novozymes®
Food & Beverages

LpHera®

colloque ENZINOV :

Enzymes Innovations Industries

27 et 28 octobre 2014

Sylvain Laperche –
Strategic Account Manager

Rethink Tomorrow

Outline

- Novozymes in brief
- Novozymes sustainability and goals
- Starch industry as an example
- Alpha amylase history
- Refinery processes
- How does Novozymes develop new enzyme product
- LpHera® plant trial results
- Summary

Novozymes
in brief

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- Danish biotech-based company.
- World leader in enzymes and microorganisms.
- More than 6,000 employees globally.
- More than 500 products for many different industries sold in 130 countries.
- 2013 sales: more than $ 2.1 BUSD.

Novozymes strives for sustainability

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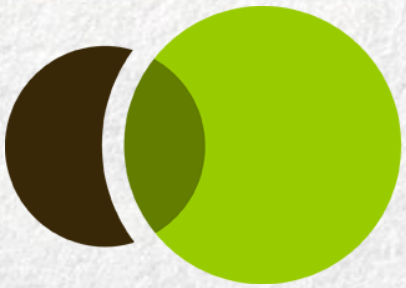
Novozymes in the Dow Jones sustainability indexes (DJSI):

- Included in DJSI Biotechnology sector since 2000
- Sector leader 2000-2007 and 2009-2012
- 'Gold Class' rating in 2010-2013 in Sustainable Asset Management (SAM) Sustainability Yearbook



ROBECOSAM
Sustainability Award
Gold Class 2013

Decoupling use of resources from growth

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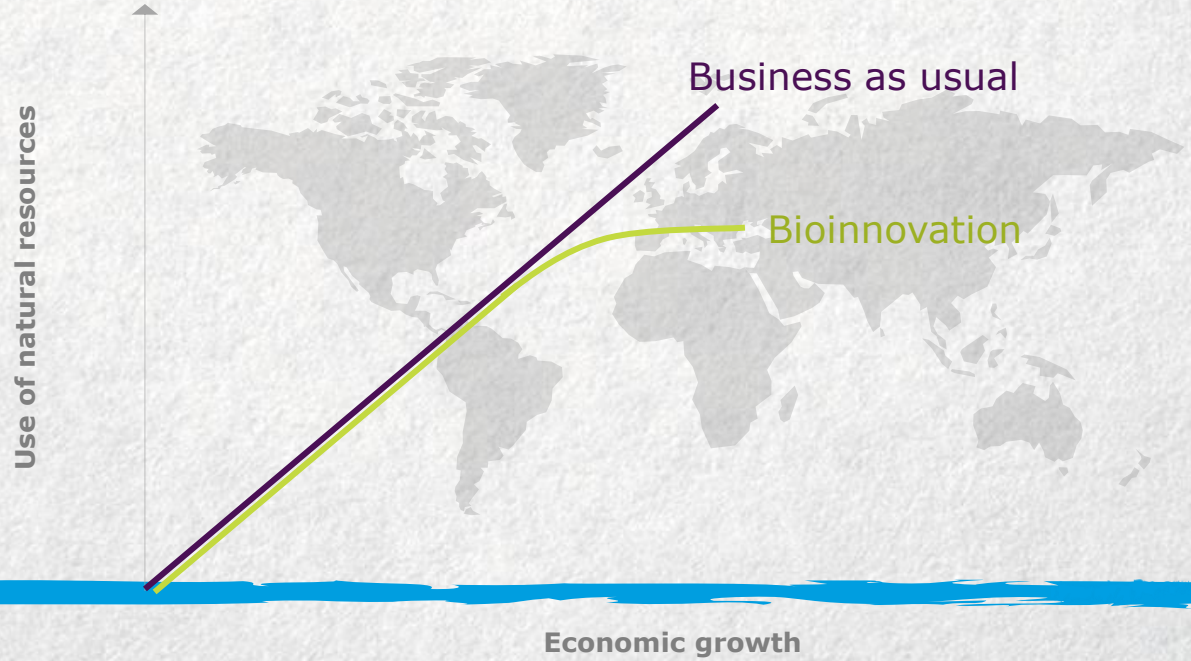
- Enzymes can increase efficiency and yield of a wide range of processes in our society
- With enzymes we can "produce more with less" and contribute to the decoupling of economic growth and use of natural resources



