DEINOVE
The deinococcus way

Press Release

DEINOVE produces 9% ethanol with its Deinococcus

A world first for a bacterial process that paves the way for 2nd generation biofuels

- **These results put DEINOVE at the forefront of the international competition for 2nd generation biofuels derived from non-food biomass.**
- **With alcohol content over the threshold the company had set and high yields, DEINOVE demonstrates the technological and economic viability of its production process based on Deinococcus bacteria.**
- **DEINOVE has initiated a test campaign in medium-sized bioreactors up to 300 liter capacity; one of the last two validation steps before moving to the industrial stage in 2015.**

Paris, January 16, 2014 - DEINOVE Alternext Paris: ALDEI, a cleantech company that designs and develops new industrial production processes based on the exploitation of Deinococcus bacteria has managed to produce 9% ethanol with unparalleled performance thanks to its exclusive production process.

For several years now, the global biofuels industry has resolutely turned towards 2nd generation biofuels, i.e. from non-food biomass. So far, no process has been able to harness lignocellulosic biomass in an economically competitive way (see glossary in appendix). DEINOVE shows that its bacterial process is suitable for converting this type of biomass to biofuel and should offer industrial production costs fall in line with market expectations. With the DEINOL project initiated in 2009 and partly financed by Bpifrance (French Innovation Bank), DEINOVE paves the way for a renewable, responsible and profitable alternative to oil and gas fossil fuels.

Emmanuel PETIOT, CEO of DEINOVE, states: "*With an alcohol titer at 9%, we are well above the objectives we set at the launch of the DEINOL program. We are delighted to have obtained results that could impose a new production standard in a world market as important as that of 2nd generation biofuels.*" He adds: "*Manufacturers around the world have strong interest in our solution and in the light of discussions with several of them, we believe we will shortly be able to announce partnerships in several areas of bio-based chemistry.*"

Jacqueline LECOURTIER, former Scientific Director of the French Petroleum Institute (IFP, today IFPEN) who has recently assumed the chairmanship of DEINOVE's Scientific Council adds: *"To our knowledge no other bacterial fermentation process has demonstrated such capabilities to date; high titer but also significant yield and productivity, key factors relevant for industrial performance. This innovative process has become a reality and could bring a commercially profitable and environmentally sustainable solution to move on to a post-petroleum era."*

Professor Rodney J. ROTHSTEIN, Board Member at DEINOVE, Professor of genetics and development at the University of Columbia Medical Center (New York) says: *"This is a real technological achievement given that no other microorganism combines such high content ethanol production with the ability to decompose non-food biomass - two fundamental technological barriers to the development of 2nd generation biofuels!"*

DEINOVE enters a new phase in bacterium *Deinococcus* industrial optimization

The 9% content v/v (volume/volume) equal to 7.2% wt/v (weight/volume) widely exceeds the 5% alcohol content wt/v, considered to be the threshold for industrial exploitation of the process for 2nd generation biofuels. The obtained performance is gradually getting closer to the maximum theoretical yield. This data supports the industrial and economic potential of the DEINOVE method relying on the unique capabilities of Deinococcus bacteria that the company is the only one in the world to exploit. To DEINOVE's knowledge no other bacterial fermentation process has demonstrated such capabilities to date; high titer but also significant yield and productivity, key factors relevant for industrial performance.

In the third quarter of 2012, DEINOVE already demonstrated the ability of optimized Deinococcus bacterium to transform 80% of a non-food biomass into simple sugars, and then convert these sugars into ethanol in laboratory fermentors (from 1 to 5 L) with a 3% titer. Today, DEINOVE engineering technology has improved and been automated in order to develop a strain producing ethanol at high alcohol content: 9%, from glucose as substrate in 20 L pre-industrial fermentors.

These results were obtained in a purely mineral and basic culture medium, a mode of production adapted to the industrial world, and in record time. At this stage, it can be concluded that *Deinococcus* is the ideal candidate for biofuel production as it is very undemanding on the environment in which it can develop and act.

