry, 1999.
- Prince Philip Award for Business Excellence in the Business Competitiveness category. Ministry of Industry and Energy and Ministry of Trade and Tourism, March 1996.
- Prince Philip Award for Business Excellence in the Technological Achievements category. Ministry of Industry and Energy, March 1996.



- Best Paper Award at the Symposium on Distribution Automation and Demand Side Management-94 Europe: for a project presented by Sainco and Unión Fenosa, Paris, September 1994.
- Gold Medal for Technological Innovation: to Sainco. National Association of Capital Goods Manufacturers (SERCOBE), 1993.
- Atlas-93 Export Award: sponsored by CEOE, DHL and Expansión, 1993.
- EIT-93: to Sainco for the use of information technology in Andalusia. Sponsored by Coopers & Lybrand, PC Week and Data General, 1993.



## Innovation projects in progress

### Demonstration projects

Abengoa believes that “demonstration projects” are a key instrument in the effective implementation of innovation policies to develop and market new products. Demonstration projects provide operational validation of the innovative product, system or process and enable an initial price to be set, which may subsequently be lowered by means of the experience curve. Furthermore, demonstration projects generate a real demand on the public R&D system, enabling science to serve the needs of society. Therefore, Abengoa, through its companies, always has several dozen demonstration projects underway at any one time, usually in cooperation with a number of scientific institutions and technology agencies. Many of these projects receive public funding.

One of our most important R&D efforts currently in progress is research in the bioenergy area into the use of lignocellulosic biomass to produce bioethanol, which is currently produced using cereal feedstocks. The objective of the project is to convert corn stover, straw from other crops and other agricultural residues into bioethanol. This will mean extra income for farmers, lower bioethanol production costs, so that it can compete with petrol, and a reduction in the greenhouse effect, as the feedstock used to produce bioethanol (plants) has previously absorbed CO<sub>2</sub> from the atmosphere in the chlorophyll function. The project, representing an RDI investment of USD 35,478,765 over five years, received a substantial outright grant from the US Department of Energy, amounting to USD 17,739,381 (50% of the total) in September of last year.

Other innovation projects in progress include:

### Bioenergy

- Project financed by the US Department of Energy to improve the efficiency of the production process by converting biomass and waste starch into bioethanol.
- Demonstration project in Castilla-León for a 5 million litre plant to convert biomass into bioethanol on an industrial scale as part of the EU 5th Framework Programme.

### Environmental services

- [Tracemar](#)

The following projects have been carried out in cooperation with the Chemical Engineering Department of the University of Castilla-La Mancha:

- Distillation process for the regeneration of waste oil using demetallised oils obtained as a result of the Aureca process.
- Development of a new finishing process for distilled oil as an alternative to hydrogenation.
- [Alfagrán](#)
  - Process to incorporate fibre glass in the thermoplastic matrix (polyamide or propylene) to produce recycled fibre-reinforced thermoplastic composites.
- [Etrinsa](#)
  - Project to develop a reductive dehalogenation process for chlorinated organic contaminants in a homogeneous state by electronic transfer, in cooperation with the University of Alicante.
- [Aser](#)
  - New process to achieve energy optimisation and increased production in the recovery of zinc and lead from industrial waste, primarily EAF dust, using Waelz kilns.

- Remetal

- Aludisc. New process to dry oil on aluminium disks.
- Refinalsa. Environmental improvements achieved by perfecting the design of a rotary furnace (Mejorot).
- Remetal and Valcritec
- Supersal. Project to upgrade the quality of the salts used in aluminium smelting.
- Optimus. Project to optimise aluminium recycling.
- Calido. Project to assess the influence of secondary metal quality and properties on the deformation of plastic materials.
- Minirex. Process to minimise the production of waste in aluminium recycling.
- Sin Fe. Process to minimise iron in the aluminium recycling cycle.

## Industrial engineering and construction

- Inabensa

- New catenary for the high-speed railway line in consortium with CITEF and other companies.
- New control system for motor control centres. Profit Programme in cooperation with the Electronic Technology Group at the University of Seville.
- New systematic testing system for electronic cards, with the support of IMADE.

- Abentel

- Integra. Implementation of WAP/GPRS in integrated facility management and maintenance.