Less chemicals used, significant savings

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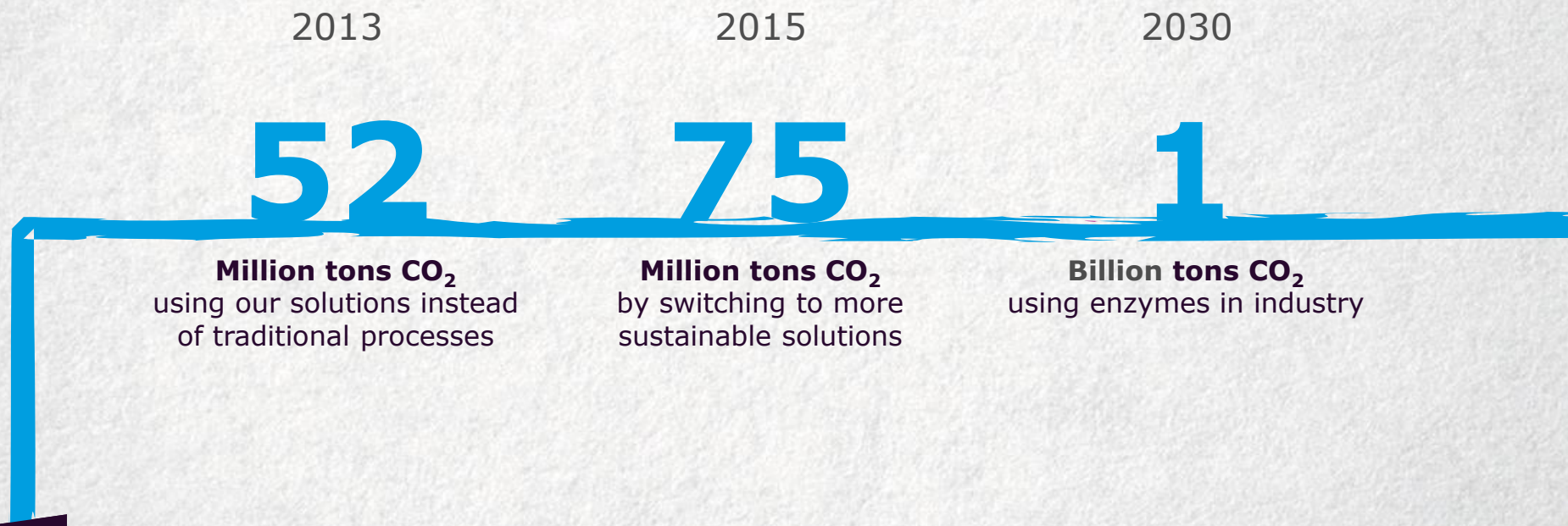

Million tons CO_2
using our solutions instead of traditional processes

Million tons CO_2
by switching to more sustainable solutions

Billion tons CO_2
using enzymes in industry

Across industries our products help reduce CO_2

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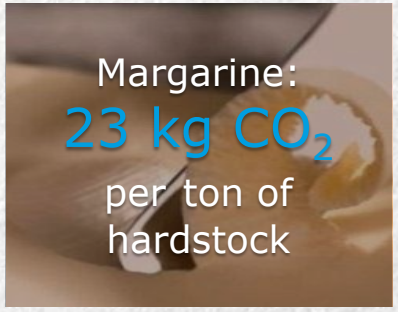

Alpha-Amylases

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Essential enzymes for starch processing

Segment	Enzymes
Liquefaction	▪ Liquefying α-amylases
Saccharification	**Saccharifying amylases** ▪ Glucoamylase ▪ Pullulanase ▪ Acidic a-amylase
Speciality syrups and dextrins	▪ β-amylase ▪ CGTase ▪ Maltogenic α-amylase

α-amylase development history

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Enzyme	Introduced	Issue addressed	Operating Parameters
Termamyl L (*B. licheniformis*)	1973	Heat-stability	pH 6.2, Ca-addition and inactivation required
Termamyl S (*B. stearothermophilus*)	1986 (fuel alcohol)	Specific activity	pH 6.0, Ca-addition and inactivation required
Termamyl LS (mixture of L and S)	1987	Sediments	pH 6.0, Ca-addition a nd inactivation required
Termamyl LC (*B. lich*. hybrid-variant)	1998	Ca-addition and pH	pH 5.6, inactivation required
Termamyl SC (*B. stearo*. variant)	1998 (fuel alcohol)	Viscosity	pH 5.6, inactivation required
Termamyl Supra (mixture of LC and SC)	1998	Specific activity	pH 5.6, inactivation required
Liquozyme X	2002	Product specificity	pH 5.6, no inactivation required
Liquozyme Supra	2003	Product specificity, viscosity	pH 5.6, no inactivation required
LpHera®	2014	Liquefaction cost savings	pH 4.5 to 5.0

