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# Development of Second Generation Biofuels and other Bio-based Products

Company Overview, Core Competencies, Biofuel Technology

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Discussion Paper

Huenenberg, April 17, 2008

**BUTALCO**  
**Bio-based Innovations**

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**BUTALCO is developing proprietary technologies to produce second generation biofuels and other bio-based products with yeasts**

- BUTALCO is a start-up company, founded in August 2007, with its headquarters in Zug/Switzerland and research resources in Frankfurt/Germany
- BUTALCO is a research and investment company focused on yeast and biofuel technology
  - BUTALCO carries out own research to develop new technologies for second generation biofuels and biochemicals based on lignocellulose as well as bioactive substances for pharma applications
  - The core technology based on genetically optimised yeasts (*Saccharomyces cerevisiae*) enables increased yields in bioethanol production by using C5 sugars as well as the production of advanced biofuels like biobutanol
  - BUTALCO is to invest in other biofuel areas as well as to develop technologies together with partners in the field of plant biotechnology, lignocellulose hydrolysis, downstream processing and fermentation technology
- BUTALCO's aim is to become a leading yeast and biofuel technology company in Europe

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<b>1</b>	<b>Company Overview</b>
2	Core Competencies
3	Biofuel Technology
A	Appendix: Biobutanol

**BUTALCO was founded in August 2007 and is focused on the development of second generation biofuels and other bio-based products**

Business Model	Milestones
<ul style="list-style-type: none"><li>• Development of (yeast) technology to produce second generation biofuels and other bio-based products<ul style="list-style-type: none"><li>- Build-up of own intellectual property</li><li>- Licencing business (together with partners)</li></ul></li><li>• Evaluation of other yeast related technologies and development together with partners<ul style="list-style-type: none"><li>- Bioactives for the pharma and cosmetics industry</li><li>- Drug screening assays</li></ul></li></ul>	<ul style="list-style-type: none"><li>• Three co-operation contracts with the University Frankfurt</li><li>• Two patent applications claiming important bottleneck technologies (production of acetyl-CoA and iso-butanol)</li><li>• Agreement about the takeover of patents from partners</li><li>• Co-operation contract with industrial partner</li><li>• Wind energy company Volkswind GmbH as investor</li></ul>

**BUTALCO is a start-up company with its headquarters in Zug/Switzerland and research resources in Frankfurt/Germany**

### Headquarters

- BUTALCO GmbH
- Schürmattstrasse 1
- CH-6331 Hünenberg / Zug
- Phone +41 41 780 1643



### R&D Facilities

- Frankfurt University / BioCampus
- Max-von-Laue-Strasse 9
- D-60438 Frankfurt / Main
- Phone +49 69 798 29 513



**Founders are Eckhard Boles, Professor of Molecular Biosciences at Frankfurt University, and Gunter Festel, founder of FESTEL CAPITAL**

**Professor Dr. Eckhard Boles**

- Professor of Molecular Biosciences at J.W. Goethe University Frankfurt since 2002
- Research focused on metabolic engineering of yeast strains for industrial purposes and transport of nutrients across the yeast plasma membrane
- Strong experience in using molecular genetics and molecular biology methods to study and manipulate sugar metabolism in yeast
- Published more than 50 articles in international peer-reviewed journals, and contributed to 7 important patents in the field of yeast biotechnology
- Landmark patents were the construction of the first recombinant yeast strain able to ferment the pentose sugar L-arabinose and a yeast strain expressing human glucose transporters in a functional form



**Dr. Gunter Festel**

- Founder of the advisory and investment firm FESTEL CAPITAL
- Previous positions
  - Member of the management team and head of the consulting business for the chemical and health-care industry with Arthur D. Little in Zurich
  - Consultant with McKinsey in Frankfurt, Brussels and London
  - Various management positions in R&D and marketing with Bayer AG
- PhD and MA in chemistry, BA in business studies and MA in economics, Executive Master of Corporate Finance
- Co-founder and member of the advisory board of the Association for Chemistry & Economics
- Founding member and member of the executive council of the China Association for Management of Technology



**BUTALCO is supported by an advisory board with international experts in the field of biofuels and yeast technology**

### Current Advisory Board

#### **Helmut Lamp**

- Member of the German Parliament and Chairman of the Executive Committee of the German BioEnergy Association
- More information: [www.helmut-lamp.de](http://www.helmut-lamp.de), [www.bioenergie.de](http://www.bioenergie.de)



#### **Prof. Dr. Uwe Sauer**

- Professor at the Institute of Molecular Systems Biology at the Swiss Federal Institute of Technology Zurich
- More information: [www.imsb.ethz.ch/researchgroup/sauer](http://www.imsb.ethz.ch/researchgroup/sauer)



#### **Dr. Thomas Schlick**

- Managing Director, VDA Verband der Automobilindustrie
- More information: [www.vda.de](http://www.vda.de)

