

Co-production of Bio-fuels (FP5) / KACELLE (FP7): Inbicon Core Technology

The projects "Co-production of Bio-fuels" and "KACELLE" are a good example of how a good research project can develop into an environmental and economical worthy product. What started out as a four year long project that combined the production of bio-fuels from biomass with the coproduction of electricity and heat (CHP), and animal feed, grew to become a €54 million demonstration plant that started operating last year.

The initial €6.5 million EU funded project "Co-production of Bio-fuels" (Framework Programme 5 – FP5) started in December 2002 and ended in March 2006. It developed the IBUS concept (Integrated Biomass Utilization System) producing bio-fuel (bio-ethanol) from agricultural residues like wheat straw, therefore a second generation bio-fuel. In 2008, after several years successfully using the IBUS technology in the FP5 project with a 1 ton straw per hour pilot plant, the matured IBUS technology spurred DONG Energy in the name of 'Inbicon' to set up a plant processing 4 tons per hour of biomass and producing 5 million litres of second generation ethanol annually.



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Inbicon's happens to be the current world largest 2nd generation lingo-cellulosic bio-ethanol demonstration plant, and it is located in Kalundborg, Denmark.

The originality of the IBUS concept, which uses a biotechnology-based process to open up and ferment the biomass, lied in the co-production of bio-ethanol, animal feed and electricity in two neighbouring plants that worked in symbiosis in an interdependent process. Hence, Inbicon's IBUS plant in Kalundborg absorbs waste heat from electricity production thereby bringing production costs down. The concept proved so successful that it has been granted further support under the Framework Programme 7 (FP7) as the KACELLE project (€9.1 million).

Background

Global bio-fuel production has been increasing rapidly over the last decade, but the expanding bio-fuel industry raises some concerns, in particular a possible displacement of food crops of first generation bio-fuels, which are produced primarily from grains, sugar cane and vegetable oils.

The "Co-production of Bio-fuels" project in FP5 concentrated on the so-called second generation of bio-fuels, which have higher CO₂ emission reduction potential and are produced from agricultural waste such as wood scraps, straw and other kinds of biomass that cannot be used as food. In this process, the technology releases the building blocks of the plant material: —cellulose, hemicellulose (both sugars for fermenting ethanol and for feed), and lignin (non fermentable) —and converts them to useful purposes. Because Inbicon's pre-treatment yields a much higher concentration of sugar in the liquid going to fermentation, the resulting alcohol concentration is at least double the normal percentage in cellulosic ethanol processing.

Working in a symbiotic process, both plants produced bio-ethanol, electricity and animal feed with little waste.

Key figures about the Kalundborg demonstration plant production:

- 5 million litres of bio-ethanol annually.
- 13,000 tonnes of lignin pellets replacing coal as fuel at the power plant of DONG Energy (CHP) neighbouring the facility, producing electricity and supplying district heating to around 5,000 dwellings in Kalundborg City.
- 11,000 tons of molasses is produced and serves as feed for livestock however C6 sugars could be converted further also into ethanol.
- More than 19.500 tons of CO₂ are saved from its current production by reusing the excess waste steam from the adjacent located power.



Objectives

The overall objective of the project was to develop cost and energy effective production systems for co-production of bio-ethanol and electricity based on Integrated Biomass Utilisation Systems (IBUS).

The IBUS concept involves the utilisation of lignocellulosic biomass, which produces ethanol, animal feed and a surplus of solid bio-fuel. Furthermore, the concept integrated production of electricity and bio-ethanol by using the low value low pressure steam from the power plant to cover the steam consumption of the bio-ethanol process.

The KACELLE project will demonstrate the 4 ton per hour industrial capacity scale and optimise the plant to lower the production costs for bio-ethanol. Ultimately it is expected to improve the capacity of the plant to process 8 to 10 tons per hour. The process will develop from being partly continuous to operate in a truly commercial continuous mode.

Results/ Impact

The success of this FP5 project led to the construction in Kalundborg, in Denmark, of a fully integrated demonstration plant, in operation since the fall 2009. The optimisation of the production cost and outputs from the demonstration plant is also partially funded by the EU under FP7 as demo project KACELLE.

The aim of this project is to bring the patented Inbicon Core Technology for second generation bio-ethanol production from a pre-commercial to a full commercial level, making the technology available in the market and attractive to investors in four to five years.

Co-production of bio-fuels has achieved other very useful results of which the most significant are:

- Development of a low cost continuous pressurised hot water pre-treatment process for lignocellulosic feed;
- Development of a high gravity liquefaction process capable of converting the biomass fibre fraction to a pumpable liquid within few hours at moderate enzyme concentration;
- Development of a thermophilic organism that produces ethanol from all sugars found in biomass hydrolysates under controlled pH and temperature.

For more information, please visit websites: www.IBUSystem.info or www.inbicon.dk

Or contact the project co-ordinator:

Martin Andersen

Kalundborg EU-Office

Email: andersen@kalundborg.dk

KACELLE

EC Contribution : €9.1 million **Duration :** 48 months **Starting date :** 01/08/2009

Project partners:

Dong Energy Power AS (Denmark); Statoilhydro ASA (Norway) ; Konijnklijke DSM N.V. (Netherlands); DBFZ Deutsches Biomasseforschungszentrum Gemeinnuetzige GmbH (Germany); Københavns universitet (Denmark) ; Universidade do Minho (Portugal)

Co-Production of Bio-fuels

EC Contribution : 6.5 million € **Duration :** 40 months **Starting date :** 01/12/2002
Ended on: 31/03/2006

Project partners:

Elsam A/S (Denmark); Centre for Plant Fibre and Biomass Technology - research body formed by: The Royal Veterinary and Agricultural University (RVAU) and Risø National Laboratory (Risoe), both in Denmark; TMO Biotec Limited (U.K.) ; Sicco K/S (Denmark)