



Economic Potentials and Market Strategies in the Field of Industrial (White) Biotechnology

Business Models & Growth / Financing Strategies

Workshop "White Biotechnology"

University of Potsdam

Potsdam, July 6, 2006

FESTEL
CAPITAL
Creating a Better
Future

FESTEL CAPITAL

- FESTEL CAPITAL is an advisory and investment firm focusing on the **commercialisation of technologies** and **optimisation of organisations** in the areas of energy, environment, health, infrastructures, materials and nutrition
- FESTEL CAPITAL supports **start-ups and spin-offs** from business planning over transactions up to business optimisation
- FESTEL CAPITAL **invests in selected companies** and supports companies based on **equity participation**
- FESTEL CAPITAL has special expertise and experience in business development and partnering in **China**

- **For queries, please contact**

Dr. Gunter Festel

Schuermattstr. 1, CH-6331 Huenenberg/Zug

E-Mail gunter.festel@festel.com

Internet www.festel.com

Phone/Fax +41 41 780 1643

Mobile Switzerland +41 79 6527 112

Mobile Germany +49 177 356 1837

Mobile China +86 1350 1880 189

Copyright and Disclaimer

Copyright

- All rights for the use of all or parts of the information in this document, including reprinting the whole document or parts thereof, the storage in databanks and translations remain with FESTEL CAPITAL
- Individual charts can be reproduced stating FESTEL CAPITAL as source; please contact FESTEL CAPITAL, should you wish to reproduce larger parts of this document

Disclaimer

- FESTEL CAPITAL has prepared this document to the best of FESTEL CAPITAL's knowledge and belief based on all available information
- FESTEL CAPITAL takes no warranty for the accuracy and completeness of this information
- Before deducting individual conclusions, it is necessary to obtain additional data and conduct further analyses
- Therefore, all liability for costs or damage resulting from information and conclusions in this document is excluded

Abbreviations

Abbreviations

- CVC Corporate Venture Capital
- IP Intellectual Property
- IPO Initial Public Offering
- M&A Mergers & Acquisitions
- R&D Research & Development
- VC Venture Capital

FESTEL CAPITAL investigated the impact of industrial biotechnology on industrial production processes in 2003

Participants

- AC Biotech
- Bayer
- BRAIN
- Celanese
- Ciba SC
- Cognis
- Dechema/Verbundprojekt Biokatalyse
- Degussa/Projekthaus Biotechnologie
- DSM
- DSM Biotech
- Jülich Enzyme Products
- Jülich Fine Chemicals
- Lonza Group
- Merck
- Roche Diagnostics
- Schirmer Consulting
- Solvias
- X-Zyme

Marktstudie zum Einfluss der Biotechnologie auf industrielle Produktionsverfahren

Interviewergebnisse, Schlussfolgerungen und Fazit

Ergebnispräsentation

Autoren: Gunter Festel und Jürgen Knöll

Hünenberg, 18. November 2003

FESTEL
CAPITAL
Innovations in Chemicals
and Lifesciences

Languages: German (Long Version) / English (Short Version)

FESTEL CAPITAL investigated financing strategies in industrial biotechnology in 2005

Participants

- AC Biotech
- Artes Biotechnology
- ATG Biosynthetics
- Biospring
- Brain
- Enzis
- Jülich Enzyme Products
- Jülich Fine Chemicals
- Prokaria
- Solvias
- Two unidentified start-ups



Market Study on Financing Strategies in White Biotechnology

Interview Results, Conclusions and Outlook

Presentation of Results

Authors: Gunter Festel and Andreas Heft

Huenenberg, April 25, 2005

FESTEL
CAPITAL
Innovations in Chemicals
and Lifesciences

© FESTEL CAPITAL, CH-6331 Huenenberg, 2005

More information: www.festel.com

Languages: only English

Market Study 2005

FESTEL CAPITAL investigated the potential of renewable resources with focus on biopolymers and biolubricants in 2005

Participants

- Bayer
- BayWa
- Biomer
- Biop
- Biotec
- Cerestar
- Cognis
- FBAW
- FKUR Kunststoff
- FNR
- Fraunhofer UMSICHT
- Fuchs
- Galactic
- Hycail BV
- IBAW
- IFAS Aachen
- Innovia Films
- INTERSEROH
- Lehmann & Voss
- NNZ
- Nordzucker
- Novamont
- Pacovis
- Panolin
- Petroplast Vinora
- Pfeifer & Langen
- Plantic
- Procter & Gamble
- Rheinchemie
- Roquette
- Schill & Seilacher
- Süd-Chemie
- Südzucker
- Total
- Treofan
- Wentus

Marktstudie zu den Potentialen nachwachsender Rohstoffe

Stärkehydrolyse, Biopolymere und Bioschmierstoffe

Ergebnispräsentation

Autoren: Gunter Festel und Sarai Kölle

Hünenberg, 15. Juli 2005

FESTEL
CAPITAL
 Innovations in Chemicals
 and Lifesciences

© FESTEL CAPITAL, CH-6331 Hünenberg, 2005

Weitere Informationen unter www.festel.com

Languages: German (Long Version) / English (Short Version)

Contents

1	Impact of Industrial Biotechnology
2	Applications and Market Potentials
3	Business Models and Growth Strategies
4	Financing Strategies and Sources
5	Conclusion and Outlook
A	Appendix: Information on FESTEL CAPITAL

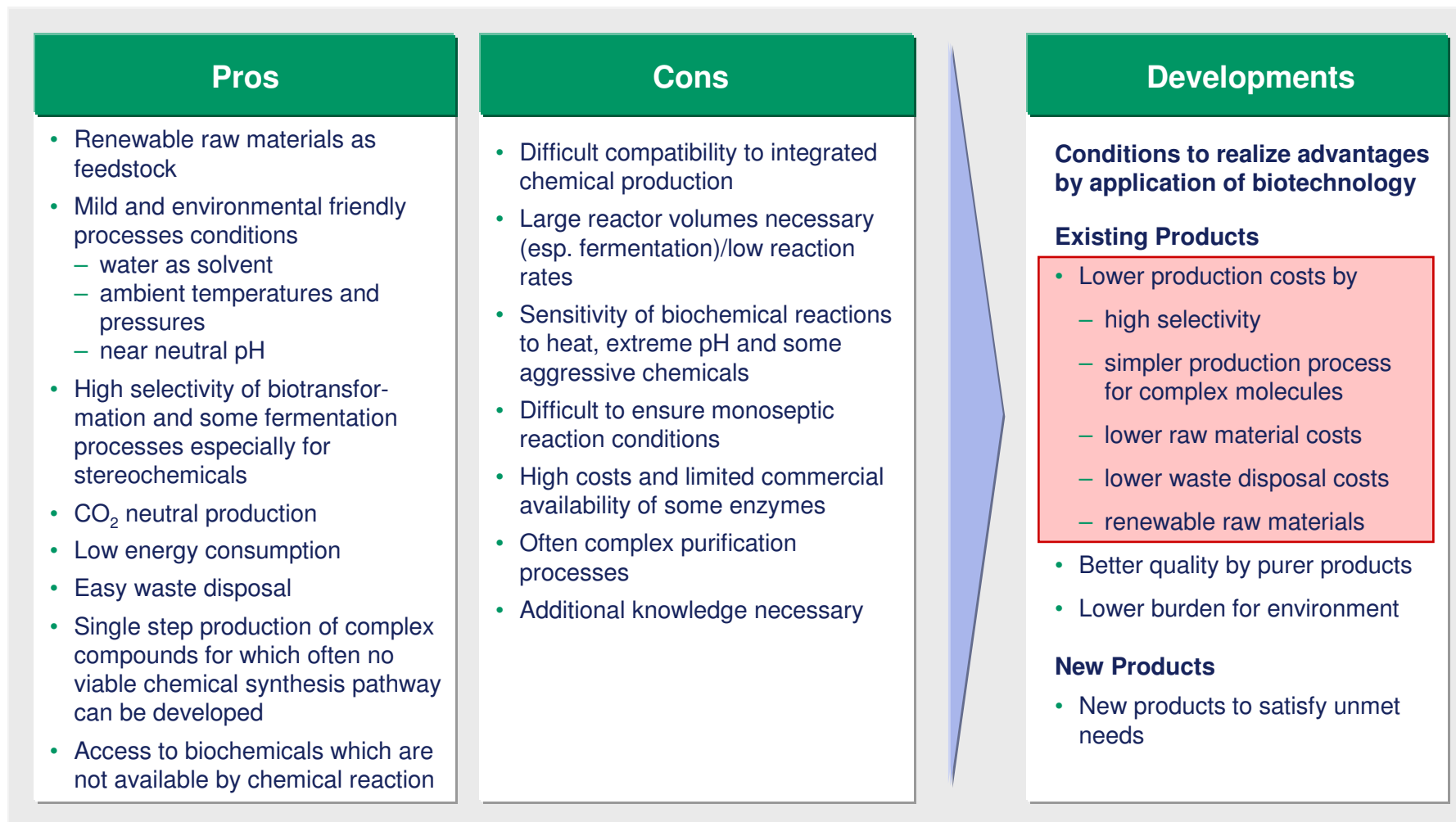
Impact of Industrial Biotechnology - Importance

