ABENGOA BIOENERGY

NEW TECHNOLOGIES

Sustainability Issues in Bioethanol Production

Corck, 16th September 2008

Science. Solutions. Service.

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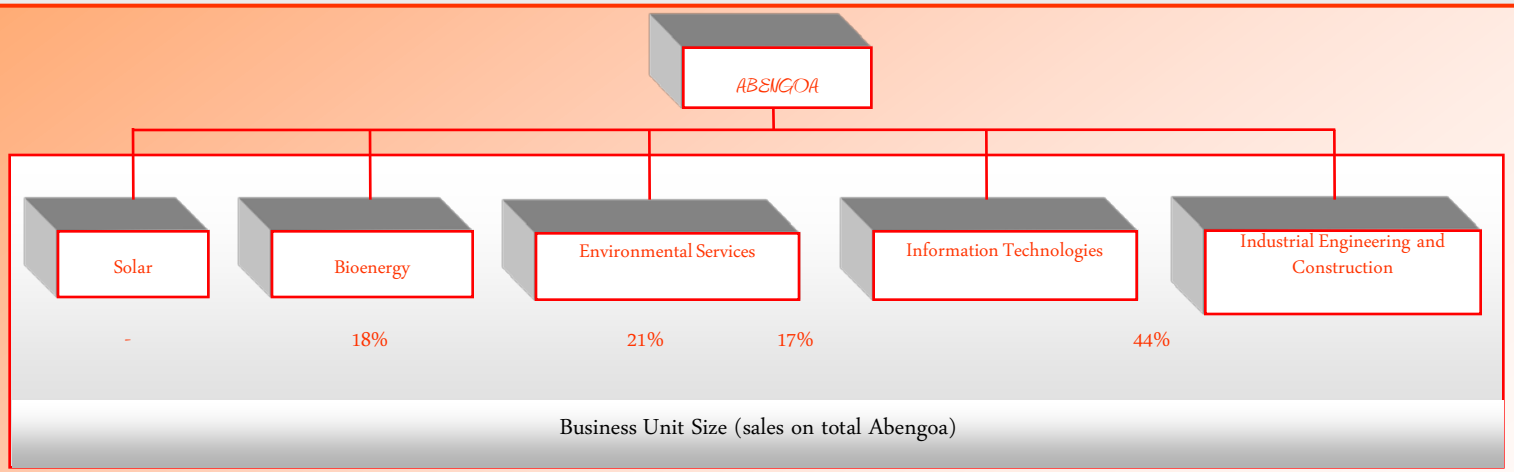
Contents