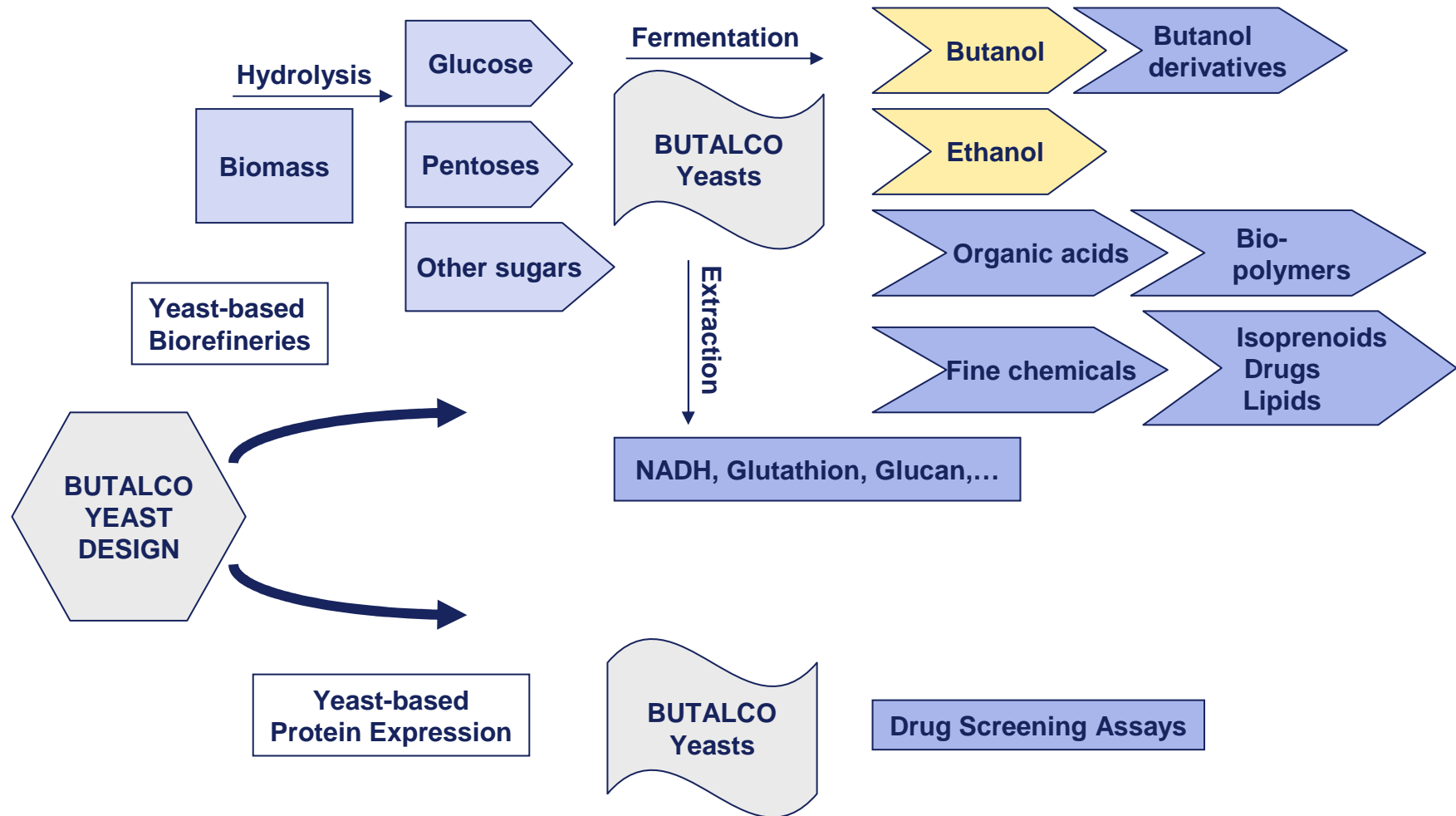


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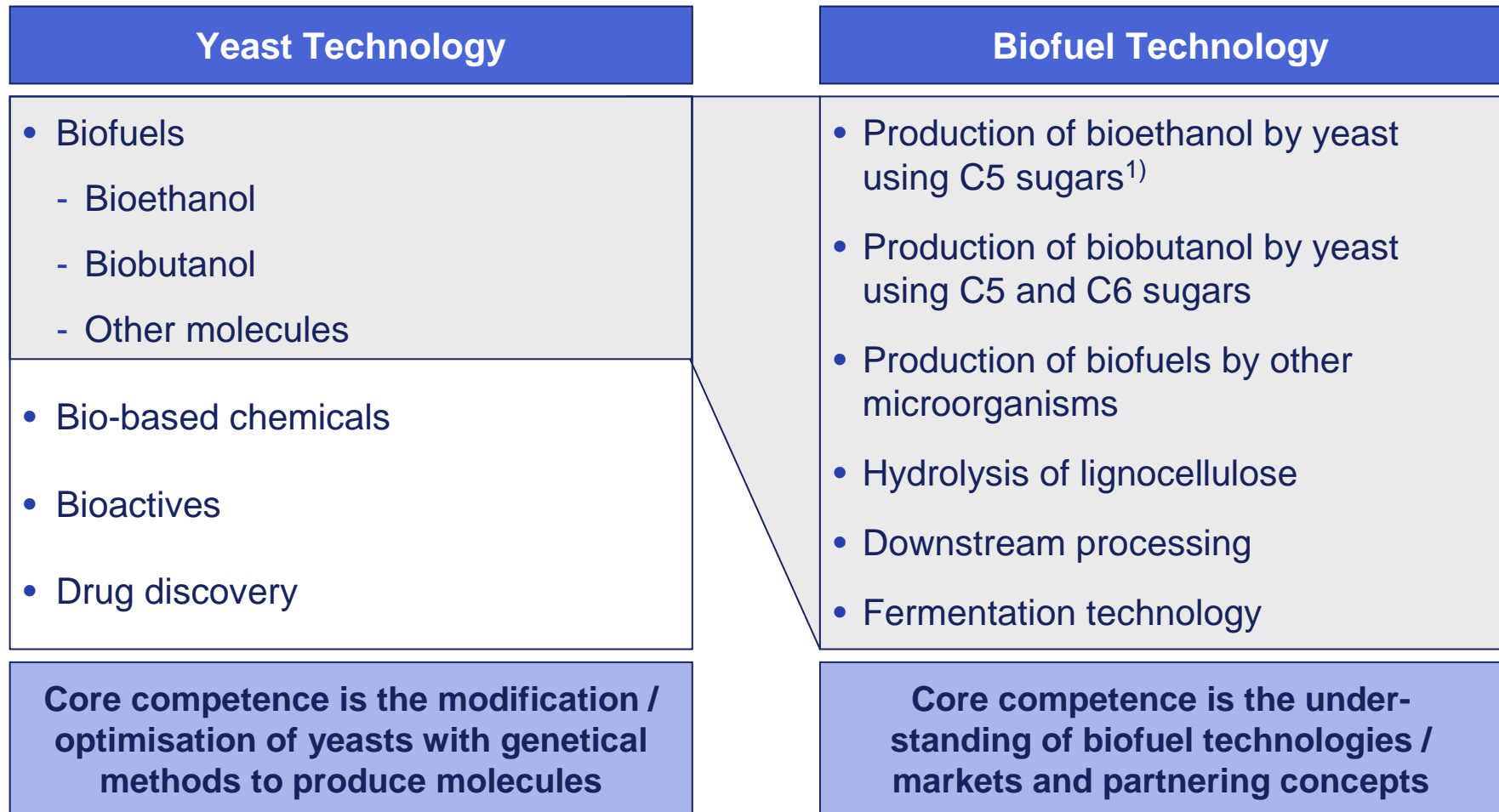
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The core competencies of BUTALCO are the optimisation of yeasts for the production of molecules and as a drug screening method