- Greencell

- Hidrofuel. Development of technology to convert bioethanol into hydrogen as an alternative fuel, in cooperation with the Catalysis and Petrochemical Institute of the Higher Scientific Research Council (ICP/CSIC). Profit Programme.
- Bio-H. Production of hydrogen from bioethanol using a plasma boosted reformer, in cooperation with the Electronic Technology Group of the School of Engineering/Andalusian Industrial Research and Cooperation Association (GTE-ESI/AICIA) and the Materials Science Institute of the University of Seville (ICMSE). The project is subsidised by the Andalusian Development Institute (IFA).
- Biocell. Design and development of a prototype 10 kW electricity generator based on a bioethanol processor and fuel cells, with the participation of the Catalysis and Petrochemical Institute of the Higher Scientific Research Council (ICP/CSIC) and the Electronic Technology Group of the School of Engineering/Andalusian Industrial Research and Cooperation Association (GTE-ESI/AICIA). The project receives support from the Industrial Technological Development Centre (CDTI). The end purpose of Biocell is the efficient transformation of bioethanol into hydrogen to power fuel cells that generate electricity. Such fuel cells can be used to provide households and even small population centres with power.
- Hy-Clean. Power generation system based on fuel cells powered by exhaust gases with a high H<sub>2</sub> content from an industrial plant.
- Tele-PEM. Design and experimental validation of a PEM fuel cell of up to 1 kW for use in telecommunications, with the cooperation of Instalaciones Inabensa, S.A., the Catalysis and Petrochemical Institute of the Higher Scientific Research Council (ICP/CSIC) and the Energy, Environmental and Technological Research Centre (CIEMAT). Profit Programme.

- Participation in the REVCELL Project: "Autonomous Energy Supply with Reversible Fuel Cell as Long-Term Storage for PV Stand-Alone Systems and Uninterruptible Power Supplies" EU 5th Framework Programme.
- Solúcar is leading the following solar power projects under the EU 5th Framework Programme.
  - Eurotrough II. Project to develop a new, more efficient parabolic trough collector.
  - Solair: Project to develop and test 300 kW and 3 MW receivers incorporating ceramic technology.
  - Cocon. Project to develop a photoelectrocatalyser for carbon dioxide reduction to transform it into organic matter using the energy carried in a photon flow.
  - Solgate. Project to develop a compressed air solar receiver and integrate it in a gas cycle.
  - Aquasol. Project to develop a hybrid solar-gas desalination system and a multi-purpose distilling plant.
  - Inditep. Project to extend the DISS collector for the generation of direct solar steam by mass producing and assembling a 200 m long collector incorporating Eurotrough technology.
  - Cac. (20X-40X) controlled atmosphere parabolic trough photovoltaic concentrator.
  - Sanlúcar Solar. 10 MW solar thermal plant with tower technology in Sanlúcar la Mayor (Seville).
  - Sevilla PV. 1.2 MW photovoltaic plant with 2x solar concentration and dual axis tracking.

## • Systems and networks

- Sainco
  - Enerdis, SMA-1AO4, SM-SERS, Plagas, S2000DP, Saitel-LON.Lonworks, Saimet, S-100, Prima, Insonet, Power-Lan, Ener-Net, Plt-Home Router, SincrOFDM, Samba, Iber-PLC, Saidap, Innova-Swiftco, Iris and Café.
- Sainco Tráfico
  - Smartoll, Adaptex, e-Park and Regula.

- SainseI
  - Display system and Weccdis SW.
- Telvent Interactiva
  - Redest, Café, Webplus, e-ESAPS and Frada.
- Internet Data House
  - IDEAL

The following are particularly significant:

- Insonet. Project led by Sainco included under the EU 5th Framework Programme. The purpose of the project is to develop low-cost technology enabling the conventional electricity grid to be used as a means of transmission for residential broadband networking applications up to 10 Mbytes/second.
- Smartoll. Integrated "free-flow" system for electronic motorway toll transaction management.
- Adaptex. Latest-generation urban traffic system integrating expert adaptive control subsystem algorithms under a single environment to provide real knowledge management.
- Café. EUREKA-ITEA Project, evolution of ESAPS with an enhanced approach for the analysis, evolution and definition of software system-families. With the support of the Ministry of Science and Technology.
- IDEAL. Definition, development and operation of a dedicated and shared colocation service platform, business information systems, information portals and Internet business platforms. Profit Programme.