1. Abengoa Overview

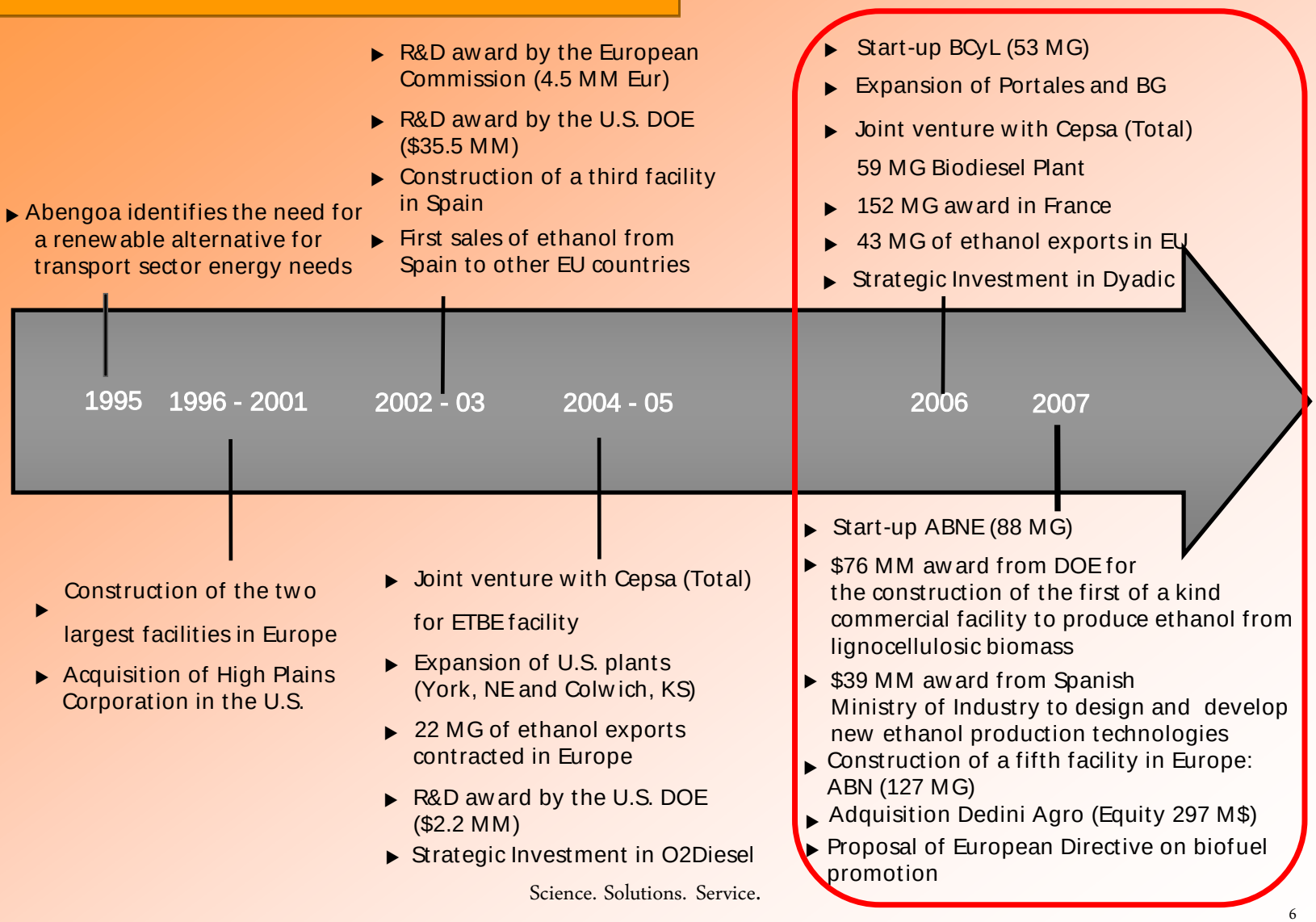
Abengoa is a technological company that applies innovative solutions for sustainable development in the infrastructures, environment and energy sectors. It is present in over 70 countries where it operates through its five Business Units: Solar, Bioenergy, Environmental Services, Information Technology, and Industrial Engineering and Construction.

Abengoa is a listed company in the Madrid Stock Exchange.



Abengoa Bioenergy generates energy from renewables resources, thus contributing to Abengoa´s main focus on sustainable development.

The Evolution of Abengoa Bioenergy



ABENGOA BIOENERGY
NEW TECHNOLOGIES

The Global Ethanol Company

Cartagena, Sp
40 MMGY
Since 1999

Coruña, Sp
53 MMGY
Since 2001

Salamanca, Sp
53 MMGY
Since 2006

Lacq, FR
66 MMGY
Since 2007

Rotterdam, NE
126 MMGY
Construction

York, NE
25 MMGY
Since 2001

Colwich, KS
55 MMGY
Since 2001

Portales, NM
30 MMGY
Since 2001

Ravenna, NE
88 MMGY
Since 2007

Evansville, IN
88 MMGY
Construction

Trinity, IL
88 MMGY
Construction

San Luis, SP
3,3 Mt/y
Since 2007

San Joao, SP
2,8 Mt/y

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2. Abengoa Bioenergy Technologies

Proposed concepts by Abengoa Bioenergy

Transformation technologies from starchy biomass.

- Cereal transformation into ethanol by means of dry milling.

Hybrid technologies: cereal & lignocellulosic biomass.

- Cereal dry milling + Enzymatic hydrolysis of lignocellulosic biomass.
- Biomass gasification for electricity production and ethanol synthesis.
- Cereal dry milling (+ Biomass EH) and biomass gasification for heat generation (distillation, steam explosion, etc.)

