



Experiences in the commercialization of innovative waste water technologies

Brussels

30 May 2018

Stephan Bocken
CEO, Paques bv

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Paques is a global company, with direct presence on most continents

A FAMILY owned business founded in 1960,
20% shares owned by S. Klatten 



>60
COUNTRIES
WORLDWIDE

>400
EMPLOYEES

> 2400
WORLDWIDE
REFERENCES

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think global, act local

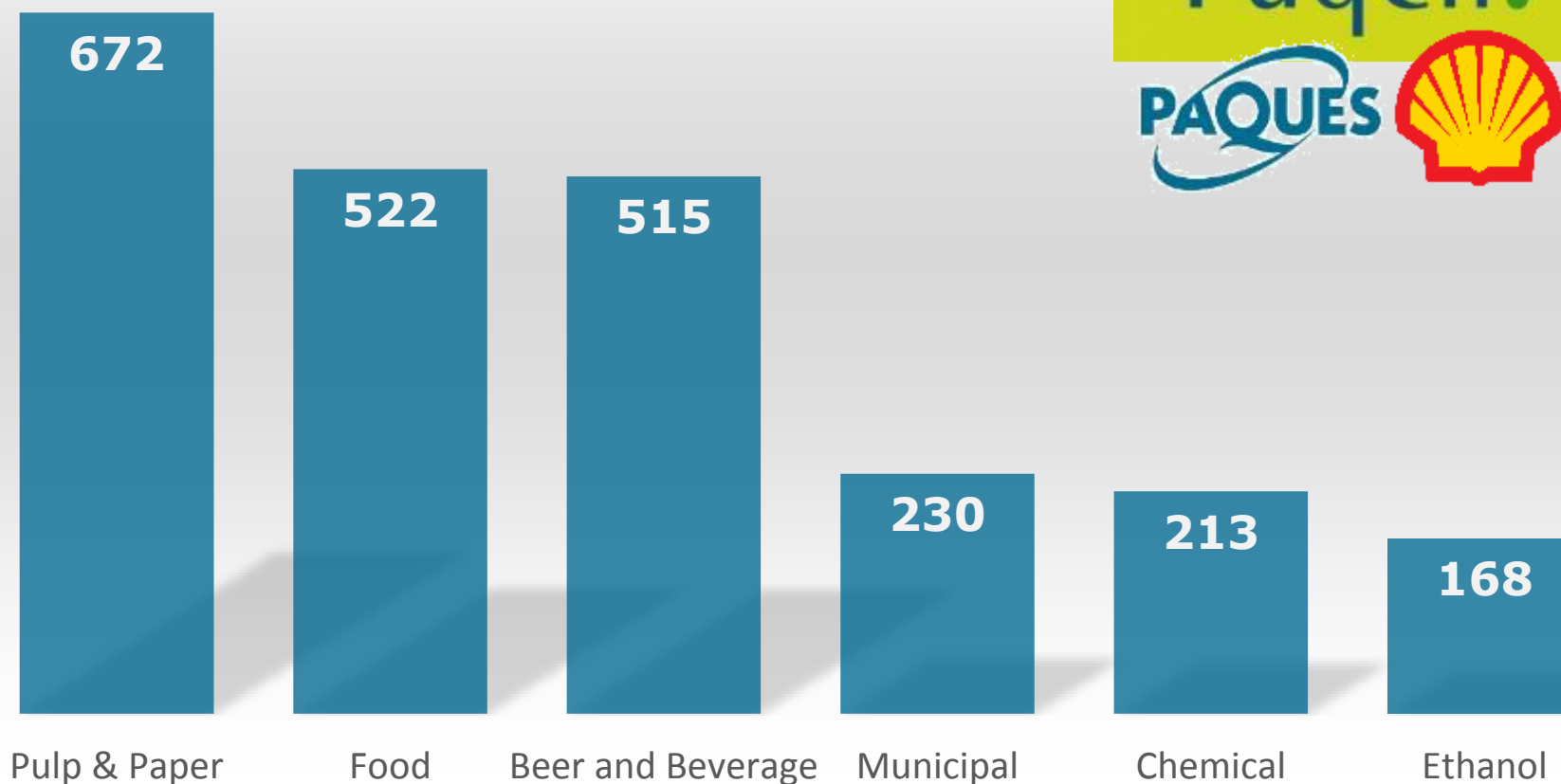




Paques is the Market Leader in industrial wastewater treatment

Paques References

Water and Gas treatment per Industry



Desulfurization **in the oil & gas** market
done through our 50/50 JV





Paques innovates by applying naturally occurring microorganisms

No Genetic Modification of Bacteria. Ever!



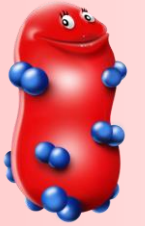
1200

References in anaerobic digestion



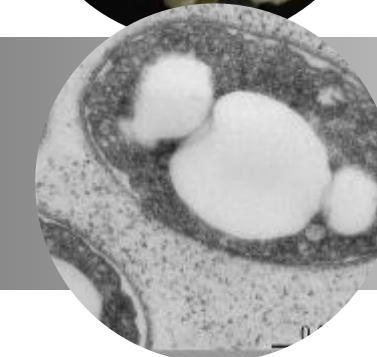
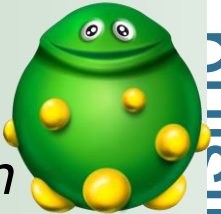
40

References in ammonium removal



200