Industrial biotechnology has already a strong impact which is expected to grow during the next years

- **Industrial biotech** is an emerging field within modern biotechnology that uses living cells like moulds, yeasts or bacteria and enzymes
- A **large number of products** are already being manufactured using biotech processes (e.g. bulk chemicals, enzymes and vitamins)
- The **impact** of industrial biotech is strong and can be recognized on different levels
 - Cost effectiveness through new processes
 - Quality improvements through better products
 - Growth through innovative products (e.g. availability of new biotech products which cannot be produced by traditional processes)
- **Established companies** are very active in this field and the impact of industrial biotech on the chemical/lifescience industry will continue to grow
- **Start-ups** in the field of industrial biotech are expected to significantly contribute to that development

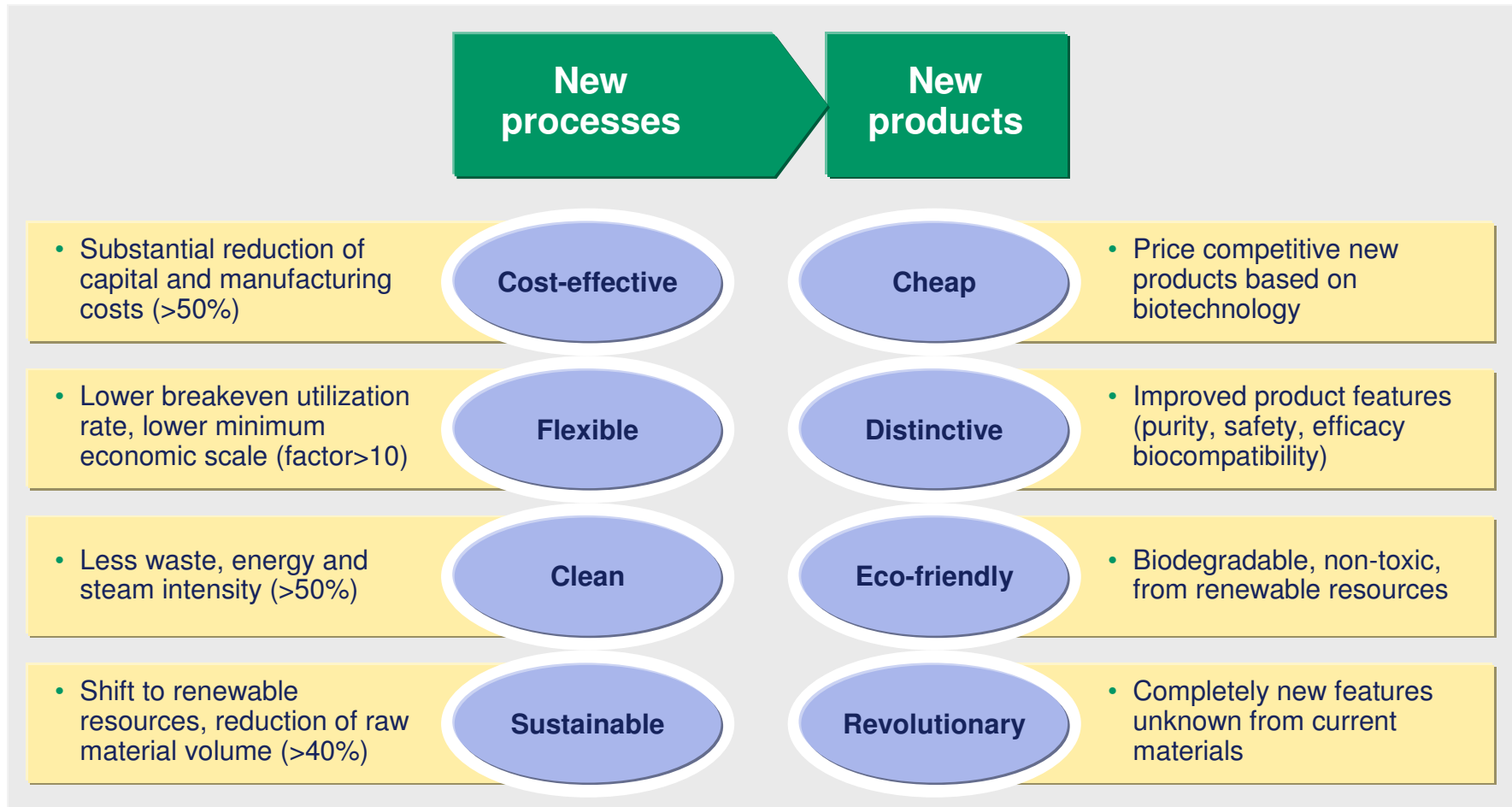
Impact of Industrial Biotechnology - Advantages

There are advantages regarding existing and new products by application of industrial biotechnology



Impact of Industrial Biotechnology - Advantages

Biotechnology is economically attractive through the introduction of new processes and the development of new products



Biotransformation, fermentation and transgene plants/animals are of economic importance

Process	Characterisation
Biotransformation - enzyme catalysis	<ul style="list-style-type: none"> Transformation of a substrate by stereospecific catalysis of a specific reaction via isolated enzymes The substrates do not have to be natural and the products are usually not natural products
Biotransformation - whole-cell bioconversion	<ul style="list-style-type: none"> Transformation of a substrate through a series of stereospecific enzymatic reactions in microorganisms or living cells These reactions are not part of the normal cell metabolism (the cells do not grow) An advantage towards enzyme catalysis is the in-situ cofactor regeneration
Fermentation – microorganisms	<ul style="list-style-type: none"> Microorganisms (bacteria, fungi, yeasts) produce simple to complex molecules as metabolic products from cheap C- and N-sources (no defined substrates) The products are natural materials
Fermentation by animal/plant cell cultures	<ul style="list-style-type: none"> Plant cells or more frequently mammal cells produce complex biomolecules (proteins) that are not accessible by microbial fermentation Especially suitable for the production of highly complicated or modified biomolecules (biopharmaceuticals)
Transgene plants/animals	<ul style="list-style-type: none"> Genetically modified plants or animals produce high-value compounds, which are available after extraction

Fermentation and enzyme catalysis are the most interesting biotechnological production processes

- **Fermentation** of microorganisms and **enzyme catalysis** are the most important processes in industrial biotechnology at the moment
 - The **fermentation** has the advantage of proceeding in one step and leads relatively simply to the intended product; the disadvantage is that a high dilution is necessary
 - In the **enzyme catalysis** concentrations of up to 50% can be used; however, a single enzyme catalytical step does not always lead to the intended product, so that reactions in several steps are necessary
- **Enzyme catalysis** (cell-free biotransformation) will replace fermentation to a large extent in coming years
- **Transgene plants and animals** will not play an important role for the production of chemical products in the next ten years

The different biotechnological processes have specific advantages and disadvantages

Process	Advantages	Disadvantages
Biotransformation - enzyme catalysis	<ul style="list-style-type: none"> • One single reaction product, no contaminants • Relatively simple process optimization • Immobilized enzymes can be re-used • Reaction at low temperature, in aqueous media prohibit racemation and side-products • Environmentally friendly process, uses renewable resources 	<ul style="list-style-type: none"> • Not all traditional reactions can be substituted (e.g. Diels-Alder reaction) • Redox reactions require cofactor recycling process • Price of reagent (enzyme) may be prohibitive • Significant R&D effort may be needed to select the enzymes and reaction process
Biotransformation - whole-cell bioconversion	<ul style="list-style-type: none"> • Allows redox reactions without cofactor recycling • immobilized cells can be re-used 	<ul style="list-style-type: none"> • Requires culture and immobilization of cells • May yield several reaction products • Possible complex down-stream processing
Fermentation by microorganisms	<ul style="list-style-type: none"> • Allows direct (single step) production of complex compounds 	<ul style="list-style-type: none"> • Isolation, characterization and process optimization of new strains requires considerable R&D effort • Process requires investment in fermentation capacity • Possible complex down-stream processing
Fermentation by animal/plant cell cultures	<ul style="list-style-type: none"> • Allows direct (single step) production of complex compounds for which often no viable chemical synthesis pathway can be developed (e.g. sugar- and lipid-modified molecules and proteins) 	<ul style="list-style-type: none"> • Isolation, characterization and process optimization of new strains requires considerable R&D effort • Process requires investment in highly advanced fermentation capacity
Transgene plants/animals	<ul style="list-style-type: none"> • Allows direct production of complex compounds by agricultural means • Allows production of new natural compounds • Allows production at sites previously unsuited for harvesting 	<ul style="list-style-type: none"> • Requires considerable R&D effort, not possible for all products and species • Process requires investment in highly advanced genetic engineering and product testing capabilities