Ethanol production from entirely lignocellulosic biomass :

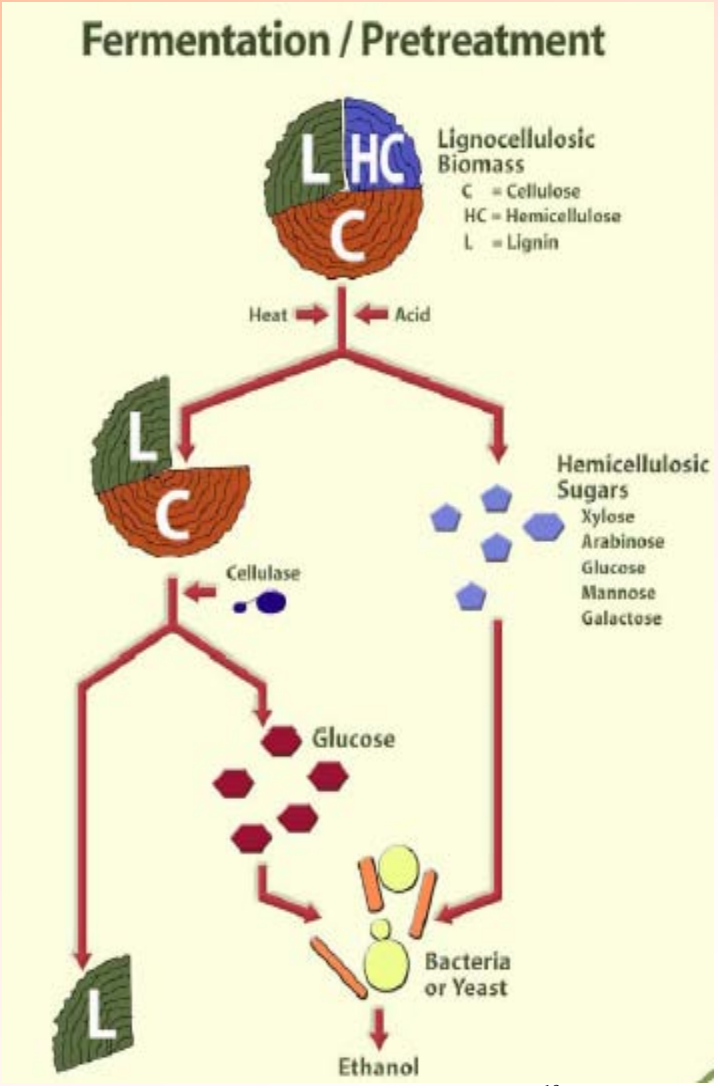
- Biomass Enzymatic Hydrolysis for ethanol production (EH)
- Biomass gasification and alcohol synthesis (GC)

Biorefinery, combination of biological and thermochemical technologies.