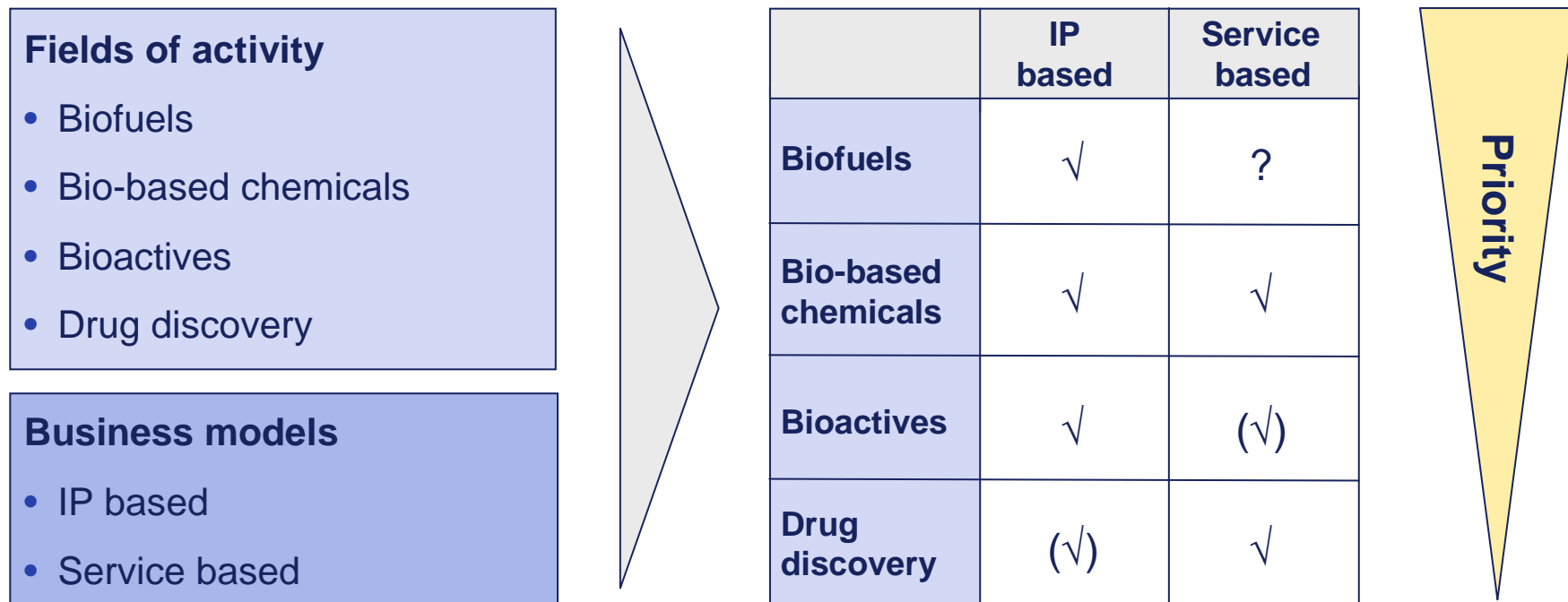
**BUTALCO's aim is to become a leading yeast and biofuel technology company in Europe**



1) The C5 sugars arabinose and xylose as well as other C5 sugars are products of the hydrolysis of lignocellulose

**The different areas will be entered into by a step-by-step approach setting biofuels with the highest priority**

- Intellectual property (IP) based business model: development of own technology / patent position and global out-licencing business
- Service based business model: service provider for established companies (fee-for-service)