Starch liquefaction processes

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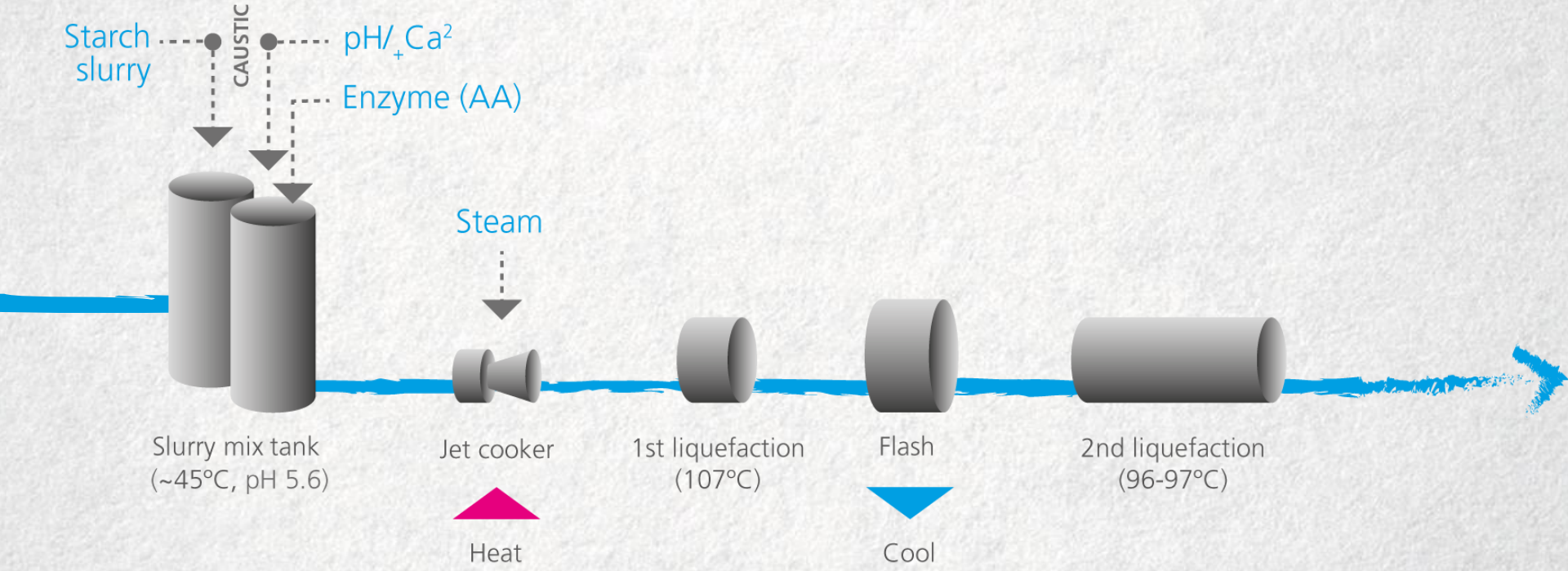

Enzyme development
Multiple stages

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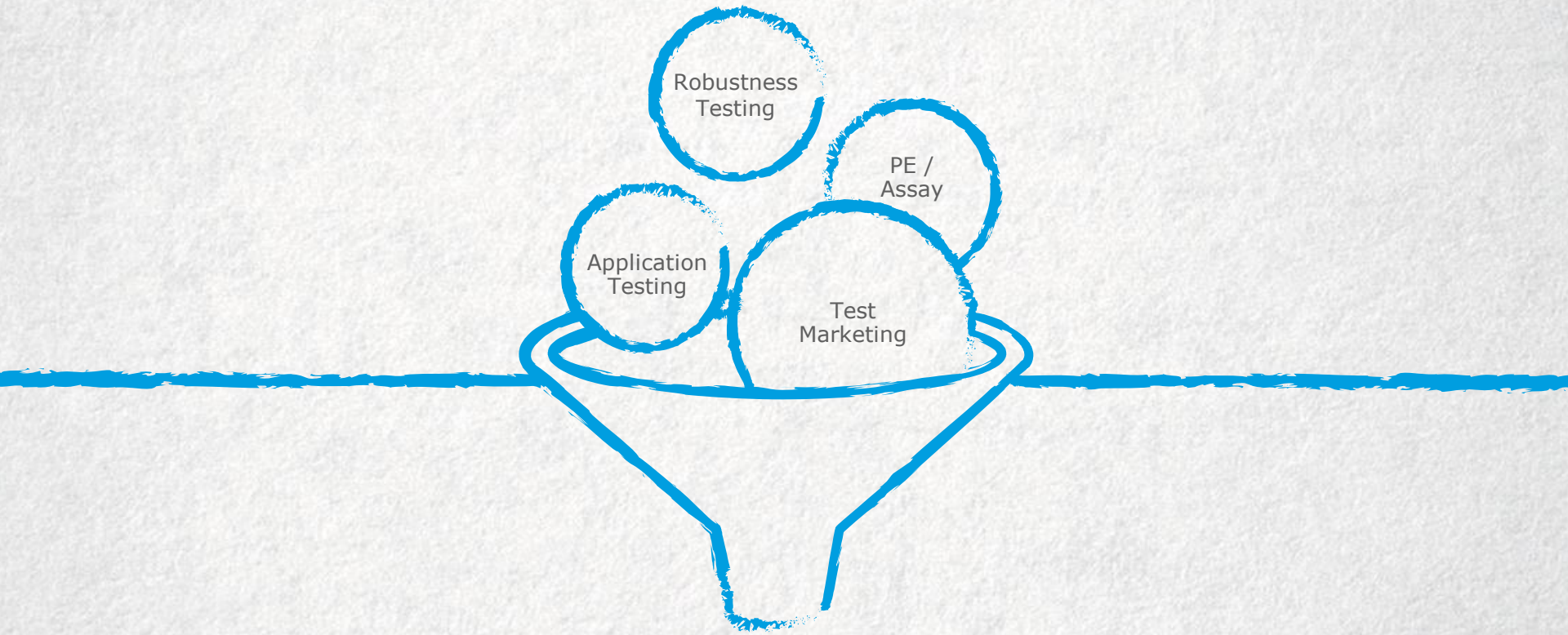