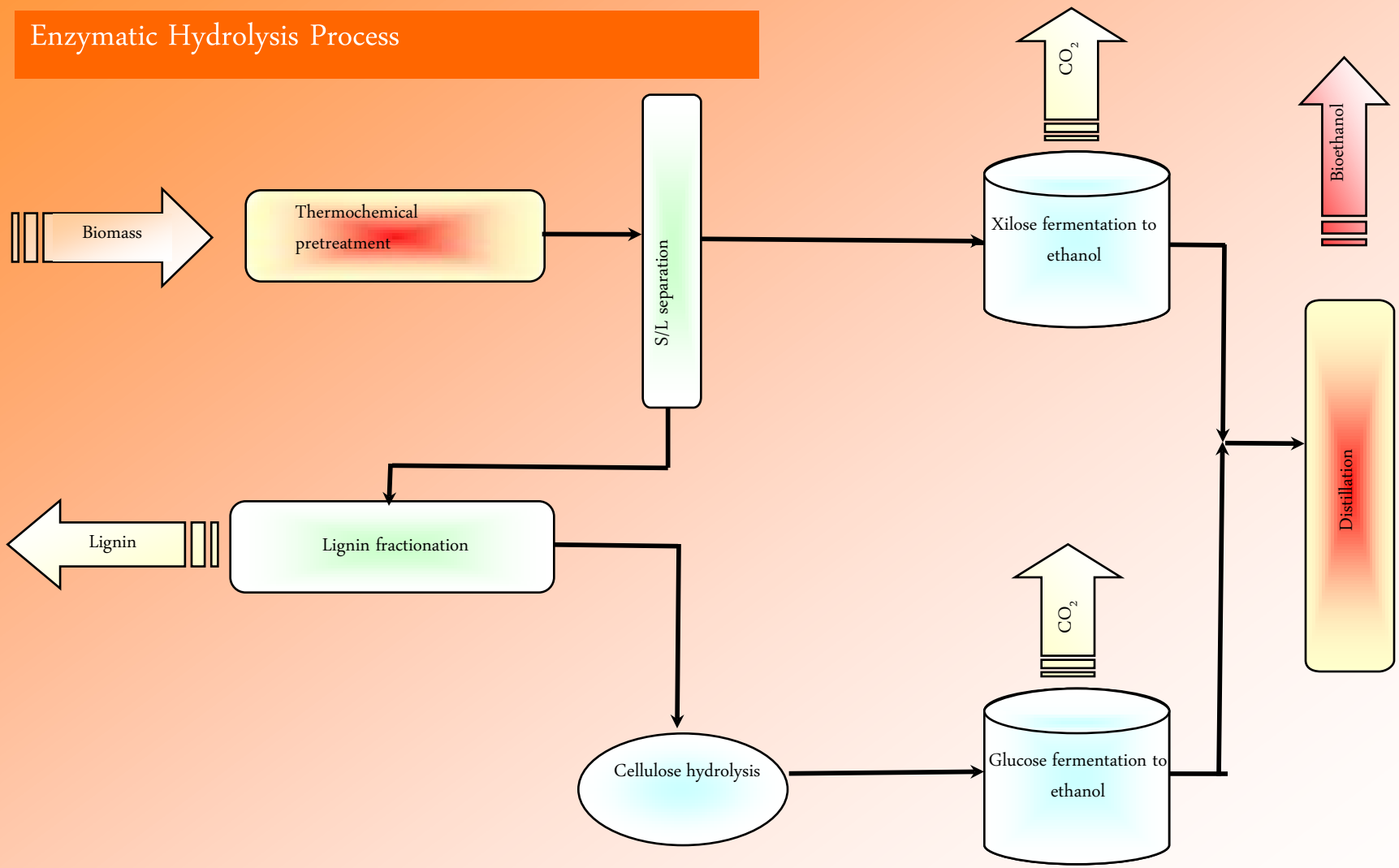
- Combination of technologies for lignocellulose conversion (HE + GC)
- Production of high value-added products as well as biofuels.

Biochemical Pathway - Enzymatic Hydrolysis Process

- Definition
  - The process is defined as the fractionation of the biomass into its main components (cellulose, hemicellulose and lignin) for further fermentation to ethanol of sugars and valorization of the remaining residue (lignin)
- Status:
  - Inexistence of commercial technologies
  - Abengoa Bioenergy is world-leader in the technology development. It is the unique player with pre-commercial facilities:
    - York pilot plant – 1 tn/d
    - Salamanca demonstration plant – 70tn/d
- Justification:
  - Alternative to the traditional production from cereals and sugar beet
  - Un-lock the potential for the biofuel production.
- Advantages
  - Possibility to use a higher raw material range of lower cost and not linked to the food and feed market.
  - Lower production costs in comparison with first generation conversion technologies
  - Higher environmental sustainability



Enzymatic Hydrolysis Process



...and Leading the 2nd Generation

Commercial Hybrid Biomass Plant Hugoton (KS, US)

- Capacity : 100 MGPY (13 MGPY biomass, 87 MGPY starch)
- Raw material : Corn starch and stover
- Technology : Enzymatic Hydrolysis (glucose & xylose)
- Objective : Production at a gasoline competitive cost
- Start-up Operations : 2010 estimated