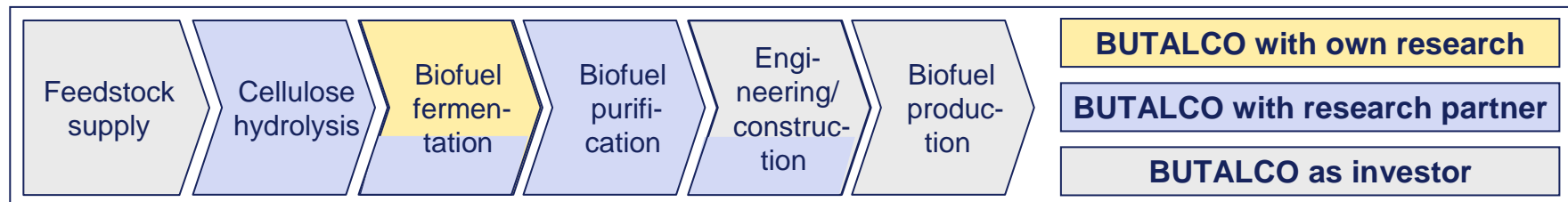
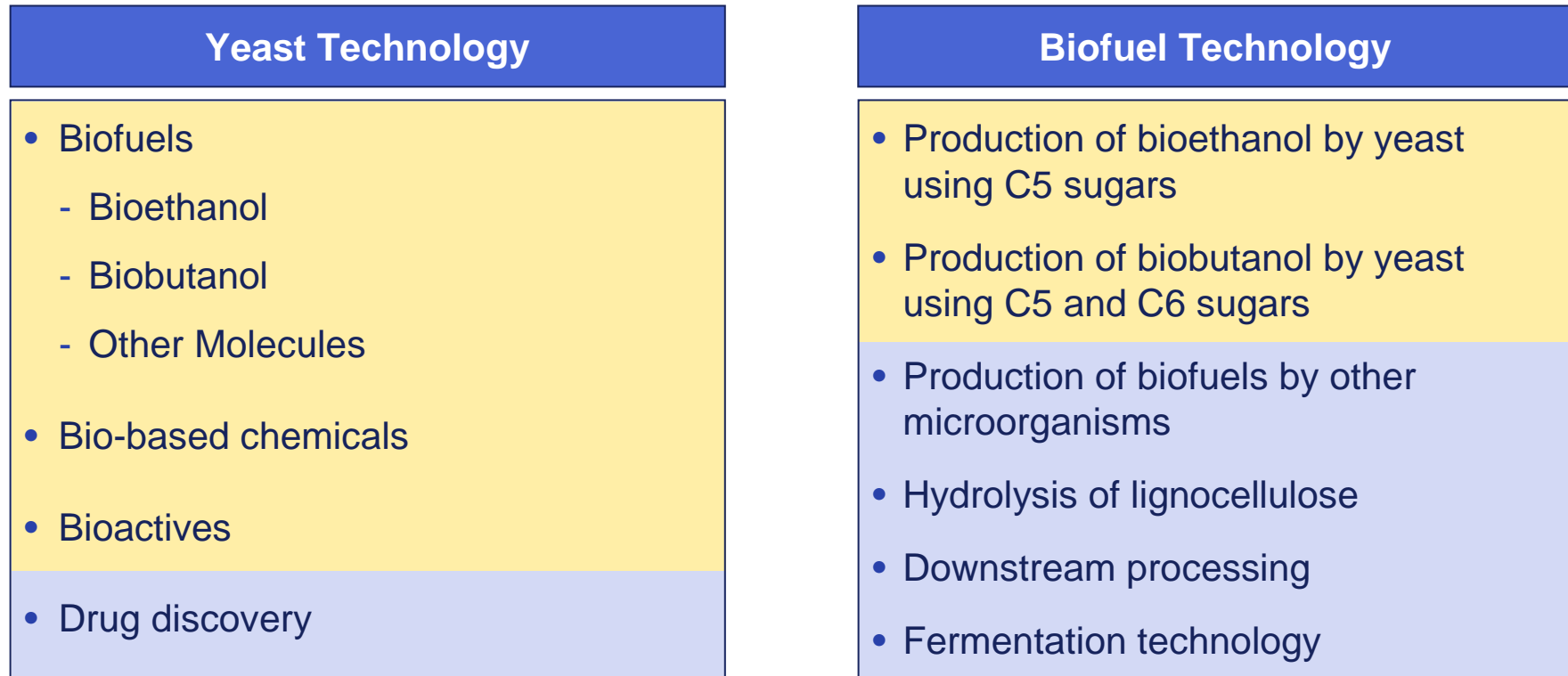


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**BUTALCO carries out own research in the core areas and will act as an investor in neighbouring areas**