References in gas desulfurization

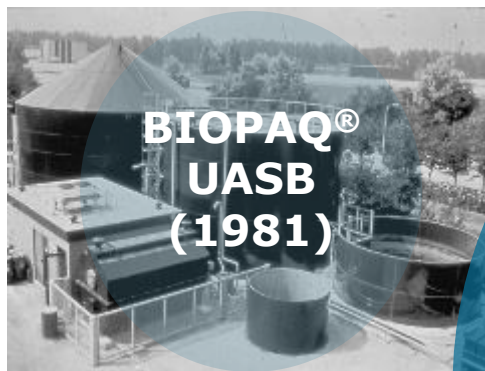


New Bioplastic production

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Paques has repeatedly successfully introduced technological innovations and converted them into high quality industrial applications



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However...Paques actually started by building silos and other equipment



On-farm tower storage systems for silage



BIOPAQ manure digestion and WindPAQ

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And one day, in an economic downturn...

The Entrepreneur met the Inspirer



Jos Pâques

“The Entrepreneur”



Prof. Gatze Lettinga

“The Inspirer”





Granular anaerobe bio-catalyst

(SIZE: 0.5-3 mm)

We're all
called
Andy the
anaerobe





And with the determination and insight of Paques' engineering head, the Biopaq® UASB was launched

The Entrepreneur meets the Inventor



Sjoerd Vellinga

"The Inventor"

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The first Biopaq ® UASB in a paper mill