Biomass Demonstration Plant in BCL (Salamanca, Spain)

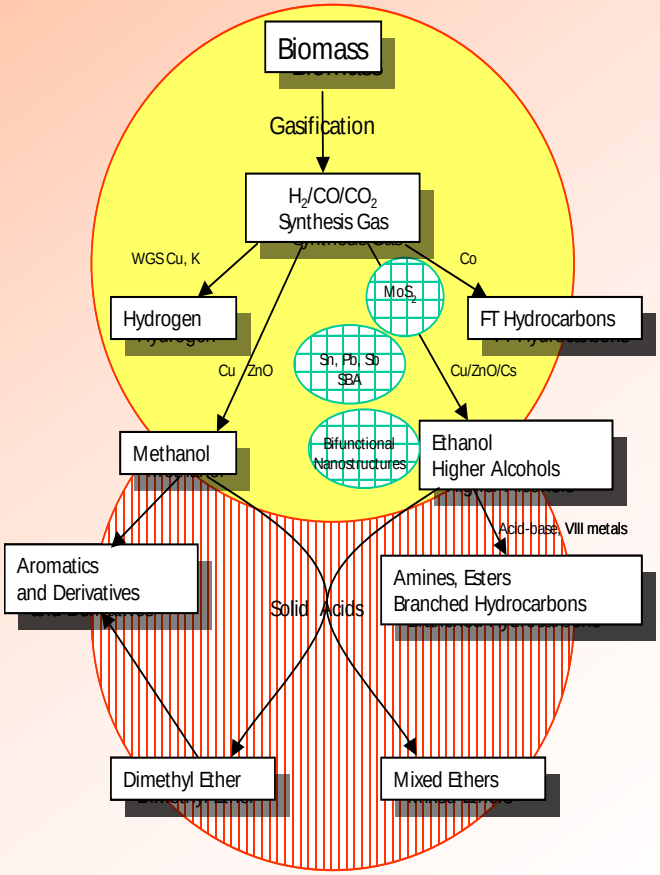
- Capacity : 1.3 MGPY
- Raw material : Wheat and Barley Straw
- Technology : Enzymatic Hydrolysis (glucose)
- Objective : Demonstrate biomass-to-ethanol process technology at commercial scale
- Start-up Operations : 2008

Biomass Pilot Plant in York (NE, US)