## Relevant Lines of Innovation

Four particularly relevant lines of innovation are:

- **Bioethanol**
- **Solar power**
- **Hydrogen (H2) technologies**
- **Broadband transmission over the electricity grid**

- Bioethanol

## Bioenergy

### Objectives

- Leadership position in Europe with Ecocarburantes Españoles (100 million l/year), Bioetanol Galicia (126 million l/year) and the Castilla-León plant (200 million l/year).
- Increased market presence in the USA based on the acquisition of High Plains (325 million l/year), with the construction of new facilities and/or further acquisitions.
- Progressive expansion to other European markets by implementing pilot projects: UK, Germany, Portugal, Sweden and Italy.
- Search of new opportunities in Latin America (Mexico, Brazil) and the Caribbean.
- Incorporation of new technologies to convert cereal crop residues to cut production costs.
- Development of the demand for ethanol in Spain based on two lines of action:
  - Agreement with Repsol and Azucarera for blending ethanol in petrol.
  - Investment in RDI for blending ethanol in gasoil.
- Biotechnological processes to improve protein feed co-products.
- Development of production processes using biomass and industrial demonstration in pilot plants.

### Your partner in Bioenergy

Our facilities:

In Spain



Ecocarburantes Españoles  
Cartagena



Bioetanol Galicia  
Coruña

In the US



York  
Nebraska



Colwich  
Kansas



Portales  
New Mexico

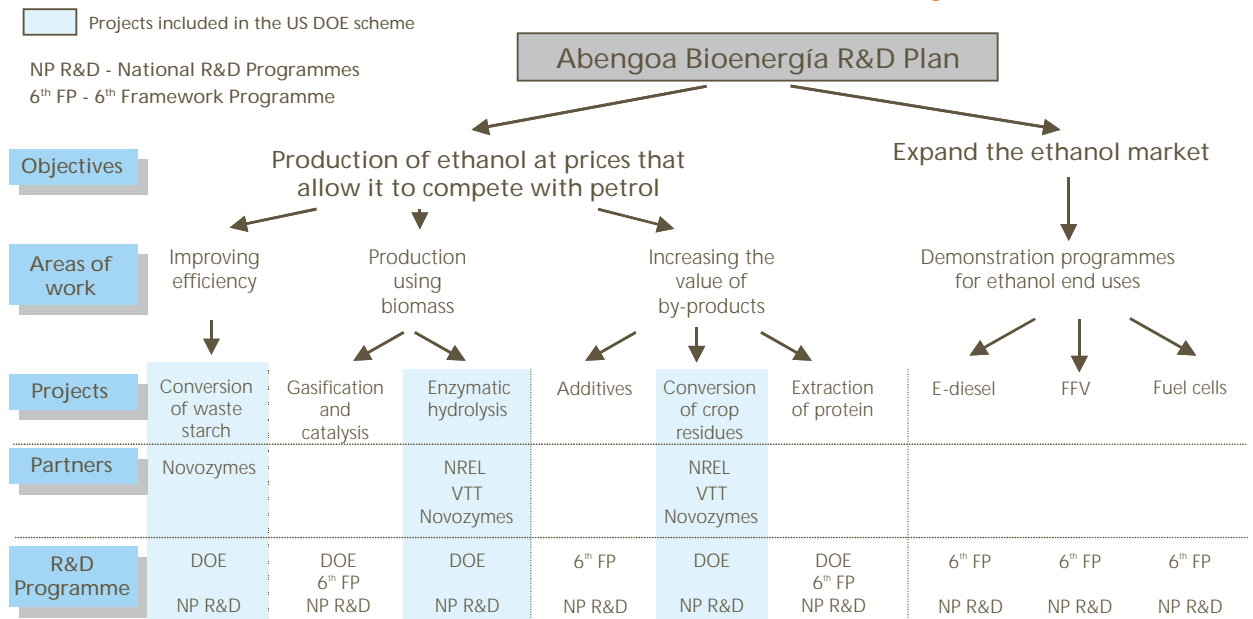
## RDI scenario

- Differential innovation to improve efficiency
- Conversion of waste starch
- Conversion of crop residues
- Improvement of DDGS
- Radical innovation to transform the business
- Lignocellulosic biomass
- Fuel cells
- E-diesel
- Biorefining

## Public funding for bioenergy

- Abengoa's RDI Plan has received the backing of the US Department of Energy and the European Commission through its 5th Framework Programme.
- Abengoa Bioenergía has plans to develop a demonstration plant to produce ethanol from biomass in Spain, which would require the support of the National R&D Plan.

