ABENGOA

Technology: Engine of Growth

Analyst & Investor Day

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ABENGOA

1 R&D: the engine of growth

2 Discipline in R&D management

3 From cutting edge research to Innovation

R&D is Abengoa's engine of growth

R&D allows to create a technological competitive advantage

Business Units

+

ABENGOA RESEARCH

R&D

Technology Leadership

Competitive Advantage

1 R&D: the engine of growth

2 **Discipline in R&D management**

3 From cutting edge research to Innovation

Efficient R&D management is critical to improve decision making

R&D identification

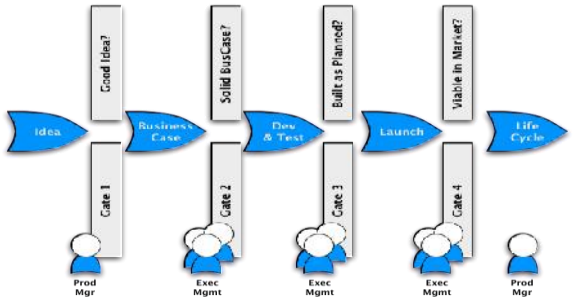
- **Internal procedures**
- Set **objectives by technology**
- **Technical surveillance information**
- **Technical** and **economical viability**

R&D project management

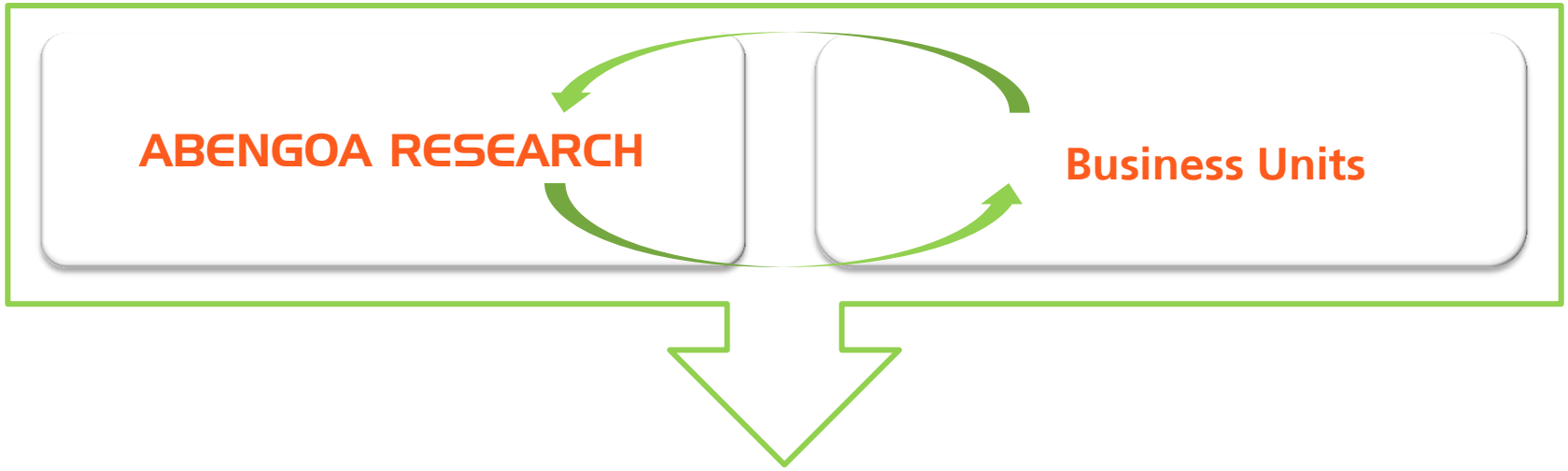
- **Stage-Gate approach**
- ✓ **Identification** of opportunities
- ✓ **Preliminary research** and **state of the art** analysis
- ✓ **Business plan**
- ✓ **Pilot / Demo plant**
- ✓ **Commercialization**

R&D valuation

- **Qualitative valuation:**
  - ✓ Strategic Fit
  - ✓ Risks
  - ✓ Market attractiveness
- **Quantitative valuation:**
  - ✓ Business model
  - ✓ Market scenarios
  - ✓ Technological risk



More than 700 people working for R&D have developed proprietary and proven technology through more than 190 patents



Research	Development	innovation
▪ Create knowledge ▪ Breakthrough ▪ Future options	▪ New technologies design, development and demonstration ▪ High-level technical assistance	▪ Product improvement ▪ Process optimization

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Abengoa´s Technology Goals

	Solar	2ª Generation Bioethanol	Water
Goal	Be competitive with CCGT in 2020	Be competitive with $70/barrel in 2-3 years	Reduce energy consumption up to ~0.6 kWh/m³
Middle steps	▪ Phase I: Reduce costs and improve efficiencies in CSP ▪ Phase II: Superheated tower ▪ Phase III: Solugas	▪ Phase I: Demonstration plant ▪ Phase II: Hugoton+ enzymes development ▪ Phase III: Large scale plants+ yield improvement + reduced capex per litre	▪ Phase I: Reduce reverse osmosis energy consumption ▪ Phase II: Direct Osmosis ▪ Phase III: Integration with renewable energy
Patents	107	45	17