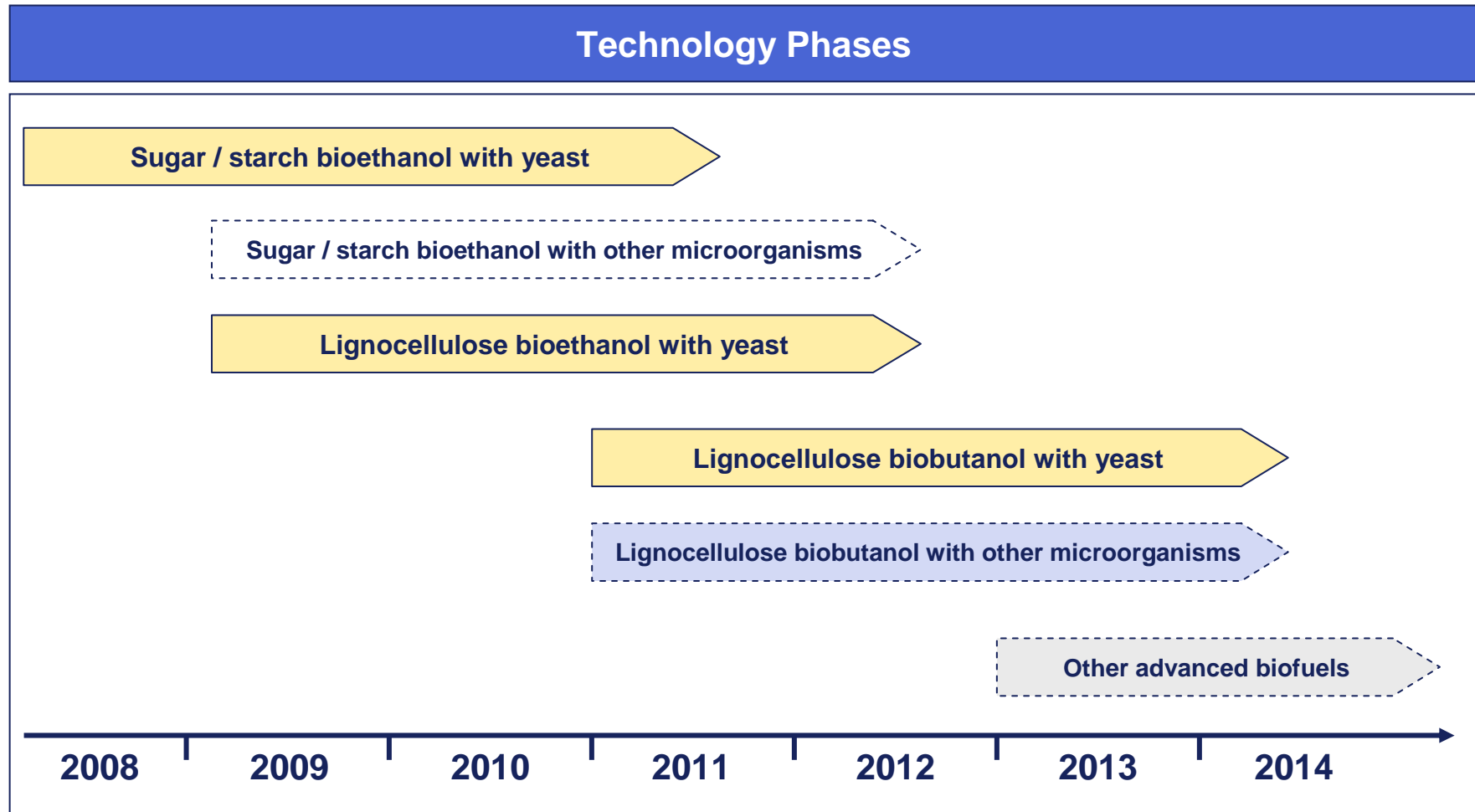
**Yeasts as production organisms for biobutanol and other products have decisive advantages compared to other microorganisms**

**Advantages of Yeast**

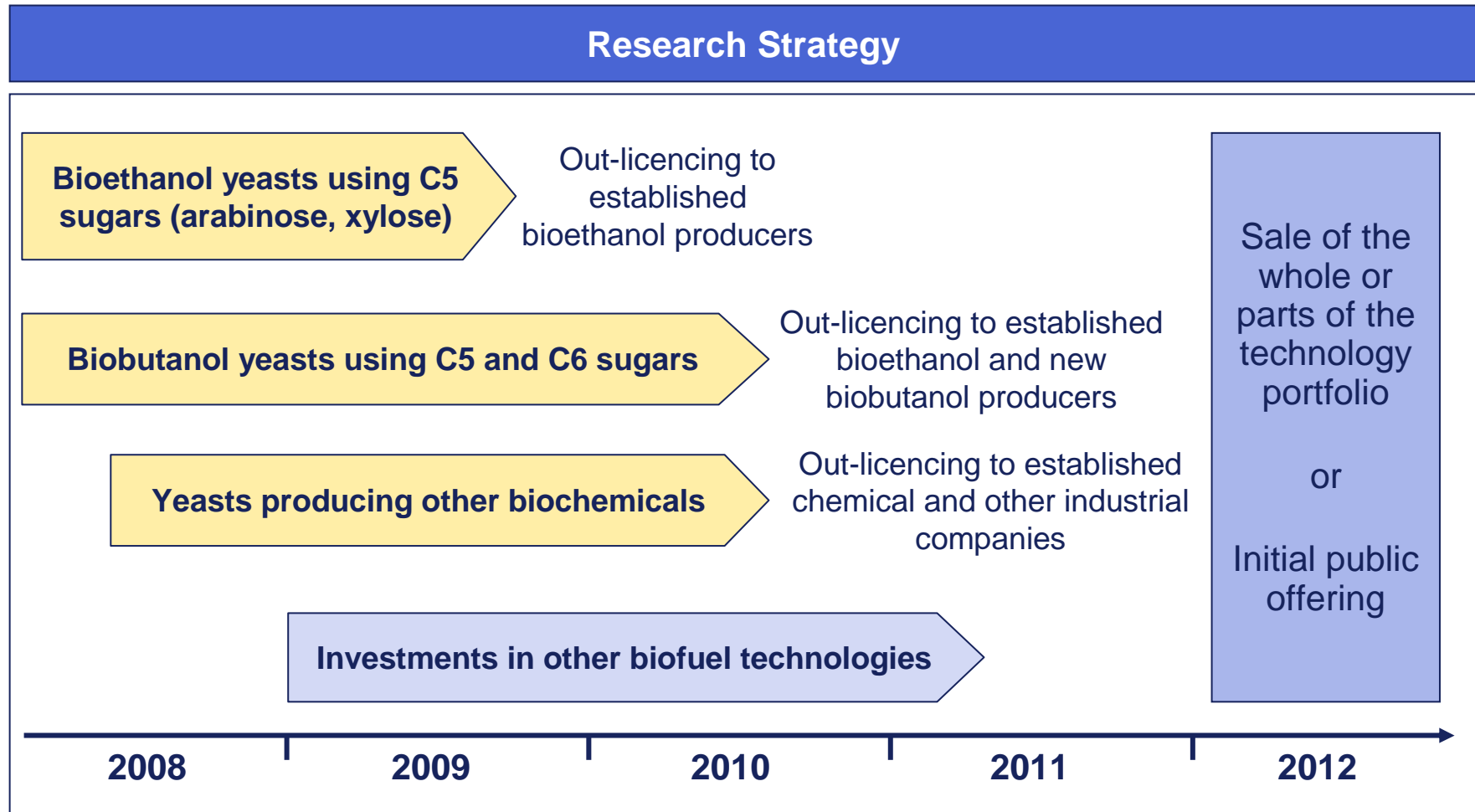
- Yeasts are among the best known microorganisms and are easy to genetically modify
- Yeasts have GRAS (Generally Recognized as Safe) status
- Yeasts are well established in production processes with a high robustness
- The production process is easier to control compared to other microorganisms
- All ethanol production facilities worldwide use yeasts and yeasts have a high acceptance among ethanol producers