## R&D objectives 2003-2006





• Solar power

Photovoltaic



- Simple

Solar thermal parabolic collector



- Large plants
- Efficient land use

Solar thermal tower



- Medium-sized plants
- High temperatures
- Reasonable cost

- High installation cost
- High generation cost

- Steam temperature 400°C

- More complex

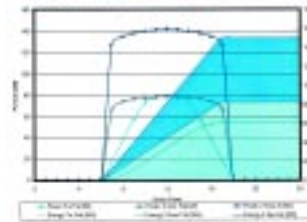
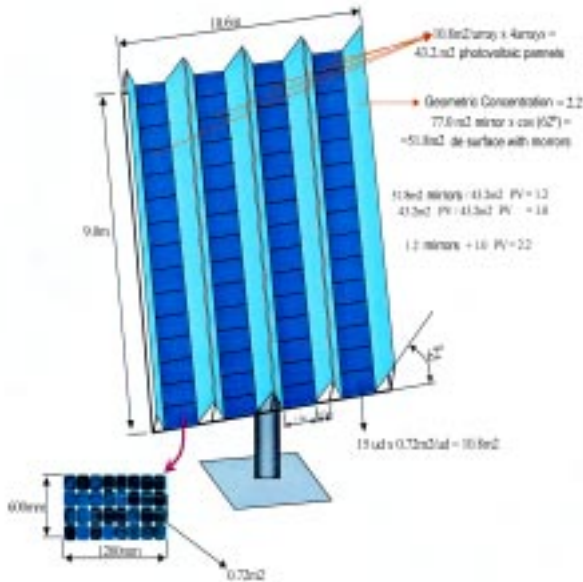
The power of the sun

- Power received by the whole of the earth's surface
  - 100,000 TW (continuous)
  - 10,000 times world production (10 TW continuous)
  - Equivalent in terms of power to a 200 mm layer of petroleum covering the entire earth's surface each year
  - Equivalent to 1.5 barrels for each square metre of the planet's surface.
- Efficiency: kWh/ heliostat incident power
  - Current technology 17%
  - Technology in 20 years >30%

Current technology to be incorporated in the Sanlúcar Solar Project

- Potential > 1,000 kWh/ha per day
- Surface area of Andalusia: 8,800,000 ha
- Solar plants occupying just 1% of this surface area would meet all electricity consumption needs in Andalusia
- Production 88 GWh/day = 32,000 GWh/year
- Total demand in Andalusia 2000 = 27,231 GWh

• Sevilla PV  
1 MWe electricity generation plant

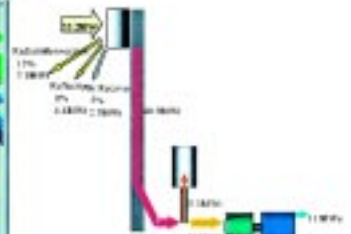
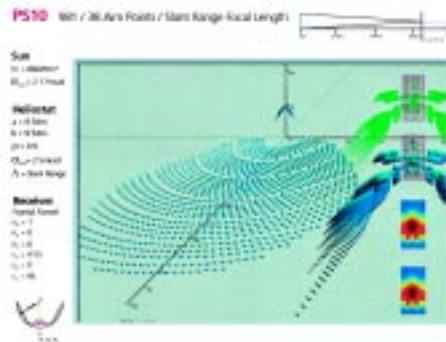
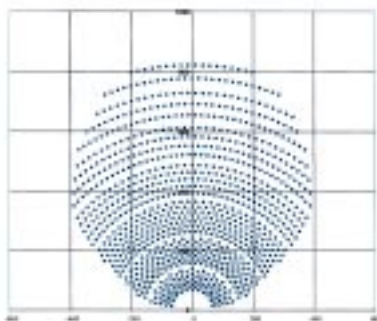


• PS10 Project  
10 MWe electricity generation plant

Sanlúcar Solar

Heliostats	981/91 m <sup>2</sup>
Tower height	90 m
Focal length	500 m
Design Point	Day Time
	0:0
Irradiance	850 W/m <sup>2</sup>
Irradiation	2063 kWh/m <sup>2</sup> año