Low pH Amylase

WO 2013/057141
WO 2013/057143

Protein Engineering (PE) approaches
Tailoring nature's product

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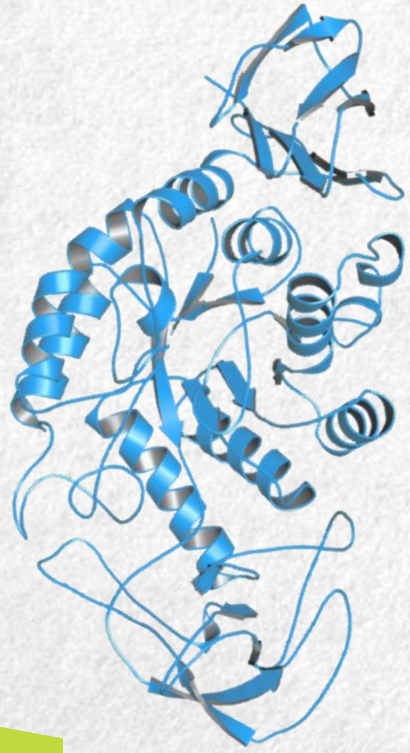
Native enzyme



Improved acid tolerance

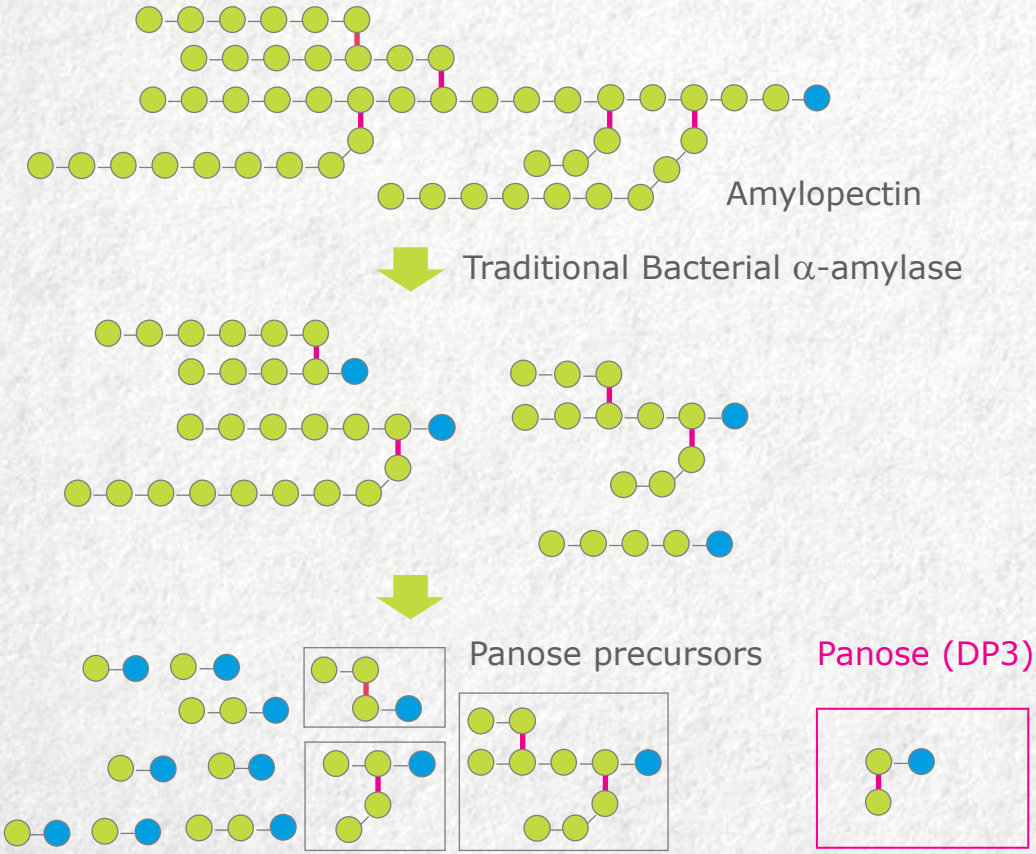
Altered specificity

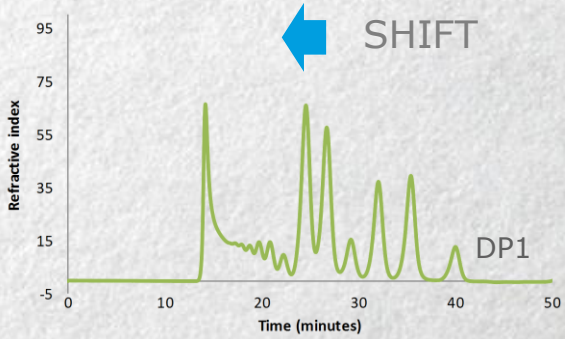
Improved thermostability

○ *mutations*

Engineered amylases

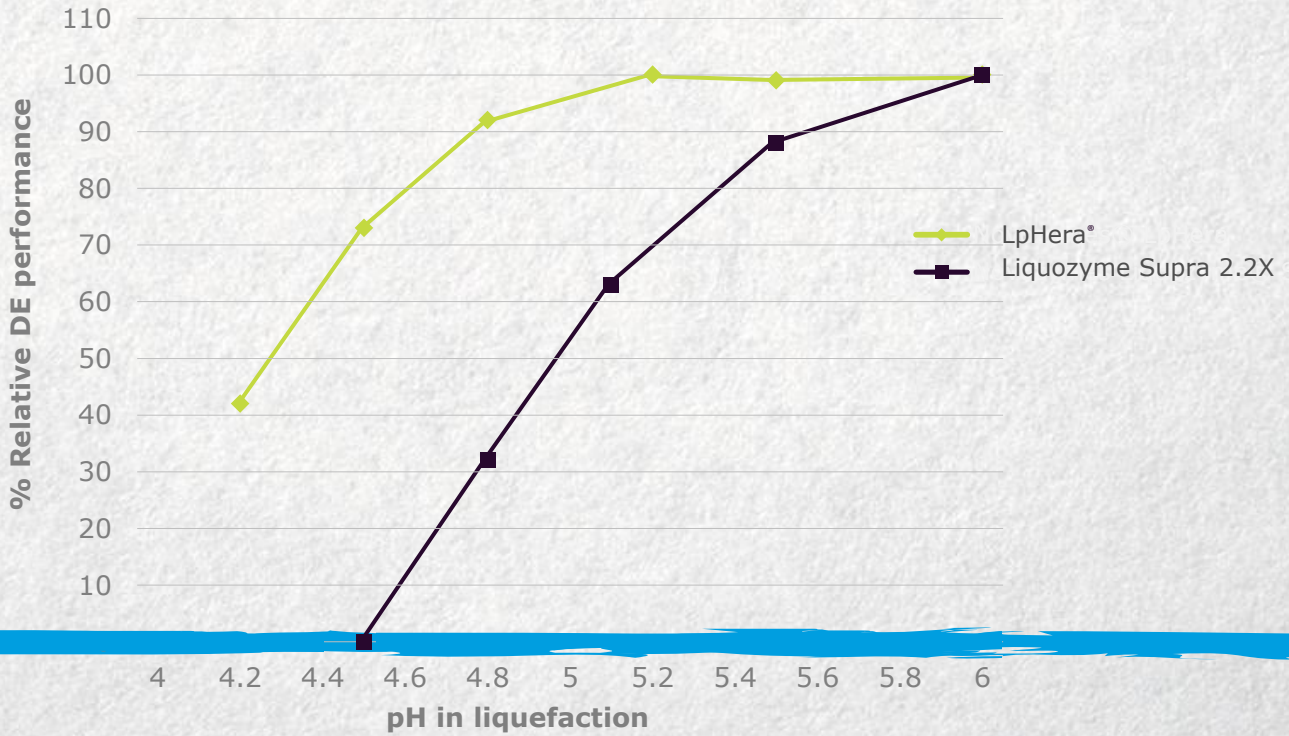
Cut further from branches for higher dextrose