**It is much more probable that the ethanol production plants in Brazil, Europe or North America will use yeasts rather than bacteria should they switch from ethanol to butanol**

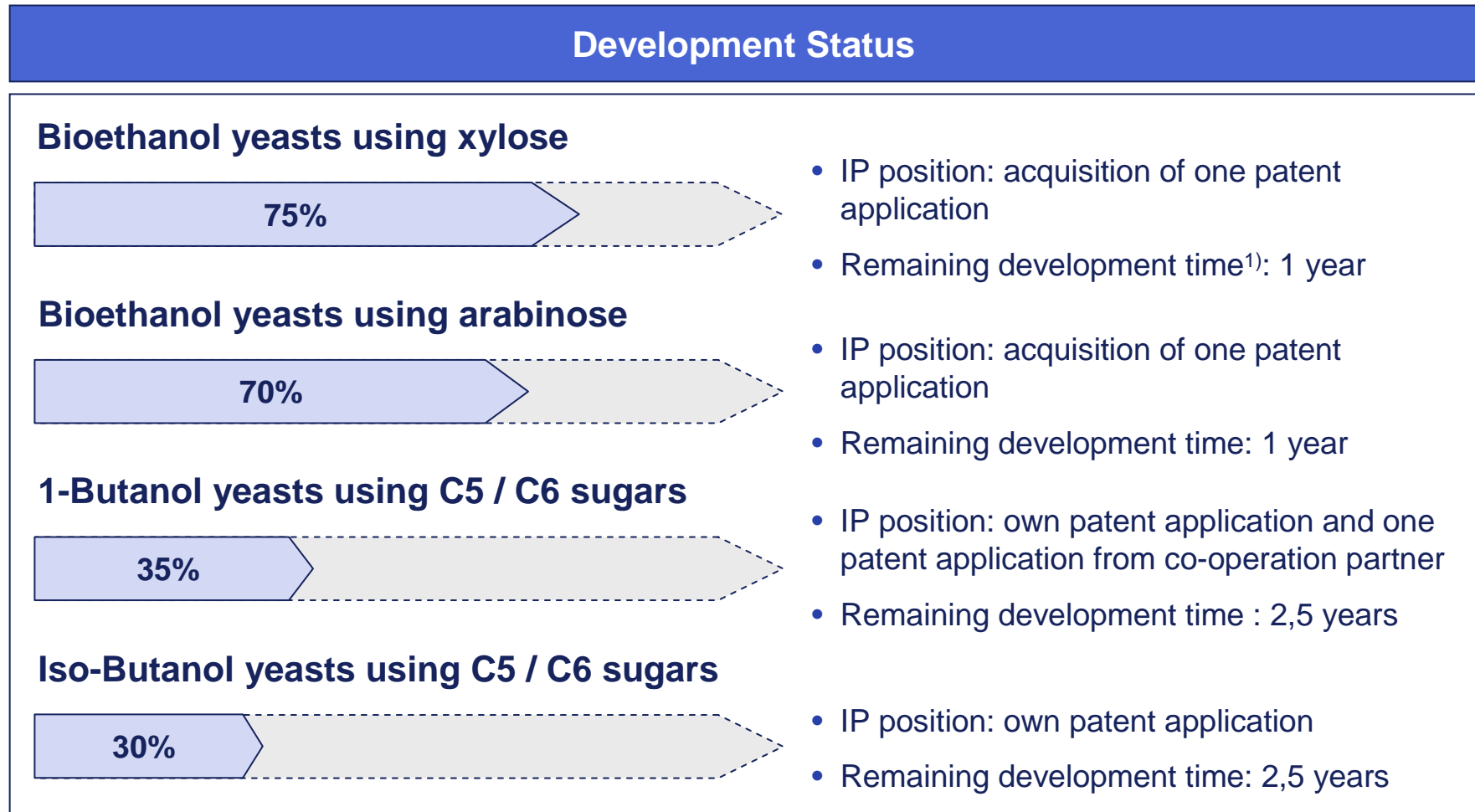
**Yeasts will most probably enable the technology switch to lignocellulose as feedstock and advanced biofuels like biobutanol**