Design point optical performance	0.729	75.880 MW -> 55.269 MW
Design receiver and storage performance	0.74	55.269 MW -> 40.919 MW
Thermal - electrical performance	0.309	40.919 MW - 5.337 MW = 35.582 -> 11.0 MW
Annual optical performance	0.647	183,496 GWh -> 118,721 GWh
Annual receiver and storage performance	0.614	118,721 GWh -> 72,895 GWh
Annual thermal - electrical performance	0.303	72,895 GWh -> 22,087 GWh

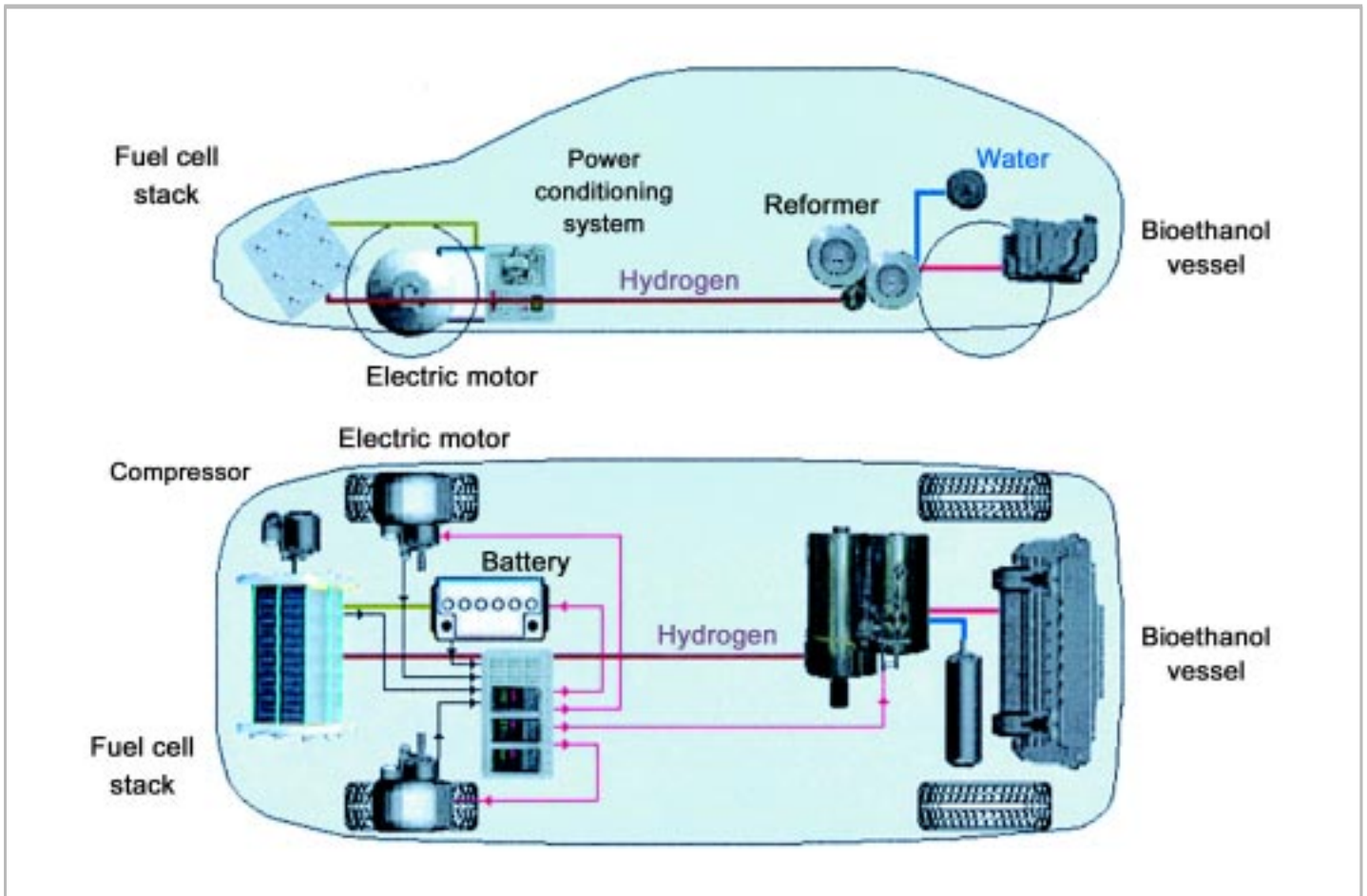


• **Hydrogen (H2) technology**

- Bioethanol (renewable fuel) reformer systems for the production of H2 and their use onboard fuel cell vehicles.
- Systems to produce electricity using fuel cells.
- Bioethanol reforming advanced vehicle: development of a prototype advanced vehicle powered by bioethanol with an onboard H2 reformer and fuel cell.

Advantages over conventional vehicles

- Bioethanol is a renewable, sustainable fuel made from plant-derived organic matter, which helps to reduce net CO2 emissions into the atmosphere, because the CO2 released was previously extracted from the air in the chlorophyll function by the plants used to make the bioethanol. The production of bioethanol also reduces oil imports, and it can be distributed through existing service stations. The fuel cells used to power vehicles are more efficient than internal combustion engines, they do not pollute the atmosphere and the vehicles are noiseless.



- **10 Mbytes/second broadband transmission over the electricity grid**
- Low-cost technology permitting the use of the conventional electricity grid as a means of transmission for broadband residential networking applications up to 10 Mbytes/second.

## Market

- Residential (prototypes at testing stage)
  - Eliminates the need for interior communications wiring and base stations in buildings.
  - Eliminates wiring between terminals and base stations.

- Urban (future)