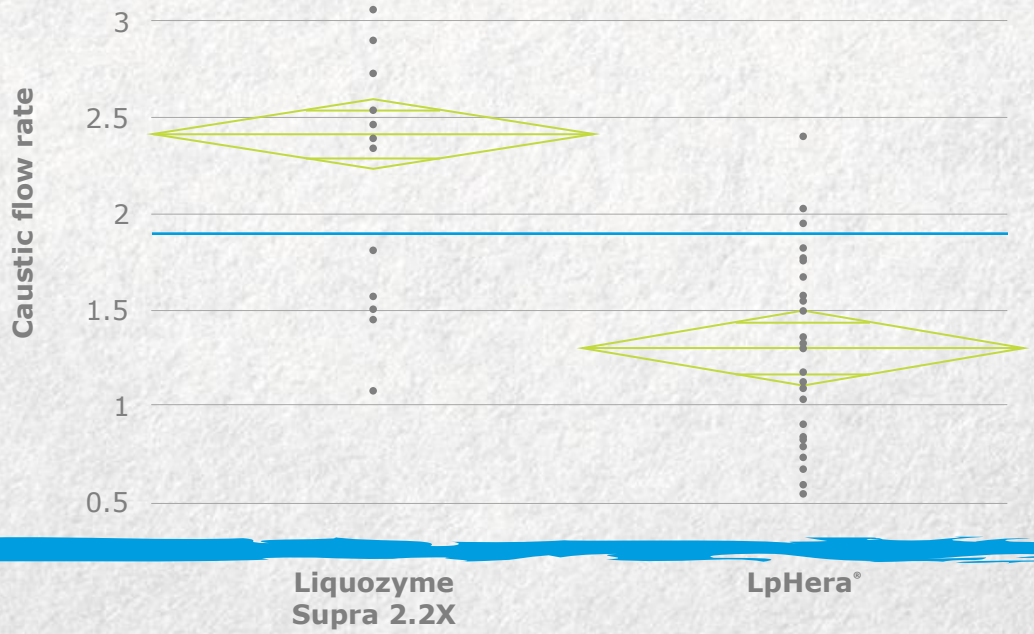
Performance
Demonstrated improvements at lower pH's

LpHera® shows excellent DE performance at low pH where conventional alpha-amylases do not.



Caustic savings

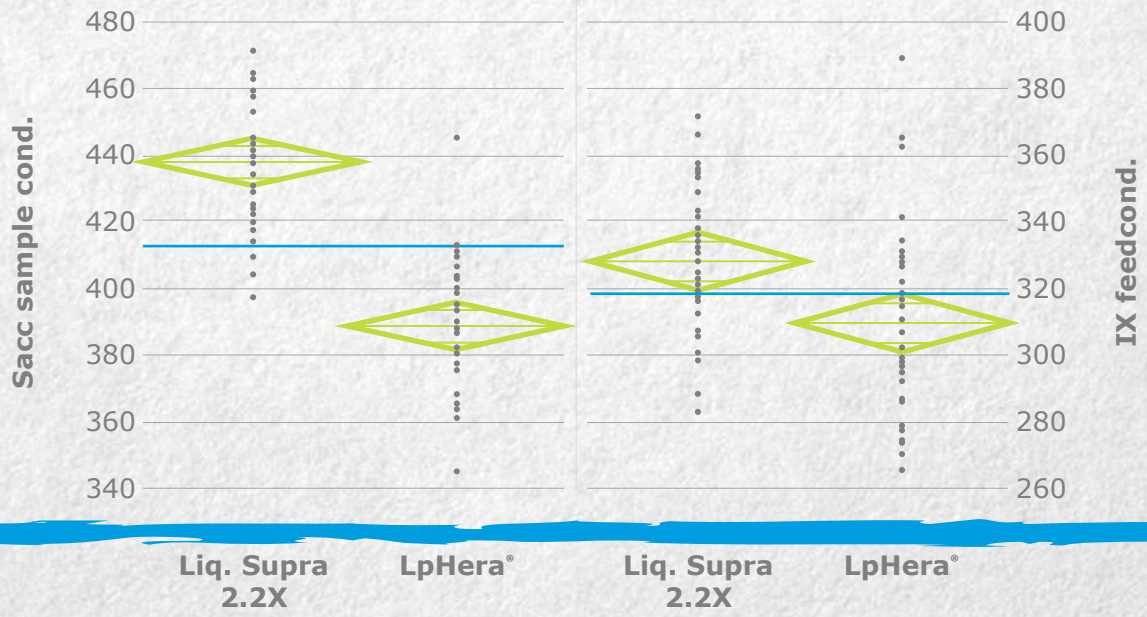
- 6% caustic flow rate (liter/min @ 2.38 vs. 1.33)



Plant trial results
Syrup conductivity reduction

The data indicates that conductivity is lowered, thus reducing IX cost.