**BUTALCO will generate first revenues by out-licencing its own technology by the end of 2009**



**BUTALCO has already a strong intellectual property (IP) position in its core technology areas**

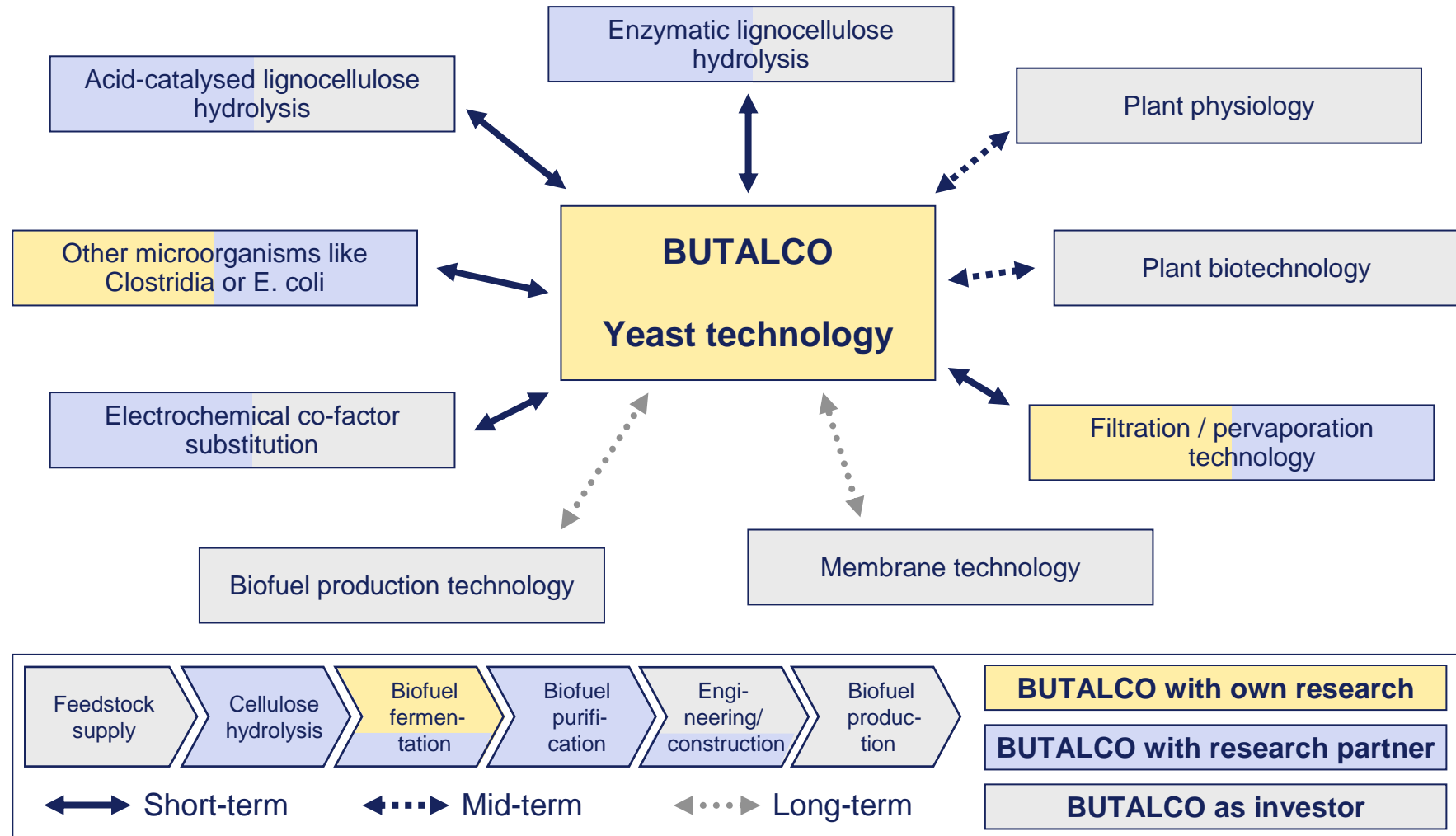


1) Remaining development time to achieve 100% (= IP ready to licence-out)