  - Broadband last mile access over the electricity grid from concentrator transformer centres.
  - City node with fibre optic connection of centres.

Abengoa's track record in the business:

- 1987 – Emetcón: electronic carrier system over medium voltage lines.
- 1992 – Sailink: DSP technology carrier system for medium voltage lines.
- 1997 – Policom: ASI-DSP technology carrier system for low voltage lines.
- 2002 – Insonet: 10 Mbytes/second broadband system for residential networking.

## Significant Figures

### Total investment in RTDI (I)

(thousands of €)

2000		2001		2002		2003 (E)	
Th. €	% of sales	Th. €	% of sales	Th. €	% of sales	Th. €	% of sales
5,980.1	0.5%	7,598.4	0.5%	11,065.2	0.7%	20,480.6	1.2%

## Total investment in RTDI (II)

(thousands € )

	2000		2001		2002	
	Th. €	% of sales	Th. €	% of sales	Th. €	% of sales
<b>Bioenergy</b>						
Ecocarburantes	48.1		0.0		0.0	
Subtotal Siema	48.1	0.0%	0.0	0.0%	0.0	0.0%
Total Business Segment	48.1	0.0%	0.0	0.0%	0.0	0.0%
<b>Environmental Services</b>						
Befesa consolidated	0.0		0.0		364.3	
Subtotal Siema	0.0	0.0%	0.0	0.0%	364.3	0.1%
Total Business Segment	0.0	0.0%	0.0	0.0%	364.3	0.1%
<b>Information Technology</b>						
Arce sistemas	499.4		311.9		371.1	
Sainco	2,310.3		2,189.0		2,410.0	
Sainco Tráfico	2,318.7		1,065.0		3,143.8	
Sainsel	186.9		210.5		112.9	
Subtotal Abengoa Traditional	5,315.4	0.5%	3,776.4	0.4%	6,037.8	2.8%
Telvent Interactiva	117.8		203.8		713.6	
Carrierhouse	0.0		0.0		510.0	
Subtotal Siema	117.8	0.0%	203.8	0.0%	1,223.6	6.1%
Total Business Segment	5,433.1	0.5%	3,980.2	0.3%	7,261.4	3.1%
<b>Industrial Engineering and Construction</b>						
Abener	134.0		2,404.0		1,000.0	
Abentel	0.0		941.8		306.6	
Inabensa	364.8		272.4		580.9	
Subtotal Abengoa Traditional	498.8	0.1%	3,618.2	0.4%	1,887.5	0.4%
Greencell	0.0		0.0		1,500.0	
Solucar	0.0		0.0		52.0	
Subtotal Siema	0.0	0.0%	0.0	0.0%	1,552.0	2.6%
Total Business Segment	498.8	0.0%	3,618.2	0.3%	3,439.5	0.7%