- Sacc sample conductivity (438 vs. 379)
- IX feed conductivity (330 vs. 299)



Dextrose output increased

Consistently seen in lab and in full-scale tests

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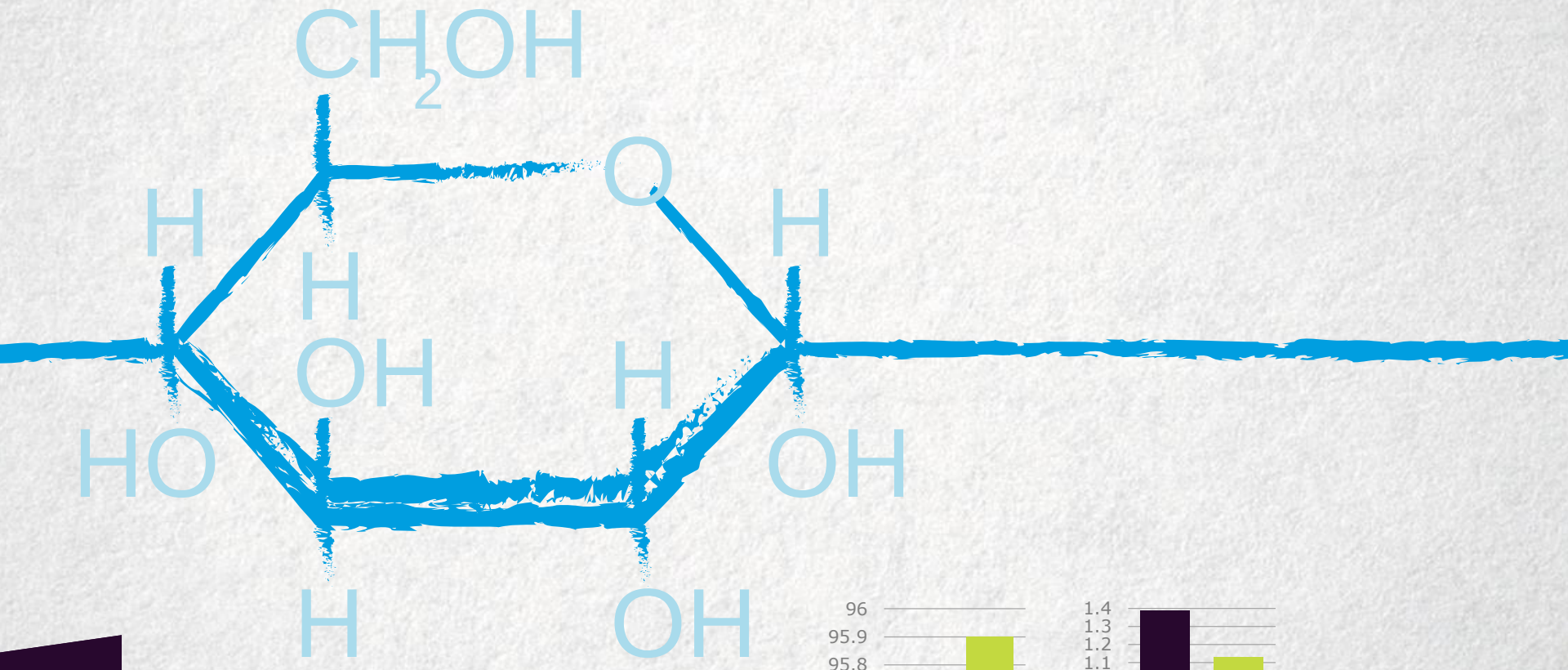