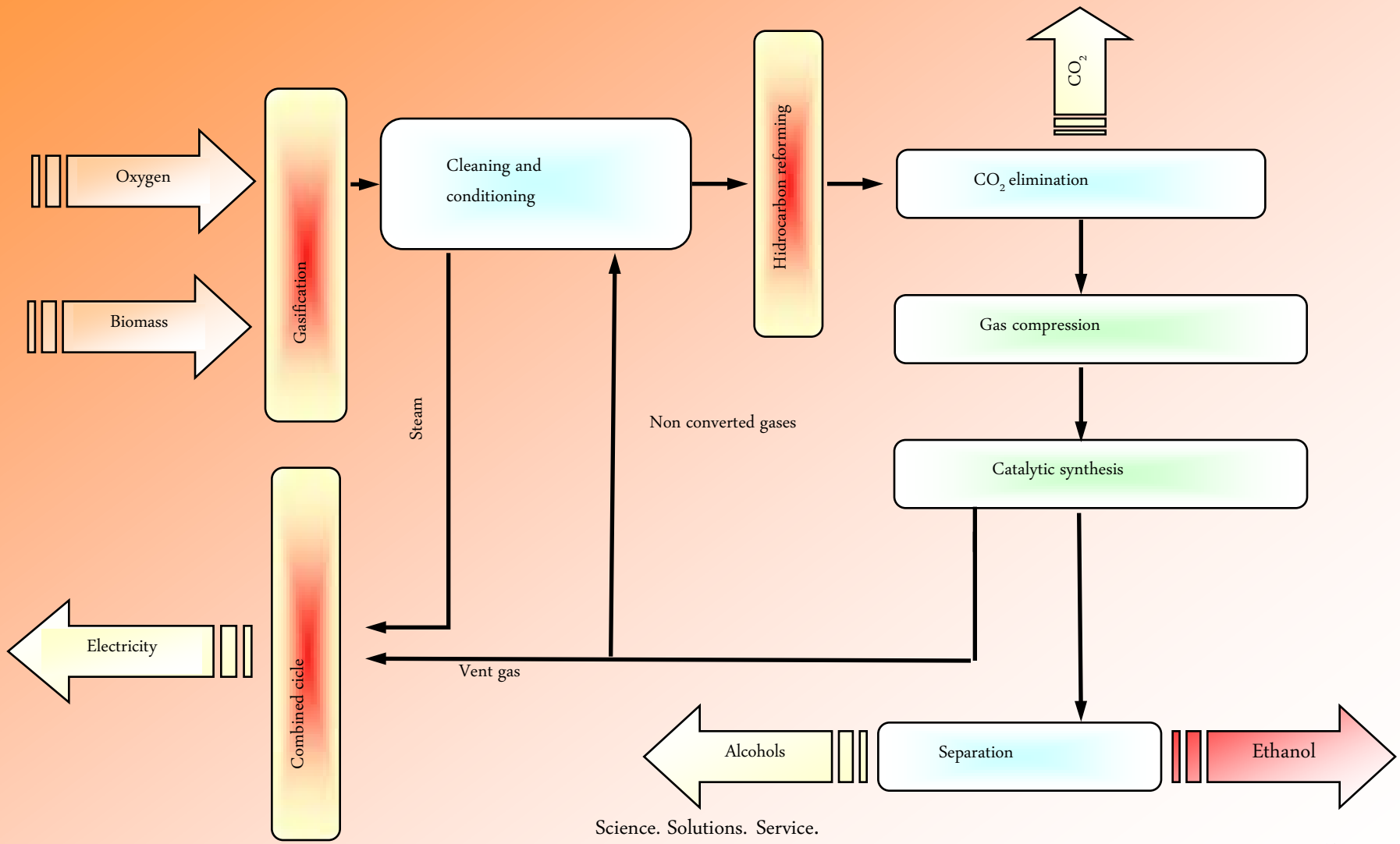
- Capacity : 0.02 MGPY
- Raw material : Corn stover
- Technology : Enzymatic Hydrolysis (glucose & xylose)
- Objective : Competitive process with grain ethanol
- Start-up Oper. : 2007

Thermochemical Pathway – Gasification and Catalysis

- Definition:
  - The process could be defined as the initial transformation of the biomass into gas and further conversion of the gas stream in products, ethanol and alcohols in this case
- Status:
  - Currently does not exist commercial technology
  - Do exist projects in demonstration phase to produce diesel and methanol
- Justification:
  - Thermochemical pathway is an alternative to the biochemical one that could transform any kind of biomass including non converted by the biochemical pathway fractions.
- Advantages
  - The process can generate simultaneously electricity
  - Energetic yields are fairly high
  - Zero fossil fuel consumption and low emissions
  - Low production costs



Gasification and Catalysis Process



3. Europe's Situation Regarding Sustainability

Status of Implementation

European Union:

- Published proposal for a directive on renewable energies containing sustainability criteria in January 2008.
- The directive still has to pass the European parliament.
- It is expected that the content of the Directive is agreed on no earlier than 2009 and that the Directive would enter into force no earlier than 2010.

Great Britain:

- Beginning in April 2008,
- Fuel suppliers which supply biofuels passed the duty point onto the UK market have to report on the sustainability of the biofuels they supply.

Germany:

- The draft of a biofuels sustainability ordinance has already passed the German cabinet and is currently still in the notification process by the EU and the WTO.
- The ordinance is expected to become effective in 2008 or 2009.

The Netherlands:

- A draft for a sustainability reporting system has been worked out.
- The reporting system is expected to come into force in 2009.

Compliance Mode

European Union:

The sustainability criteria of the EU directive for biofuels need to be complied with, if:

- These biofuels shall be accounted for the national renewable energy targets set up within the directive,
- These biofuels shall be accounted for the national biofuels obligations
- The use of these biofuels shall be eligible for financial support.