The production costs are a decisive driving force for the change towards biotechnological production processes

- The decisive driving force for the change towards biotechnological production processes is clearly the **cost factor** - other factors play almost no role
- The goal is to reach **production cost savings** by process simplifications and savings in the raw, side and waste products
 - The replacement of several chemical steps by a single **biocatalytical step**
 - The products from biotechnological production are frequently more pure, so that only simple **purification** is needed
 - Further reasons are sustainability and supply with **cheap raw materials**
 - Biotechnological processes use lower temperatures and pressures, so that the **risk potential** is reduced
- In some segments (e.g. food and cosmetic industry) biotechnologically produced products are easier to sell due to higher **customer acceptance**

Certain restrictions have to be considered for biotechnological production processes

- The restrictions of biotechnological production processes are predominantly viewed on the side of **economics** (operative costs, R&D costs, investments)
 - The synthesis of simple molecules by chemical synthesis is usually so inexpensive, that the development of a **new biotechnological production process** is normally not economical
 - The development of a suitable **biocatalyst** is very costly and time intensive and therefore the enzyme catalysis is not economical especially for niche products
 - Production facilities for chemical synthesis already exist; these cannot be changed for biotechnological production, so that massive **new investments** are necessary
- In **developing countries** industrial biotechnology has very good growth prospects, as biotech processes do not have to compete with established processes in existing production facilities

One key aspect of feedstock supply for biotech processes is the conversion of starch into sugar products with the help of enzymatic processes

- With regard to its volume, the **starch hydrolysis** (saccharification of sugar) is the largest enzymatic process
- Enzyme hydrolyzed starches are used in the **food industry** and as **feedstock** for the production of e.g. ethanol, polyols, cyclodextrins, ascorbic acid, enzymes, sodium glutamate, lysin and penicilin
- Basic resources for the starch hydrolysis are in most cases **corn and wheat**, whereas both processes differ substantially
- For the selection of the **raw material** criteria such as availability, price, technological suitability, profitability of the extraction process as well as the price of the by-products are crucial
- The demand for starch hydrolysis will increase, as **new technologies** (e.g. bioethanol production) require the starch hydrolysis as an intermediate step

By increasing the profitability of the hydrolysis processes, the importance of cellulose hydrolysates could increase in the future

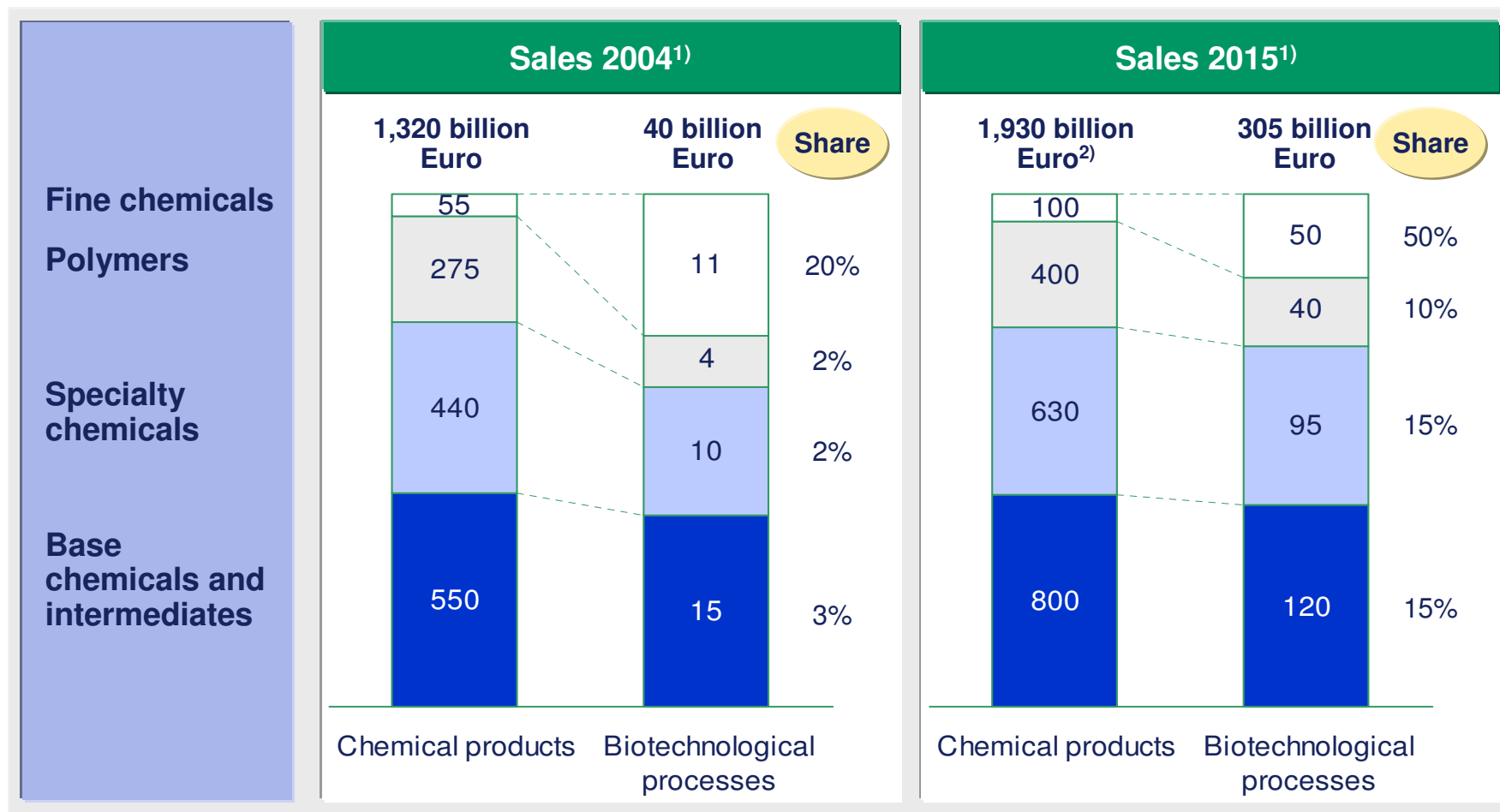
- Within the scope of a research project requested by the US Department of Energy, **Genencor and Novozymes** have reduced the costs of enzymes twelvefold
- Currently, research on **thermostable cellulases** with increased product and substrate tolerance is being carried out; aim is to achieve a higher reaction rate, a lower microbial contamination, longer application time, easier cleaning and higher production yields
- The cellulose hydrolysis does not only offer the possibility of producing **bioethanol**, but also to manufacture biopolymers or commodities
- The extraction of sugar out of cellulose for a usage in the **food industry** does not seem possible at the moment as the sugar extracts are of minor pureness
- In the future, **cellulose hydrolysates** could play a very important role should production costs be lowered significantly and the production yields increase

Contents

1	Impact of Industrial Biotechnology
2	Applications and Market Potentials
3	Business Models and Growth Strategies
4	Financing Strategies and Sources
5	Conclusion and Outlook
A	Appendix: Information on FESTEL CAPITAL

Applications and Market Potentials - Overview

In the year 2015 about 15% of the chemical products with a sales volume of approx. 300 billion Euro will be produced using biotechnology



1) Global chemical sales without pharma products but including pharma intermediates (source: CEFIC)

2) Calculation with an average growth rate of global chemical sales of 3,5% p.a.