DEINOVE undertakes a test campaign in 300 L bioreactors

DEINOVE started a new test campaign in 300 liter bioreactors provided by SANOFI in Toulouse, which are 15 times the size of current production volumes, to confirm the obtained results in quasi-industrial conditions. The trial results are expected in the first half of 2014.

Subsequently, tests on the scale of several m^3 are planned for the end of 2014, with content, productivity and performance higher than those initially planned.

The DEINOL process is at the forefront of the international competition for 2G biofuels

The DEINOL process has many competitive advantages to prevail in the race for a 2nd generation biofuel standard:

- The Deinococcus confirm their unique and exceptional properties: very stable bacteria even after being optimized and particularly resistant to many molecules normally toxic for any organism.
- DEINOVE has extremely powerful proprietary tools in its new laboratories that allow the company to modify the Deinococcus genome easily due to its natural genetic properties.
- DEINOL simplifies production with an "all-in-one" Consolidated BioProcessing process (CBP) to jointly ensure hydrolysis and fermentation.
- DEINOL removes thermal stress: in a process using "classic" microorganisms the heat generated by the fermentation kills off the microorganisms. This makes it necessary to control the reactor temperature resulting in considerable energy cost and waste of time. Deinococcus makes this unnecessary as it is thermophilic and thus works at high temperatures of 48°C.
- Finally, in contrast to most bacteria, the Deinococcus are capable of simultaneously fermenting different types of simple sugars, such as C5 and C6, derived from the hydrolysis of cellulose and

hemicellulose, and even other organic compounds such as glycerol and acetic acid, thus increasing the final yield of the process.
- DEINOL relies on DEINOVE' strong worldwide intellectual property rights for the industrial exploitation of the Deinococcus.

ABOUT DEINOVE

DEINOVE (Alternext Paris: ALDEI) is ushering in a new era of green chemistry by designing and developing new standards of production based on bacteria of untapped potential: the *Deinococci*. Taking advantage of the bacteria's unique genetic properties and unusual robustness, DEINOVE optimizes natural fermentation and metabolic capabilities of these bacterial "micro-factories" to produce high value added products from non-food biomass. The Company's primary markets are 2nd generation biofuels (DEINOL) and chemical intermediates (DEINOCHEM). Listed on Alternext since April 2010, DEINOVE was founded by Philippe Pouletty MD, General Partner of TRUFFLE CAPITAL, and Professor Miroslav Radman, of the Faculty of Medicine of the University René Descartes. The company employs over 40 people in its new offices and laboratories located at the Biopôle Euromédecine, in Montpellier.

More information at www.deinove.com

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Appendix: Glossary

BIOFUELS 1G / 2G	**Biofuels are liquid or gaseous fuels used in transportation and produced from biomass.** **First-generation biofuels (1G) are produced from agricultural product food components such as starch (cereals), sucrose (cane sugar), glucose (sugar beet) and vegetable oils (rapeseed, palm).** **Second generation biofuels (2G) are produced from non-food biomass such as dedicated crops (eg arundo donax), agricultural and forest residues, and urban and domestic waste.**
LIGNOCELLULOSIC BIOMASS	**Lignocellulosic matter is the main constituent of the cell walls of plants. It is the most abundant source of renewable carbon in the world. It is made up of three major components - cellulose, hemicellulose and lignin.** **Inside the lignocellulosic biomass these three macromolecules intertwine and form a very strong and complex three-dimensional structure which provides rigidity to plants.**
PRODUCTIVITY	**Productivity is an output measurement relative to the time unit and volume unit expressed in grams/liter/hour.**
YIELD	**Yield is the ratio between the amount of valuable product derived from the fermentation process and the amount of raw material used in its production.**
SUBSTRATE MODEL	**Substrate is raw material converted into product by an enzyme or a microorganism. To standardize the tests, DEINOVE added glucose to the bacteria as a substrate model to study ethanol production from simple sugar.**
MINERAL CULTURE MEDIUM	**The culture medium is the environment that allows bacteria to grow. It is more or less rich in nutrients required for bacterial growth. A mineral culture medium is an environment with weak growth factors.**
ALCOHOL CONTENT	**Unit of measurement for the amount of ethanol content per unit of liquid produced. It is expressed in volume/volume or weight/volume.**