Great Britain:

- Criteria of the UK sustainability reporting system do not have to be fulfilled.
- However, companies blending biofuels have to report to which extent they comply with the criteria. The submission of empty reports (the so called "do-not-know"-reporting) is aloud if the respective company cannot collect the needed data.
- The UK government announced their intention to make the fulfillment of their sustainability criteria mandatory in the year 2011.

Germany:

- The sustainability criteria of the German biomass sustainability ordinance need to be complied with, if these biofuels shall be accounted for the German biofuels quota obligation.

The Netherlands:

- The sustainability criteria of the Dutch sustainability reporting system do not have to be fulfilled. However, companies blending biofuels have to report to which extent they comply with the criteria. The submission of empty reports (the so called "do-not-know-reporting ") is aloud if the respective company cannot collect the needed data.

Sustainability Criteria

Scope of sustainability criteria in the EC proposal and in different EU Member States with national legislation on the sustainability of biofuels.

	EC	DE	UK	NL
GHG emissions	35%	30/40%	40/45/50%	?
Land use change in areas of high biodiversity	+	+	+	+
Good environmental practices (Water/Soil/Air)	Only for EC feedstock	+	+	+
Social issues (labor conditions + land rights)	-	-	+	+
GMO	-	-	-	-
Indirect land use change	-	-	-	-
Competiton with food production	-	-	-	-

Current Status

- UK: legislation in place
- NL and DE: prepared and stopped waiting for RED
- EU: receiving amendments to the draft directive proposed in January. Second draft expected by October-November 2008

Main topics under discussion:

- % of GHG emissions reduction
- Inclusion of social criteria
- Methodology for GHG evaluation (inclusion of factors to evaluate land use change, bonus for cultivation in degraded land.
- Indirect land use change

4. Tools Towards Sustainable Certification

Tool Towards Sustainable Certification – Raw Material Traceability

Goal

Quantify GHG emission and energy consumption for each batch of raw material

Input

Origin and logistic of raw material

Methodology

Output

Balance

1. GHG emissions
2. Primary Energy

Methodology

High level of subtasks

Data

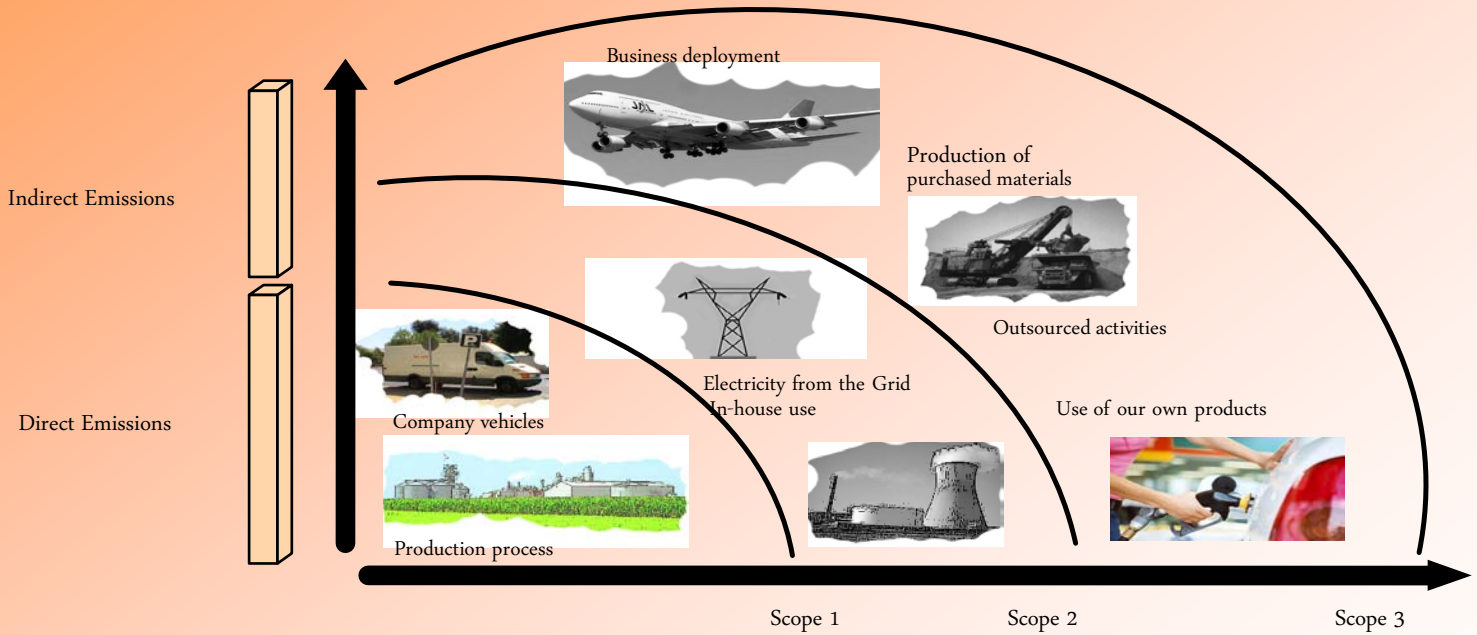
Depend on the origin of the raw material