Applications and Market Potentials - Overview

The largest potential lies in the production of agents and performance chemicals in the fine and specialty chemicals sectors

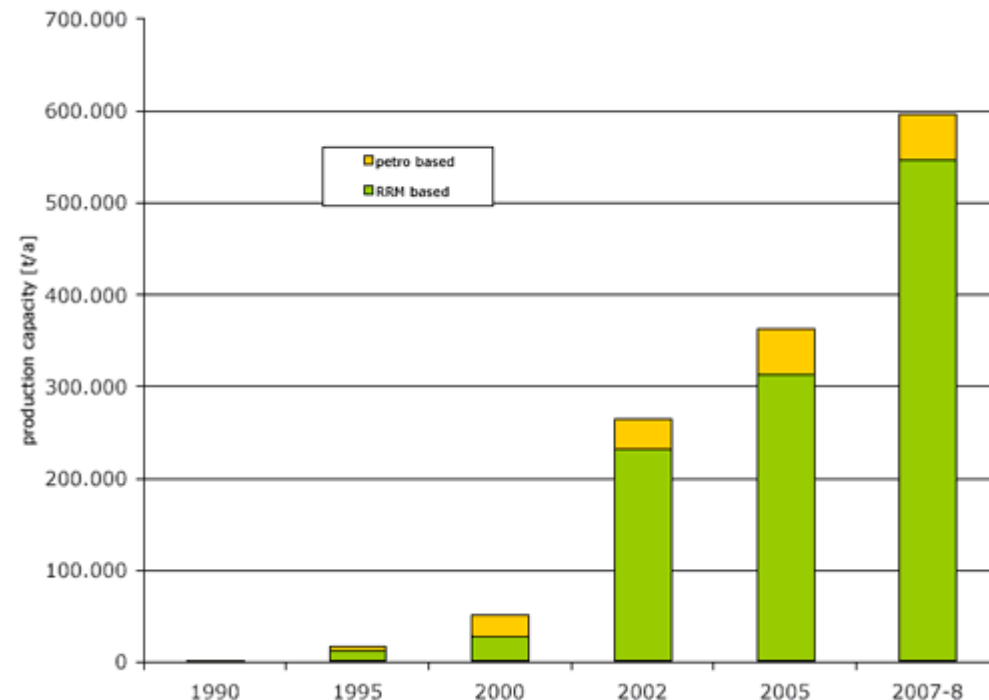
Chemical Sector	2010 Biotechnologically Produced	Trends
Fine Chemicals	~ 50%	<ul style="list-style-type: none"> • Trend towards chiral pharmaceutical agents • Often simplified synthesis paths • Many reaction types can be catalysed by enzymes (oxidation, reduction, carbon-carbon bond formation) • Only through biotechnological process accessible products
Polymers	~ 10%	<ul style="list-style-type: none"> • Stronger use of renewable raw materials • Polymers with new properties • Biopolymers cost competitive to polyesters
Specialty Chemicals	~ 15%	<ul style="list-style-type: none"> • Strong growth in industrial enzymes • Advantages especially in the food, cosmetic, textile and leather industries
Base Chemicals and intermediates	~ 15%	<ul style="list-style-type: none"> • Stronger use of renewable raw materials • Production of organic chemicals through biocatalysis and fermentation

Applications and Market Potentials - Polymers

The growth of the production capacity clearly shows, that biopolymers are emerging from a niche market application to mass production scale

- At the beginning of the 90's first pilot plants for biopolymers were built and after a process of upscaling, biopolymer products are now in a **market launch phase**
- The **European consumption** increased from about 20,000 tons in 2001 to 50,000 tons in 2004
- During the last 10 years, the **quality** of biopolymers has improved significantly
- **Technical properties** that were not previously available now exist

Development of the worldwide production capacity of biodegradable polymers



Source: IBAW

Applications and Market Potentials - Polymers

Today, there are numerous types of biopolymers based on different raw materials

Polymer	Enterprises (<i>brand name</i>)	Production capacity (t /year)
Starch polymers	<ul style="list-style-type: none"> • Biop (<i>Biopar</i>) • Novamont (<i>Mater-Bi</i>) • Plantic • Rodenburg Biopolymers (<i>Solanyl</i>) 	<ul style="list-style-type: none"> • 35,000¹⁾; further 15,000 - 20,000 by 2006 • Several thousand tons • 47,000
Poly lactide acid	<ul style="list-style-type: none"> • NatureWorks (<i>NatureWorks</i>) • Galactic • Hycail BV (<i>Hycail</i>) 	<ul style="list-style-type: none"> • 140,000 • Still in pilot phase (several tons p.a.) • 1,000
Polyhydroxyalkanoates	<ul style="list-style-type: none"> • Biomer (<i>Biomer</i>) • Procter & Gamble (<i>Nodax</i>) 	<ul style="list-style-type: none"> • Several tons per month • Still in pilot phase
Polymers based on bio-based 1,3-propanediol	<ul style="list-style-type: none"> • DuPont (<i>Sorona</i>) 	<ul style="list-style-type: none"> • Still in pilot phase
Cellulose polymers	<ul style="list-style-type: none"> • Innovia Films (<i>Natureflex</i>) 	
Blends	<ul style="list-style-type: none"> • Biotec (<i>Bioplast</i>) • FKUR Kunststoff GmbH • Novamont (<i>Mater-Bi</i>) 	<ul style="list-style-type: none"> • 10,000 • 3,500 • 35,000¹⁾; further 15,000 - 20,000 by 2006

1) Starch hydrolysis, polymers based on vegetable oils and blends

In vielen Bereichen der Spezialitätenchemie werden biotechnologische Verfahren zunehmende Bedeutung erlangen (1/5)

Marktsegment	Zeithorizont/Grad der Auswirkung	Vorteile Biotechnologie / Hindernisse	Stand / Potentialbeispiele
Antioxidantien	Kurzfristig/ starke Auswirkung	<ul style="list-style-type: none"> + Möglichkeit organische Materialien direkt durch Oxidation-Reduktion zu produzieren + EHS-Auflagen + Natürliche Produkte - Chemische Synthese meist billiger 	<ul style="list-style-type: none"> • Organische Antioxidantien in Nahrungs- und Futteranwendungen • Gesteigerte Beta-Karotin Leistung • Organische Antioxidantien in Nicht-Nahrungsanwendungen
Nahrungsmittel-zusätze	Kurzfristig/ starke Auswirkung	<ul style="list-style-type: none"> + Höhere Ausbeute und bessere Nahrungsmiteleigenschaften durch hochreine Kulturen + Trends zur Reduktion von Pestiziden 	<ul style="list-style-type: none"> • Aminosäuren (z.B. MSG), Mais-basierte Süsstoffe, Käse, Bier; PUFAs
Detergenzien	Kurzfristig/ starke Auswirkung	<ul style="list-style-type: none"> + Umweltgesetze erfordern umweltverträgliche Produkte (z.B. Verbot von Phosphaten) + Sehr spezielle Funktionalität erforderlich, um bestimmte Proteine abzubauen 	<ul style="list-style-type: none"> • Lipasen, Carbohydrasen (Carbohydrate), und Proteasen (Blut) • Tenside mit hervorragender biologischer Abbaubarkeit zugänglich durch Fermentation oder Enzymtechnologie
Elektronik-materialien	Langfristig/ niedrige Auswirkung	<ul style="list-style-type: none"> + Notwendigkeit ultrareiner Chemikalien könnte von biotechnologischer Selektivität profitieren 	<ul style="list-style-type: none"> • Biochips aus Proteinem mit bessere Performance als Siliciumchips

In vielen Bereichen der Spezialitätenchemie werden biotechnologische Verfahren zunehmende Bedeutung erlangen (2/5)

Marktsegment	Zeithorizont/Grad der Auswirkung	Vorteile Biotechnologie / Hindernisse	Stand / Potentialbeispiele
Farbstoffe und Pigmente	Kurzfristig/ niedrige Auswirkung	<ul style="list-style-type: none"> + Komplexe, organische Moleküle anwendbar in der Biotechnologie - Viele Farbstoffe niedermolekular - Viele Pigmente nicht UV-stabil - Wirtschaftlichkeit 	<ul style="list-style-type: none"> • Astaxanthin (Pigment) • Modifizierte Extrakte (z.B. Indigo als Farbstoff)
Feinchemikalien	Kurzfristig/ starke Auswirkung	<ul style="list-style-type: none"> + Anwendungen mit hoher Wertschöpfung - Notwendigkeit für GRAS (generally recognized as safe) Produktion 	<ul style="list-style-type: none"> • Pest-resistente Pflanzen • Insulin und Wachstumshormon • Gentherapie • Antibiotika • Aktive Inhaltsstoffe
Flammschutzmittel	Langfristig/ niedrige Auswirkung	<ul style="list-style-type: none"> + Umweltauflagen werden mit gegenwärtigen Produkten erfüllt (Bioabbaubarkeit) - Niedrigere Wertschöpfung der Produkte 	
Funktionelle Flüssigkeiten	Langfristig/ niedrige Auswirkung	<ul style="list-style-type: none"> - Wenige Anwendungen 	<ul style="list-style-type: none"> • Pflanzenbasierte Extrakte und Biopolymere als Basis für funktionale Flüssigkeiten

In vielen Bereichen der Spezialitätenchemie werden biotechnologische Verfahren zunehmende Bedeutung erlangen (3/5)