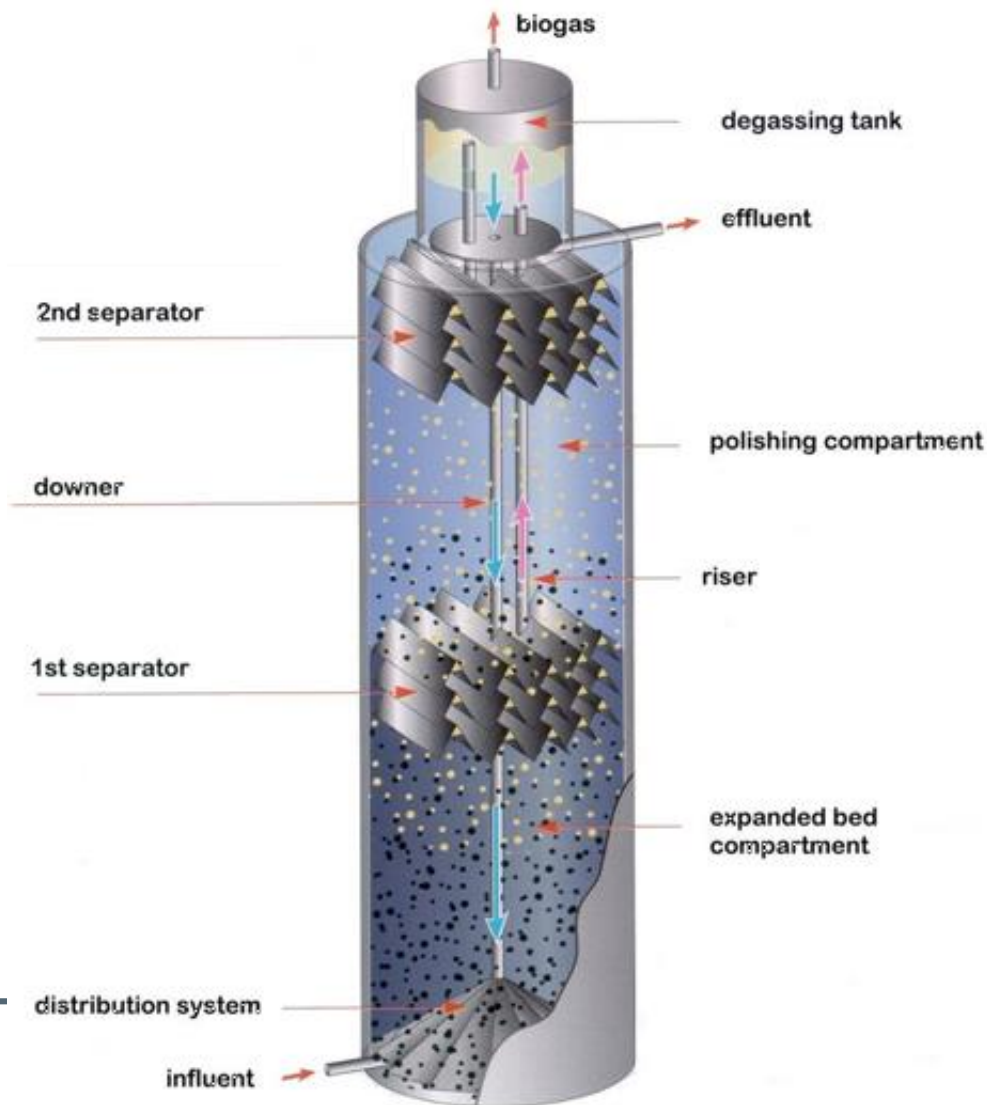


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No patent protection for the UASB soon catalyzed the invention of the higher performing Biopaq® IC reactor