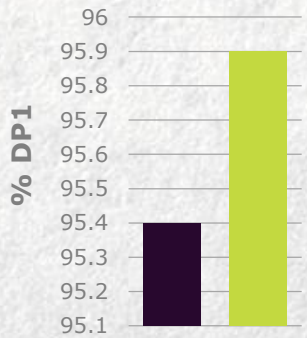

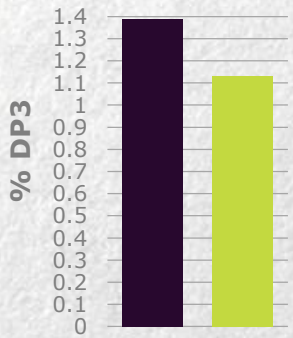

LpHera®
Liquozyme® Supra 2.2X

Lab scale data.
Production scale data might be different

LpHera® offers a range of benefits
From liquefaction and beyond

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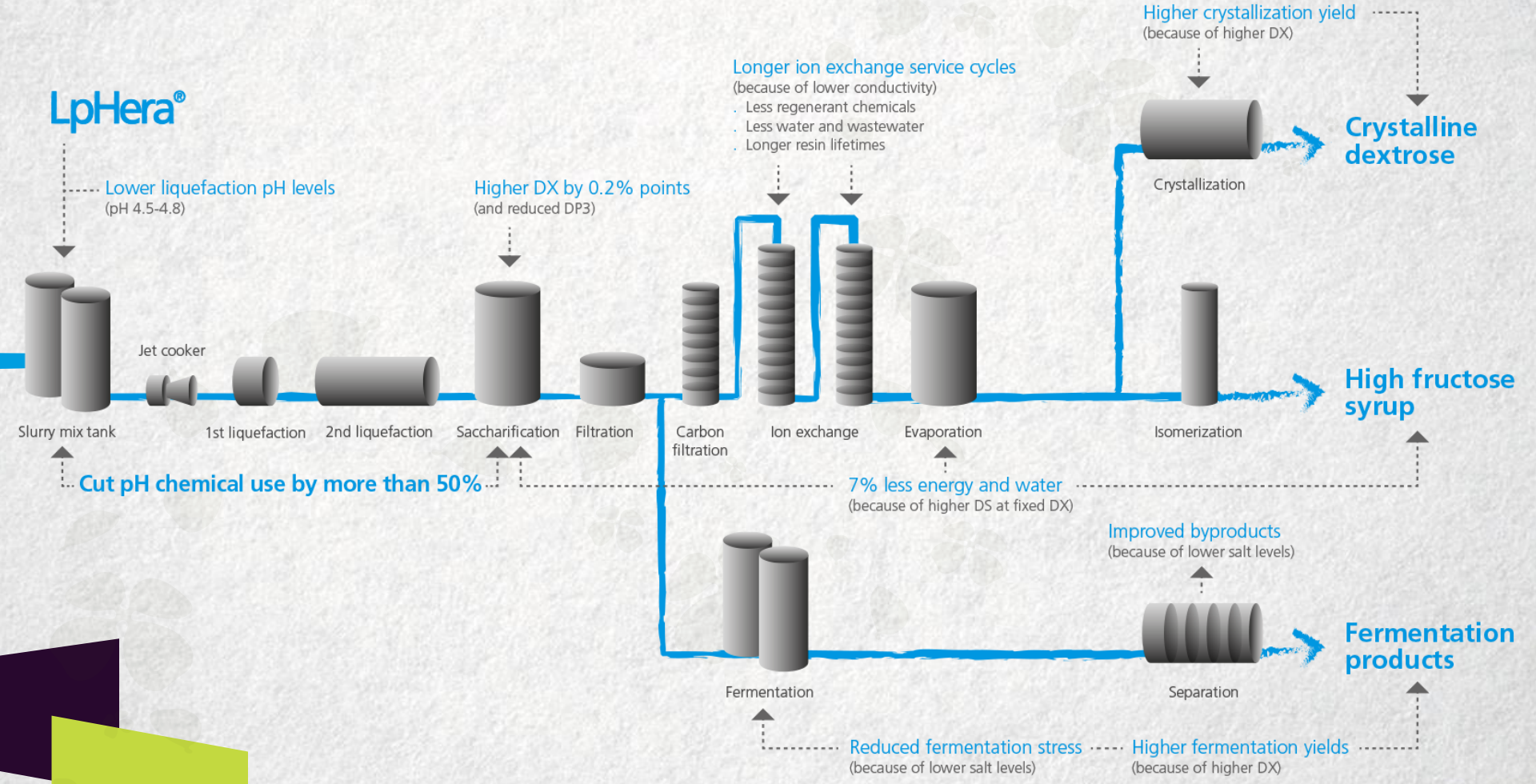

In summary…

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LpHera® alpha amylase:

- Drops liquefaction pH to 4.8-5.0, while conventional liquefaction with conventional amylases are done at pH 5.5-5.8.
- Saves customer plant chemicals.
- Boosts dextrose levels.
- Potentially reduces enzyme usages.
- Has potential to provide other process savings such as energy, water, and wastewater treatment etc.
- Has demonstrated performance in full-scale testing.
- LpHera® launches a whole new era of low pH liquefaction.

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Thank you