**BUTALCO has a clear strategy to develop own technologies with an own and independent intellectual property position**

Information only available after signing of a NDA

**BUTALCO is to develop technologies together with partners and to invest in other biofuel areas**

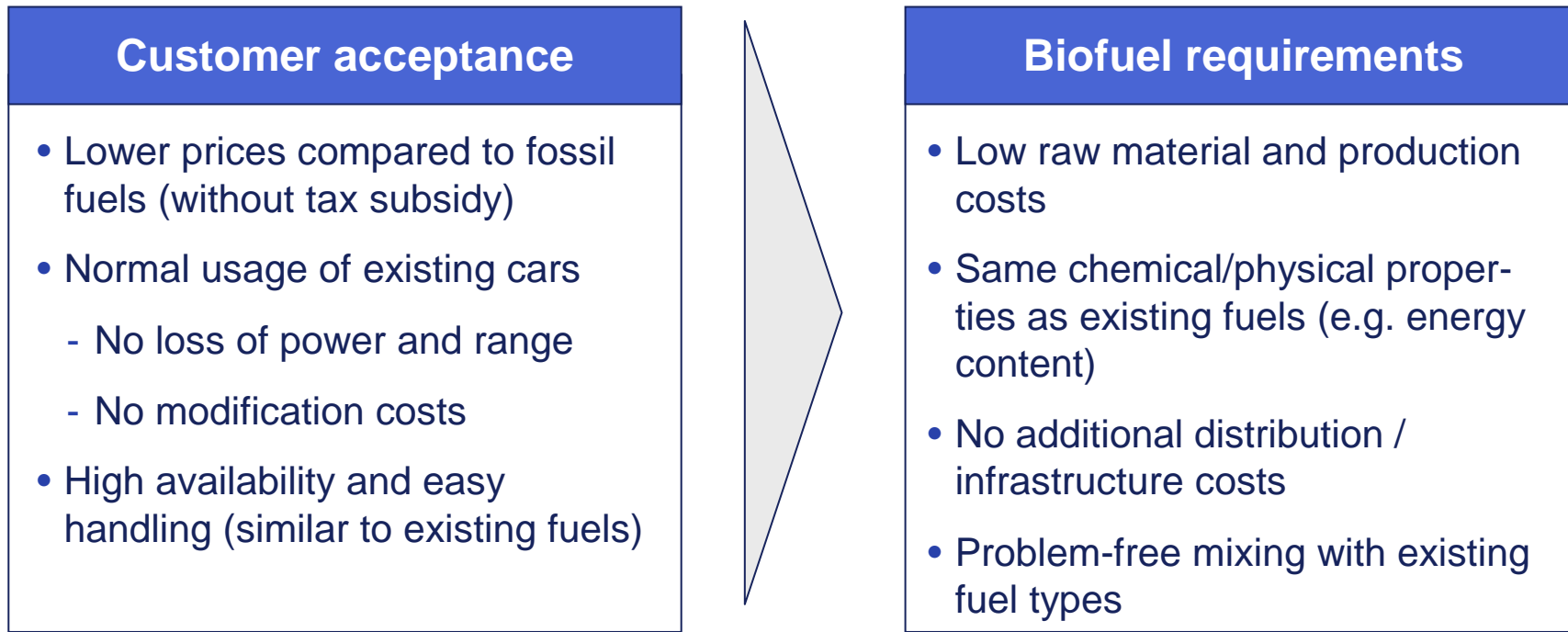


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**Fundamental aspects of customer acceptance will define the requirements for short- to mid-term biofuel usage**

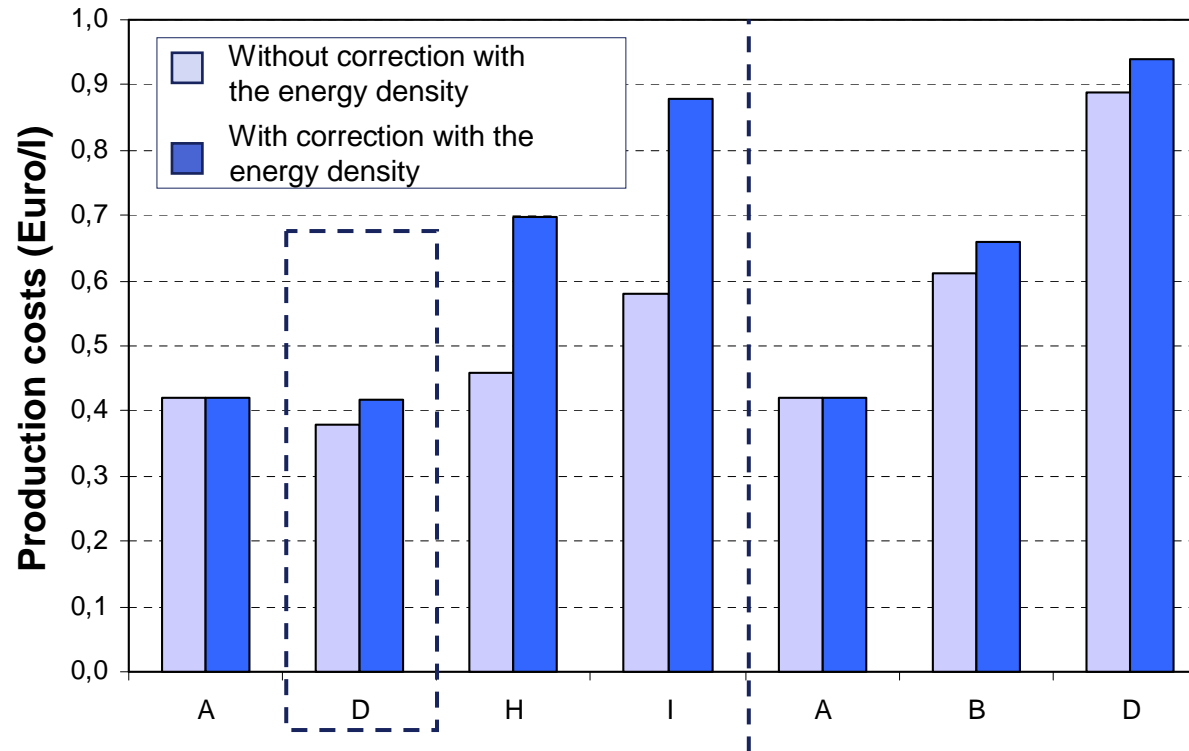


**Important are economical factors and not ecological aspects - the deciding factor for market success are the costs for the car owner at the filling stations**

**Butanol is being seen as a more superior alternative fuel than ethanol due to its more favourable chemical / physical properties**

- Butanol has clear advantages such as lower vapour pressure (butanol 5,6 hPa, ethanol 58,5 hPa) and higher flashpoint (butanol 36°C, ethanol 12°C - this is an advantage with regard to fire safety)
- Butanol is less miscible with water and far less corrosive so it can be shipped and distributed through existing infrastructure (pipelines and filling stations)
- Butanol can replace fossil fuels up to 100% without modifying the engine whereby ethanol can only be blended up to 85% and here modifications to the engine are required (FFV = Flexible Fuel Vehicle)
- Besides using butanol as a straight substitute for petrol, butanol can be blended with diesel or biodiesel and burned in diesel engines
- But, compared to ethanol, butanol has a lower octane rating / research octane number (butanol 96, ethanol 130) and a higher viscosity

**The most competitive biofuel type for the German market is European bio-butanol made from straw**



A: Petrol (crude oil, 60 USD/barrel)

D: Biobutanol (lignocellulose, Europe, Large scale 2008)

H: Bioethanol (straw, Europe, Large scale 2008)

I: Bioethanol (corn, Europe, Large scale 2006)

A: Diesel (crude oil, 60 USD/Barrel)

B: Biodiesel (rape seed, Europe, Large scale 2006)

D: BTL (wood, Europe, Large scale 2012)

Source: FESTEL CAPITAL analysis 2006