Marktsegment	Zeithorizont/Grad der Auswirkung	Vorteile Biotechnologie / Hindernisse	Stand / Potentialbeispiele
Geschmack- und Duftstoffe	Kurzfristig/ starke Auswirkung	+ Vermarktung natürlicher Verbindungen mit verbesserten Eigenschaften - Formulierungs-Know-how muss zunehmen	<ul style="list-style-type: none"> • Geschmackstoffe (z.B. pflanzliche Produkte, die nach Fleisch schmecken) • Bioengineering von Geschmacks- und Duftstoffen
Kunststoff-Additive	Langfristig/ starke Auswirkung	+ Notwendigkeit biologisch abbaubarer Kunststoffe - Nur bei hoher Wertschöpfung wirtschaftlich	<ul style="list-style-type: none"> • Biologisch abbaubare Kunststoffe (z.B. Verwendung von Stärke oder Zellulose) • Polyester-Kunststoff-Produktion durch Pflanzen
Ölfeldchemikalien	Kurzfristig/ starke Auswirkung	+ Getrieben durch Umweltauflagen - Wirtschaftlichkeit existierender Technologien stark abhängig vom Ölpreis	<ul style="list-style-type: none"> • Modifiziertes niedermolekulares Xanthan als Verdickungsmittel
Papier und Zellstoff	Kurzfristig/ starke Auswirkung	+ Getrieben durch Umweltauflagen + Bestimmte Anwendungen im wässrigem Medium - Niedrigere Wertschöpfung mancher Produkte	<ul style="list-style-type: none"> • Zellulose-Entwicklung zur Verbesserung von Fasereigenschaften • Biochemische Bleichmittel • Enzyme als Entfärbungsmittel • Ligninzerersetzung durch Mikroorganismen (Biopulping)

In vielen Bereichen der Spezialitätenchemie werden biotechnologische Verfahren zunehmende Bedeutung erlangen (4/5)

Marktsegment	Zeithorizont/Grad der Auswirkung	Vorteile Biotechnologie / Hindernisse	Stand / Potentialbeispiele
Personal Care	Kurzfristig/ starke Auswirkung	+ Hochwertige Produkte, bei denen eine natürliche Herkunft eine besondere Qualität bedeutet + Ersatz von chemischen Prozessen, die zu Gerüchen oder Verfärbung führen	<ul style="list-style-type: none"> • Natürlicher Farbstoff für Lippenstift • Verdickungsmittel • Deodorantien • Bioaktive Substanzen
Technische Spezial-Katalysatoren	Kurzfristig/ starke Auswirkung	+ Produktion hochspezifischer Produkte (z.B. chirale Chemie im kontinuierlichen Prozess) + Trend zu höherer Produktreinheit und Effektivität	<ul style="list-style-type: none"> • Hydrolytische Enzyme • Chirale Chemie
Tenside	Kurzfristig/ starke Auswirkung	+ Übergang zu natürlichen Produkten mit besseren Eigenschaften + Wirtschaftlichkeit	<ul style="list-style-type: none"> • Antibakterielle Anwendungen • Hautfreundliche Tenside durch Fermentation oder Enzymkatalyse
Textilbehandlung	Kurzfristig/ starke Auswirkung	+ Leistungssteigerung in natürlich vorkommenden Fasern/Textilien (z.B. verbesserte Farbaufnahme)	<ul style="list-style-type: none"> • Spezialisierte Enzyme zur Alterung von Stone washed Jeans • Textile Schlichtungsmittel

In vielen Bereichen der Spezialitätenchemie werden biotechnologische Verfahren zunehmende Bedeutung erlangen (5/5)

Marktsegment	Zeithorizont/Grad der Auswirkung	Vorteile Biotechnologie / Hindernisse	Stand / Potentialbeispiele
Trennmittel	Kurzfristig/ starke Auswirkung	+ Selektivität jenseits der Grössentrennung	<ul style="list-style-type: none"> • Membrananwendungen (z.B. Abgasreinigung und chromatographische Auftrennung)
Wasserbehandlung	Kurzfristig/ starke Auswirkung	+ Geringere Auswirkung auf Umwelt und effektiver in der Zerstörung von Organismen	<ul style="list-style-type: none"> • Wasseraufbereitung, Trinkwasserreinigung • Wachstumskontrolle von Microben
Wasserlösliche Polymere	Kurzfristig/ starke Auswirkung	+ Produktion von Polymeren kontinuierlich und in wässrigem Medium	<ul style="list-style-type: none"> • Biologisch abbaubare Polymere zu niedrigen Preisen

Contents

1	Impact of Industrial Biotechnology
2	Applications and Market Potentials
3	Business Models and Growth Strategies
4	Financing Strategies and Sources
5	Conclusion and Outlook
A	Appendix: Information on FESTEL CAPITAL

Established industrial biotech start-up companies in Europe are mostly small and medium enterprises

- Established **industrial biotech start-up companies** in Europe have normally the following characteristics
 - Predominantly **service-oriented** business model
 - Primarily **organical growth**
 - Profitable, but **subcritical structures** with regard to size and financial strength
 - Not able to realize growth opportunities due to **lack of financial resources**
- Most of the companies are **small and medium enterprises** with operations for more than 5 years

Service- and IP-oriented business models have been established in the field of industrial biotech

- **Service-oriented business model**

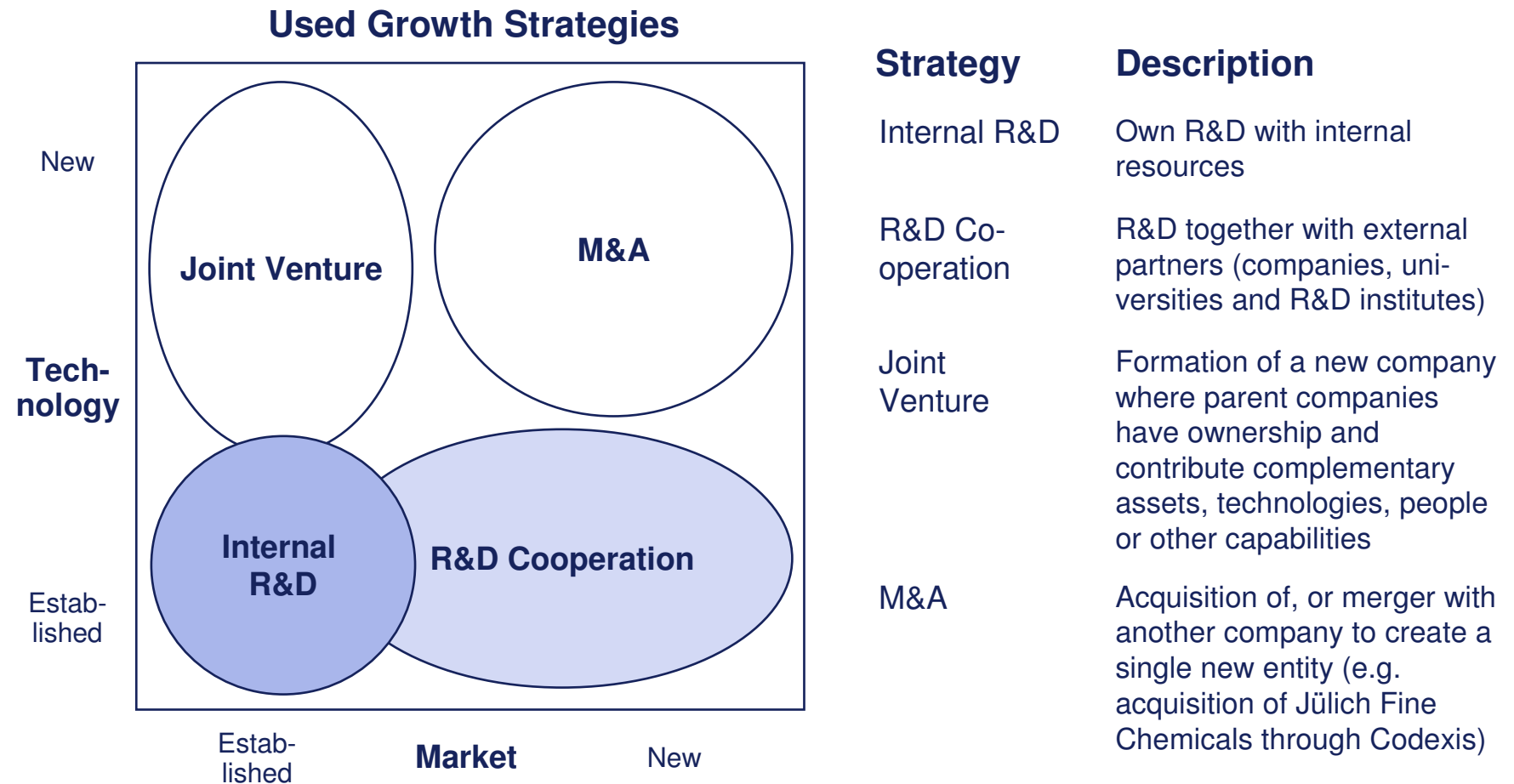
- Start-up companies offer their particular know-how predominantly as services to support established companies
- Project risks and developed IP remain with the customer
- The growth potential is very limited and, therefore, the development and commercialisation of own IP is important for further growth