Tower: superheated steam

The superheated tower technology has already been proven at pilot scale

R&D

- Develop a new technology
- Superheated steam

Pilot projects

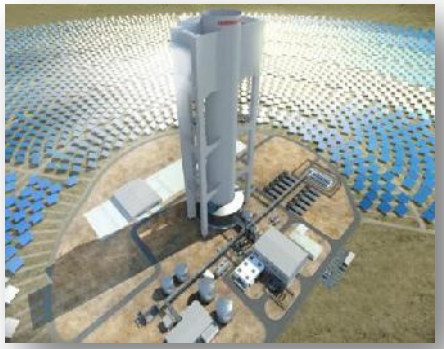
- Pilot plant built
- Operation over 2 years (2009 - 2011)
- Learning and feedback for commercial design

Commercial projects

- Engineering ready
- Offering commercially superheated plants of several sizes

Solúcar R&D Center

Eureka



Khi Solar One PS50

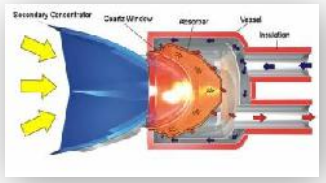
Solar Tower Patents: 26

Tower: gas

Abengoa is developing a new concept: Solugas

R&D

- Higher temperatures: around 1000 ºC
- New receivers
- Turbine design



Solugas Turbine

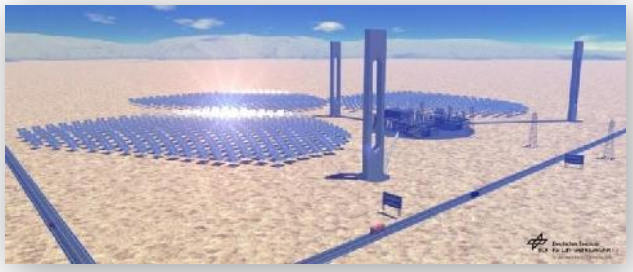
Pilot projects

- Building the pilot plant (800ºC)
- In operation by Q2-2012

Solugas Pilot Plant

Commercial projects

- Analysis of the different plant configurations



Solugas Tower

Solugas Patents: 4

CCP: 3rd Generation Trough

Abengoa is developing the next generation technology for troughs

R&D

- New larger aperture trough collector and new optics
- Developing receiver and interconnection technology

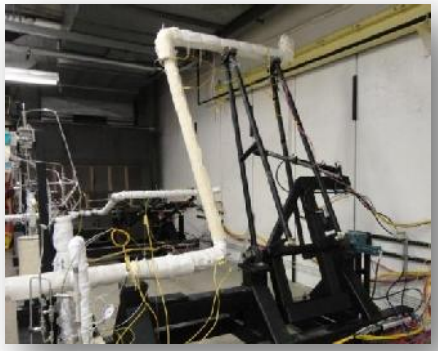
Pilot projects

- New high temperature fluids
- Molten-salt component testing laboratory
- Direct Steam Generation (DSG) pilot plant in operation for more than one year

Commercial projects

- Basic engineering completed for commercial DSG plant
- >25% cost reduction over current HTF plants
- Low costs, efficient and dispatchable TES

Large Aperture Trough



New Fluids Test Lab

MS 140

Trough Patents: 33

Enzymatic hydrolysis

Proprietary 2G bioethanol producing technology from lignocellulosic raw material

R&D

- Develop technology at pilot scale

Demo projects

- Demonstration plants, York (EEUU) and Salamanca (Spain)
- Salamanca capacity : **5 Ml/yr**

Commercial projects

- Continues yields improvement, reaching commercial level, **95 Ml/yr** (Hugoton)

Time Frame	2009	2011	2014
Enzyme price (USD/Kg cocktail)	1	0.8	0.6
Enzyme productivity (g/Kg broth)	40	70	80
Enzyme dosing (mg/g cellulose)	30	20	10
Glucan to ethanol yield (gal/kg)	0.23	0.24	0.25
Enzyme Contribution (USD/gal ethanol)	**3.29**	**0.95**	**0.30**
% Cost Reduction		**↓70%**	**↓70%**

Salamanca

Hugoton

Enzymatic Hydrolysis Patents: 14

Remineralization

R&D

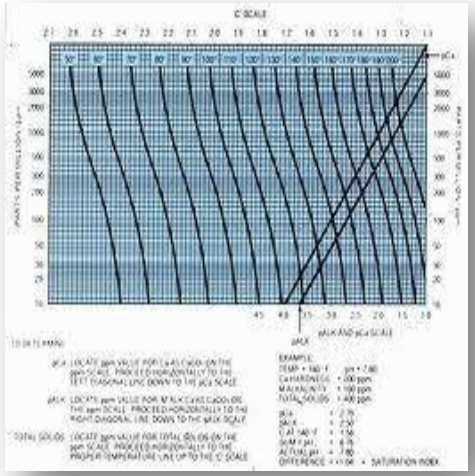
- Concentration limits
- Chemical reaction kinetics
- Filtration modes

Pilot projects

- Pilot plants
- Filtration units

Commercial projects

- Engineering developed for several sizes
- Operation in Qingdao plant
- Product water turbidity < 0,2 NTU (potable waters turbidity 1 to 5 NTU)



Remineralization Patents: 1

Abengoa´s future technologies

Waste to biofuel

- **Be competitive on bioproducts**
  - Build a bioplastic pilot plant
  - Build a MSW-to-Biofuel plant

Energy Crops

- **Sustainable energy crops with genetic biomass traceability**
  - Develop biotech prototypes
  - Pilot-scale plantations for pellets production

Sea Power

- **Be competitive with wind offshore (~15 c€/kWh)**
  - Research on different technologies, as point absorber

Hydrogen

- **Develop cogeneration plants with fuel cells**
  - Build a 300 kW plant with MCFC technology at CPA

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Thank you!

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