Data Base

Statistics and reliable information for each country

Tool Towards Sustainable Certification - Emissions Inventory

- GHG included into the Balance: CO_2, N_2O, CH_4, PFC, HFC, SF_6
- Kind of emissions:

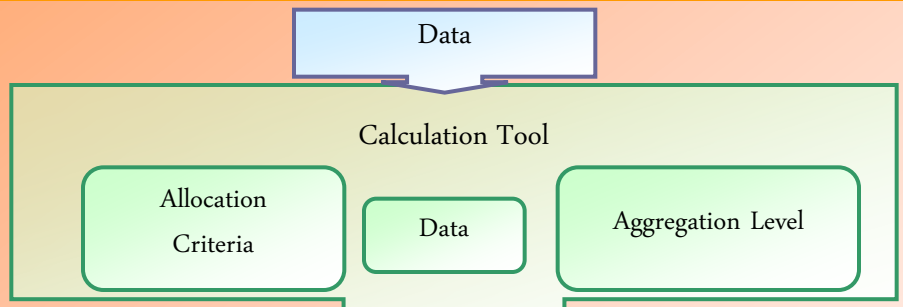


Tool Towards Sustainable Certification-Life Cycle Analysis

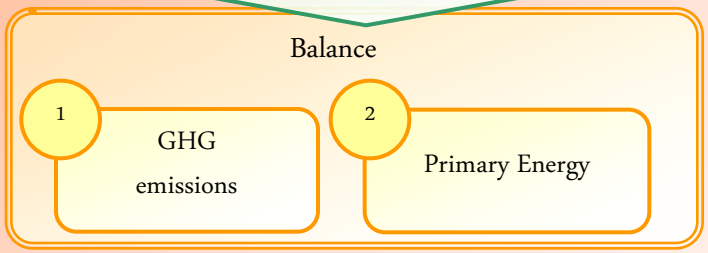
Goal

Quantify GHG emission and energy consumption for production plants, depending on methodology

Input



Output



Methodology	Different methodologies depending on criteria
Quantity	Real and actual data (from production plants and Raw material Traceability)
Factors	Statistics and reliable information;
Tool	Allows to compare results at stage, task and sub task level for whatever methodology

5. General conclusions

Conclusion

- Abengoa Bioenergy is world lider in bioethanol production from cereals and is the main actor in lignocellulose to ethanol technology development

- Regarding GHG emmision reduction results for Abengoa Bioenergy production technologies:
  - For cereal to ethanol:
    - Based on real data for both supply chain, production process and distribution, all our production facilities accomplish with GHG reduction percentages over 35%
  - Hybrid facilities
    - Based on rigorous simulation and pilot data hybrid facilities accomplish with GHG reduction percentages over 60%
  - Biomass to ethanol:
    - Based on rigorous simulation and pilot data biomass to ethanol technologies accomplish with reduction percentages over 90%
  - Other improvements are related to CO2 capture using algae and use of algae as raw material could increase GHG reduction over 100%