- **IP-oriented business model**

- Start-up companies focus on the development of their own portfolio of technologies and products which they sell or license out
- Project risks and developed IP remain with the start-up company
- A suitable network and co-operation strategy has to ensure the successful commercialisation of own IP

Business Models and Growth Strategies - Growth Strategies

There are four different potential growth strategies to move from a service-oriented to an IP-oriented business model



Business Models and Growth Strategies - Growth Strategies

The four different growth strategies have specific advantages and disadvantages from an entrepreneurial view

Strategy	Advantages	Disadvantages
Internal R&D	<ul style="list-style-type: none"> • Enables the development of own IP • Start-up decides on R&D projects • Increased flexibility on project choice and research goals 	<ul style="list-style-type: none"> • Cost and capital intensive • High project risk • Limited research capacities prevent a fast reaction concerning new projects • Lack of networks that provide new ideas with regard to the research
R&D co-operation	<ul style="list-style-type: none"> • Increases number of possible technologies available for R&D projects • Makes use of synergies, uses resources of the partner • Splitting the risk of the project • Rarely receive considerable volume of IP developed in the project (often the case with academic partners) 	<ul style="list-style-type: none"> • Need for a strong project management • Limited possibility of development of own IP
Joint Venture	<ul style="list-style-type: none"> • Enables growth in a new business area • Makes use of the resources of the partner (assets, technologies, human capital) • Uses synergies of complementary resources (technologies) 	<ul style="list-style-type: none"> • The time involved for negotiations and contract development is high • An inflexible co-operation model, where the search for the appropriate partner is critical
M&A	<ul style="list-style-type: none"> • Enables use of synergies • Enables expansion into new markets / international markets • Enables acquisition of IP and technologies 	<ul style="list-style-type: none"> • Loss of control in the company • Loss of flexibility in the decision making process

Business Models and Growth Strategies - Internal R&D

Internal R&D is the preferred strategy to realize future growth based on known markets and known technologies

- The majority of start-ups in industrial biotech focuses on **internal R&D** to realize growth based on known markets and known technologies
- Most biotech start-ups keep up very good relationships with **universities and research institutions** and have very fast access to the latest research results
- Since start-ups have to carry the entire costs of internal R&D projects, the number of projects that can be realized is very limited due to **limitations** (equipment and laboratory space, number of employees and qualifications)
- A possibility, that is widely used, is the financing of internal R&D using **governmental funds** within special research programs
- However, the governmental funds are predominantly allocated to **basic research** projects rather than product development
- Consequently, the governmental funds do not sufficiently finance the internal R&D projects and a **lack of financing** remains

R&D co-operations with established companies enable start-up companies to get access to new markets

- The development of new or emerging markets is very costly and time consuming and hence most start-ups establish **R&D co-operations** with established chemical/lifescience companies to get access to new markets
- The interest of **chemical/lifescience companies** in industrial biotech is increasing and the contact to start-ups is developing in order to get access to the state-of-the-art technologies and products in industrial biotech
- In contrast, R&D co-operations (or joint ventures) **between start-ups** to get access to new technologies and to realize technological synergies are very unusual
- The reason is **strong competition** between the start-up companies to get funding from established companies for joint R&D projects
- Therefore, the dominant position of established companies reduces the **development potential** of start-ups

The realisation of the biotechnology potential often causes problems in established industrial companies

- The **commercialisation** of R&D results is sometimes problematic in established companies (bureaucratic structures, fear of cannibalism, not invented here-syndrome)
 - In some companies there still exists a conflict between chemical and biotechnological **point of view**; since many chemists are in executive positions, it is sometimes more difficult to enforce a biotechnological variant (however the tendency is strongly declining)
 - In established companies, **R&D capital** is sometimes not provided although interesting perspectives exist, because the executives do not want to invest for the long term; this represents the classical conflict between operative short-term optimisation and strategic long-term point of view
- New technologies, which were developed in academic institutions, do not always find the way into the industry, because academics are not involved in **process development**

Contents

1	Impact of Industrial Biotechnology
2	Applications and Market Potentials
3	Business Models and Growth Strategies
4	Financing Strategies and Sources
5	Conclusion and Outlook
A	Appendix: Information on FESTEL CAPITAL

The capital requirements of existing and new industrial biotech start-ups in Europe will amount to 200 million Euro during the next years

Growth financing

- In Europe there are currently around 40 industrial biotech start-ups in operation
- About 50% of these companies need a new financing round within the next two years with a volume of 5 million Euro on average to realise the next growth step

100 million Euro

Seed financing

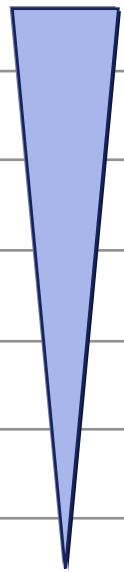
- The potential to found new industrial biotech start-up companies is between 30 and 50 companies during the next years
- The average capital requirement for one start-up company is about 2 million Euro

60 - 100 million Euro

Financing Strategies and Sources - Sources

The various financing sources are of very different importance for industrial biotech companies

Financing Sources	Importance ¹⁾
Operational income	7
Private investors	6
Governmental funds	5
VC	4
Debt funding	3
CVC	2
IPO	1



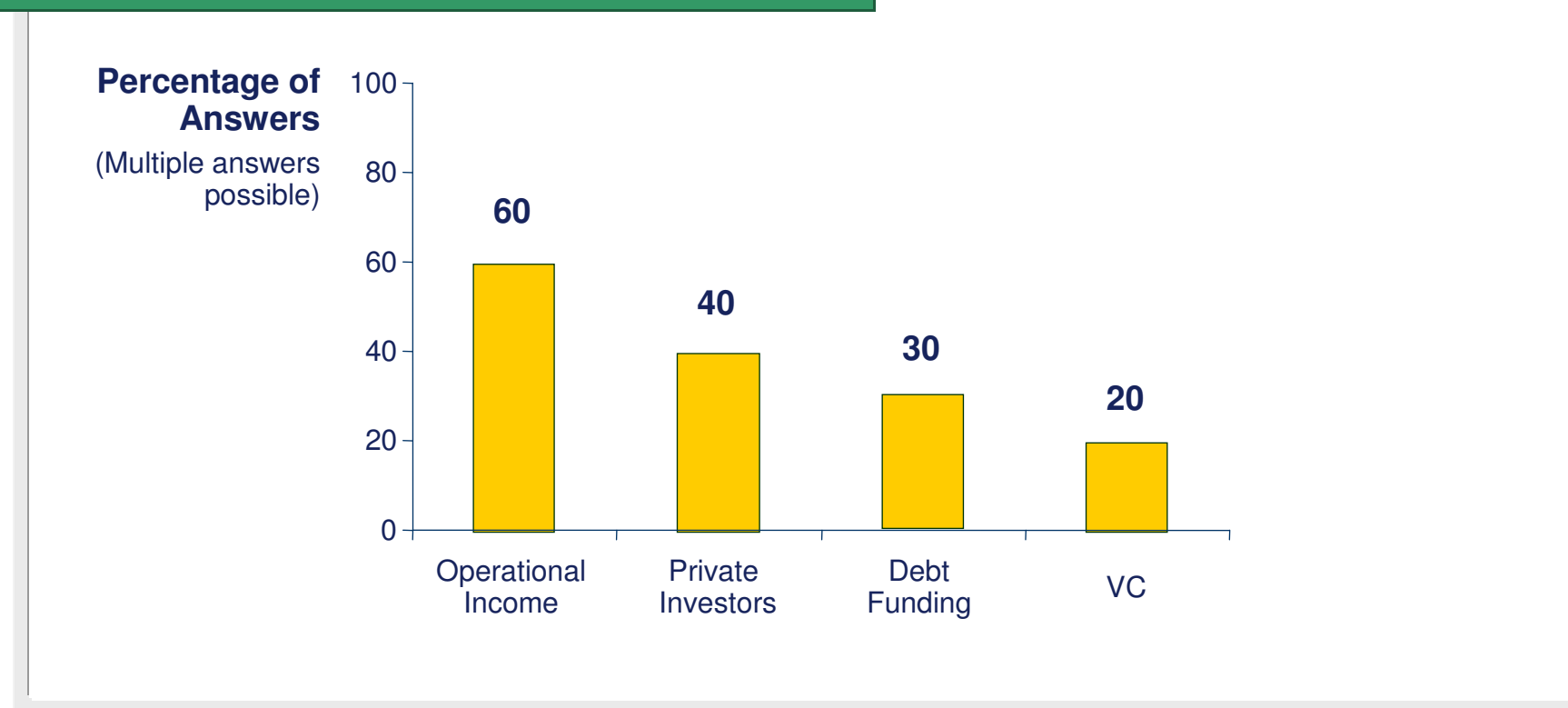
1) The ranking of the importance was calculated based on expert interviews

Source: Market study of FESTEL CAPITAL

Financing Strategies and Sources - Sources

The operational income is the most important financing source for industrial biotech start-ups

Financing Sources: Financing sources of industrial biotech start-ups



Source: Market study of FESTEL CAPITAL

Financing Strategies and Sources - Assessment

The considered financing strategies each have specific advantages and disadvantages

Strategy	Advantages	Disadvantages
Private investors	<ul style="list-style-type: none"> • Invest in early stage, often after first year • Lower expectation on rate of return / long term investment horizon • Improves equity ratio • No intervention in operations 	<ul style="list-style-type: none"> • Investments are smaller than with VC • Increased dependence from external Stakeholders
Governmental funds	<ul style="list-style-type: none"> • Do not need to be paid back • Employees and overhead are paid • Enables to strengthen the portfolio (technology and products) 	<ul style="list-style-type: none"> • Excessive bureaucracy causes add on costs and is time consuming • Inflexible programs and long admission processes • Limited number of Programs for service-oriented start-ups
VC	<ul style="list-style-type: none"> • Enables to collect large sums • Enables a fast development of the start-up • Strategic investment over the total period of development and growth with no intervention in operations • Improves equity ratio and enables financing of further expansion 	<ul style="list-style-type: none"> • Efforts/expenditures to get VC are very high • Increased probability of loss of control • Increased dependence from external Stakeholders • Sale of stake of the company
Debt funding	<ul style="list-style-type: none"> • Increases liquidity • No participation in the profit • No intervention in operations 	<ul style="list-style-type: none"> • Permanent costs with interest payments • Banks require securities to back up the loans – start ups predominantly cannot offer them
IPO	<ul style="list-style-type: none"> • Enables acquisition of large financial volumes • Enables to pursue a fast development of the start-up 	<ul style="list-style-type: none"> • Regulations with regard to the IPO cause significant add-on costs • New stakeholders in the firm that cause a loss of independence and control

Start-ups are predominantly financed by own cash-flows, private investors, governmental funds and debt funding

- The problem with regard to the financing of start-ups in industrial biotech is their **low financial strength**
 - Unexpected events can cause **serious threats** for the whole company
 - Companies have to **cancel R&D projects** due to a lack of funding
- Particular problems arise for volumes **between 0.5 and 5 million Euro** („equity gap“) due to a limited number of financial partners covering this range
 - For financial volumes **below 0.5 million Euro**, start-ups collect the funds from operational income, private investors, governmental funds
 - For financial volumes **above 5 million Euro**, they try to use VC

Private investors play an important role as they strengthen the financial situation of the start-up in critical situations

- **Private investors** are normally management or employees of the start-up or external investors like business angels
- External private investors can provide **additional know-how** to the start-up company
- They can improve the **equity to debt ratio** to enable the access to debt financing in early stages
- The volumes of private investments are **rather small** which restricts the use of private investors for large projects

Governmental funds play an important role in financing industrial biotech start-up companies especially in early stages

- About one third of the start-ups consider **governmental funds** as an integral part of their financing strategy and use them to strengthen and enhance the technology basis
- Governmental funds do not support the growth phase of start-ups because they exist predominantly for **basic research**
- In Germany, most managers indicate that there are **not enough** appropriate programmes for industrial biotech start-ups
- A problem is the complicated **application process** and the bureaucracy during the project
- Start-ups in developing areas of Europe have access to the “**Structural Fund of the EU**” which has a much larger volume at its disposal compared to research funds, and is not only restricted to basic research

Only 15 to 20% of industrial biotech start-ups in Europe were able to acquire VC due to their service-oriented business model

- Most of the industrial biotech start-ups have discussions with **VC companies**, but VC financing rounds are only finalized in a few cases
 - This was caused by the **service-oriented business** model which cannot realize the appropriate rate of return for VC companies
 - VC's **lack of knowledge** about the industrial biotech sector often leads to a false evaluation of the company value (e.g. VC's undervalue the b2b relationships)
- **CVC investments** are pretty rare in industrial biotech and the focus was primarily on start-ups with IP-oriented business models
 - A potential conflict with the start-up companies and other financial investors is the **exit strategy**
 - In the future, CVC investments are **likely to increase** since the companies want to actively participate in the development within the industrial biotech sector

Other financing sources such as debt funding and IPOs are not relevant for industrial biotech start-ups

- **Debt funding** is only a limited financing source for start-ups in industrial biotech due to the low equity basis of start-ups limiting the possibility of using debt
- For **IPOs**, the start-ups mostly lack the critical size compared to start-ups in red biotech so that industrial biotech start-ups are normally seen as too small for an IPO
- It can be anticipated that there will be **no IPOs** of industrial biotech start-ups in the foreseeable future

Contents

1	Impact of Industrial Biotechnology
2	Applications and Market Potentials
3	Business Models and Growth Strategies
4	Financing Strategies and Sources
5	Conclusion and Outlook
A	Appendix: Information on FESTEL CAPITAL

Conclusion and Outlook - Situation

Most of the industrial biotech start-ups use primarily their operational income for financing current operations and growth

- Start-ups in industrial biotech are more **conservatively financed** than start-ups in red biotech (nearly all of the start-ups in red biotech are financed by VC compared to only 15% to 20% in industrial biotech)
 - Most of the start-up companies are **profitable from the beginning** and use their operational income for financing current operations and growth
 - The **investment volumes** are lower, the development periods for new products are shorter and there are no admission procedures for the product
 - Consequently, the products can be commercialized more rapidly and **operational income** contributes to the financing much earlier and the start-up needs lower pre-financing
- The growth potential of service-oriented companies is limited to a certain extent - in order to realize further growth, the **development of own IP** is necessary
- The realization of **growth options** is very limited due to low financial strength of most of the industrial biotech start-ups

Conclusion and Outlook - Recommendation

Europe is a long way from using the potential of industrial biotech as the start-up scene in that area is not properly developed

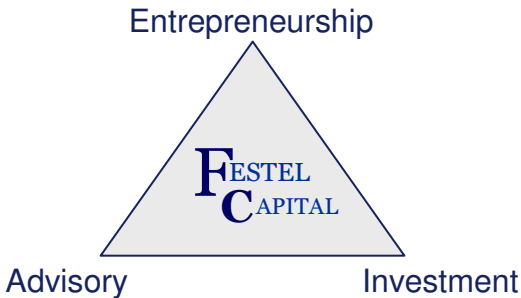
- Industrial biotech is of enormous importance for the competitiveness of the **European chemical/lifescience industry**
- In Europe, the further development of industrial biotech depends on the ability to establish a **prospering start-up scene**
- The field seems to be **rather unattractive** for investors, due to the lack of experience and positive examples
- Long-term oriented **financial support** during the seed and growth phase is the key success factor to develop a prospering industrial biotech start-up scene in Europe
- The establishment of a dedicated “**European Industrial Biotech Seed and Growth Fund**” would be a suitable instrument to enable capital markets access and foster industrial growth in industrial biotech
- **M&A** might increase in importance since most start-ups only possess low financial strength which might lead to consolidation

Contents

- 1 Impact of Industrial Biotechnology
- 2 Applications and Market Potentials
- 3 Business Models and Growth Strategies
- 4 Financing Strategies and Sources
- 5 Conclusion and Outlook

A Appendix: Information on FESTEL CAPITAL

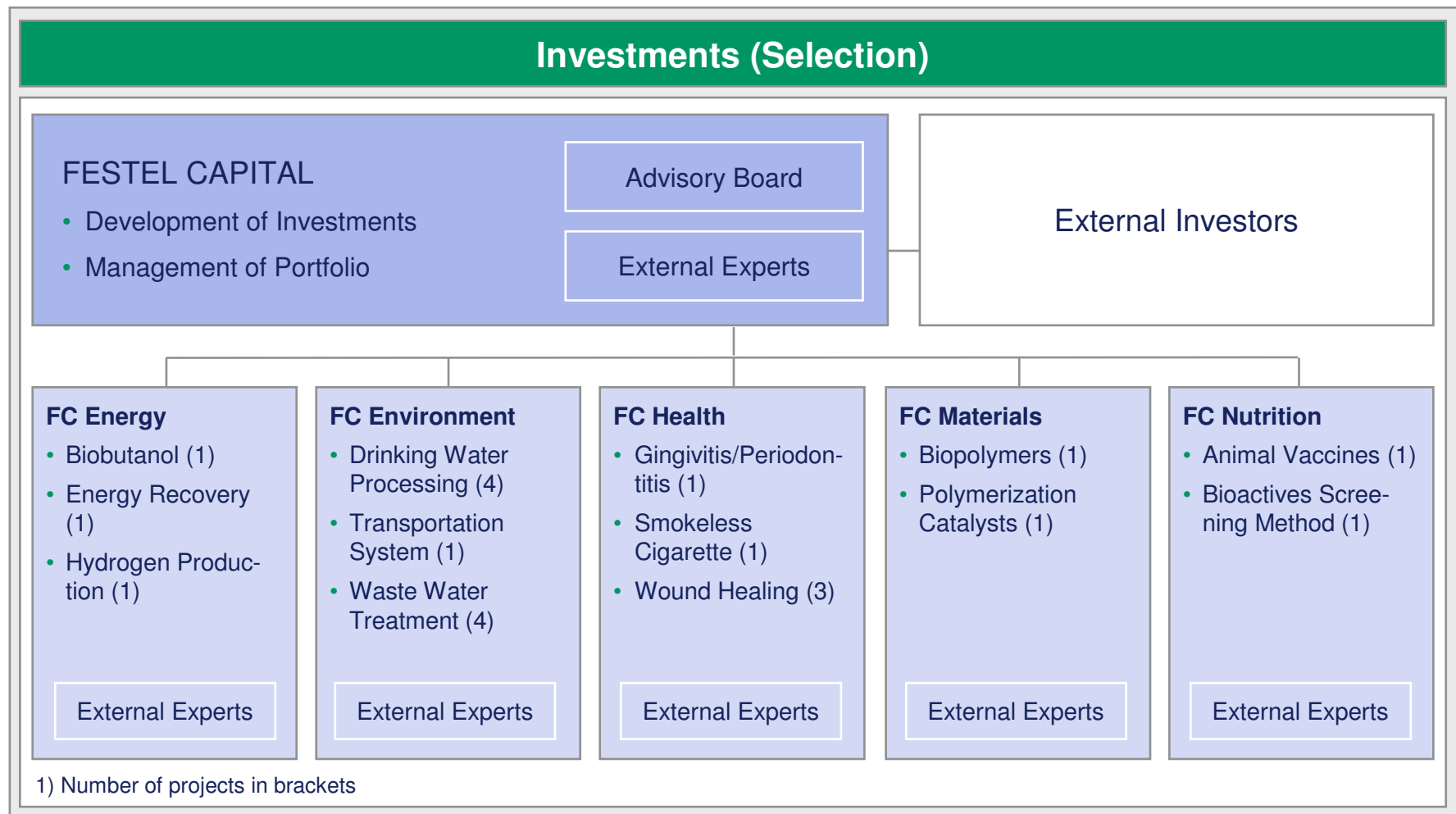
FESTEL CAPITAL is an international advisory and investment firm focusing on the commercialisation of technologies and optimisation of organisations

Profile	Activities (Examples)
<p>FESTEL CAPITAL is an advisory and investment firm focusing on the commercialisation of technologies and optimisation of organisations in the areas of energy, environment, health, infrastructures, materials and nutrition</p>	<p>FESTEL CAPITAL ...</p> <ul style="list-style-type: none"> • supports companies to commercialise innovative products and technologies • advises entrepreneurs and investors to successfully create and develop new businesses • invests in selected start-up and spin-off companies mainly in the seed phase • shares the entrepreneurial risk by providing services for equity • advises on the optimisation of organisations • fosters the development of technology-related businesses and co-operations in China
<p>FESTEL CAPITAL combines entrepreneurship, advisory and investment to create and develop innovative businesses</p> 	

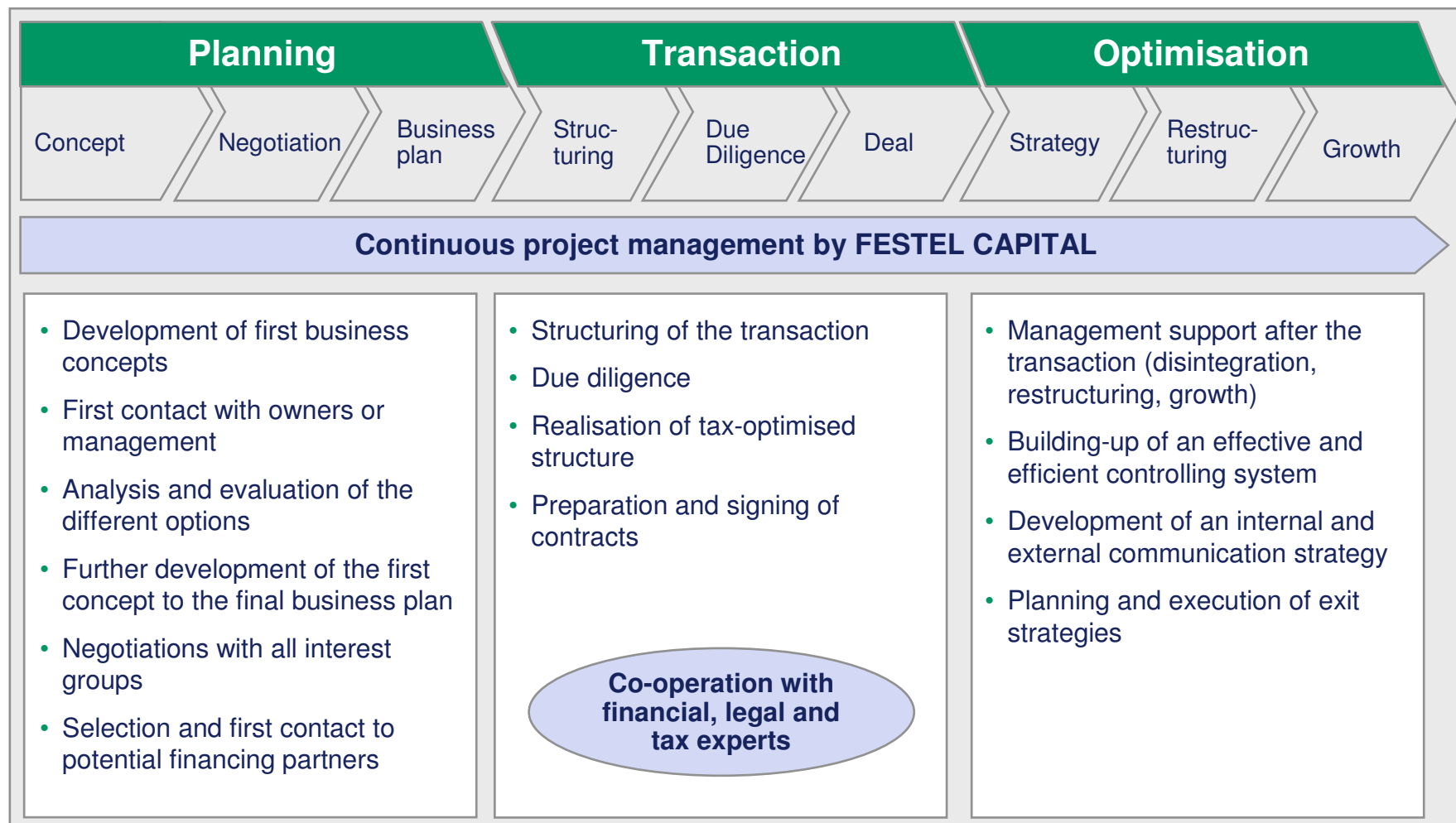
FESTEL CAPITAL has expertise in the areas of energy, environment, health, infrastructures, materials and nutrition

Area	Expertise (Examples)	
Energy	Drug Discovery & Development	<ul style="list-style-type: none"> • Biological Targets • Active Substances • Synthesis & Process Development
Environment	Industrial Biotechnology	<ul style="list-style-type: none"> • Bioconversion & Biorefineries • Biopolymers • Enzyme Technology
Health	Industrial Parks	<ul style="list-style-type: none"> • Facility & Infrastructure Management • Safety & Environmental Protection • Utilities & Waste Management
Infrastructure	Molecular Biology	<ul style="list-style-type: none"> • Bioactives • Drug Delivery • Wound Healing
Materials	Nanotechnology	<ul style="list-style-type: none"> • Nanobiotech & Nanomedical • Nanocomposites • Nanoelectronics
Nutrition	Production Technology	<ul style="list-style-type: none"> • Biopharmaceuticals • Catalysis • Process Optimisation
China	Renewable Energy	<ul style="list-style-type: none"> • Bioenergy • Biofuels & Synthetic Fuels • Solar Energy
	Water Technology	<ul style="list-style-type: none"> • Drinking Water Processing • Waste Water Treatment • Water Chemicals

FESTEL CAPITAL is building up a portfolio of technology projects in five investment categories¹⁾



FESTEL CAPITAL supports start-ups and spin-offs from business planning over transactions up to business optimisation



FESTEL CAPITAL has worked together with leading technology-oriented companies

Partners (Selection)