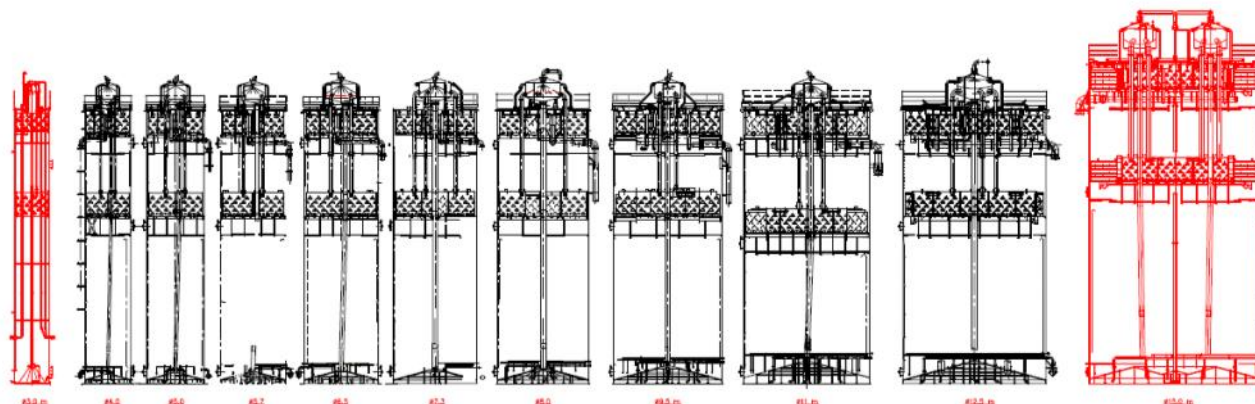
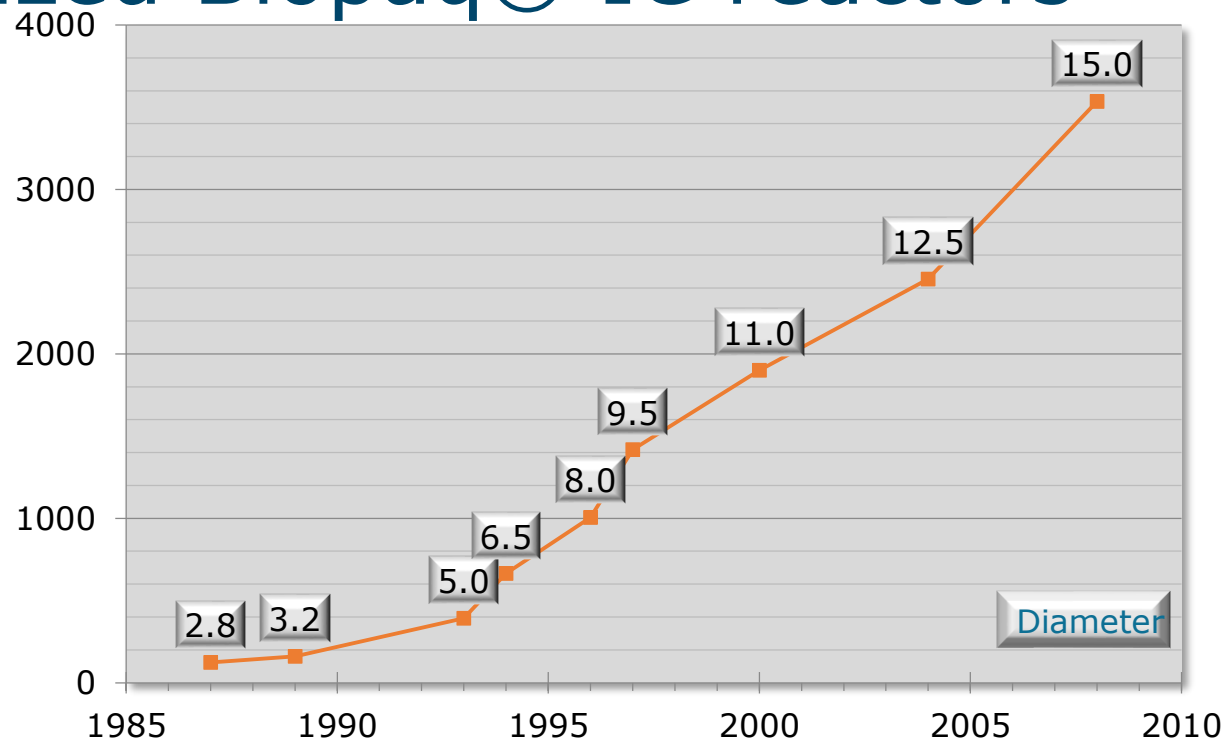
BENEFITS OF BIOPAQ® IC REACTOR

- Small footprint and high Vol. Loading Rates
- Superior Bio-catalyst retention rates
- Low operating and maintenance costs
- Reliable operations

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Over the years, market demand pushed for ever-larger sized Biopaq® IC reactors



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Anaerobic Digestion at large scale!

...up to 15m tank diameter and 28m height

Capacity:

>100 ton COD/day

>50,000 m³ biogas/day

Equivalent to:

~15 MWth or ~5 MWe

(~10,000 households)

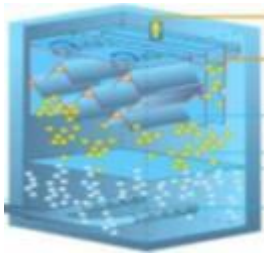


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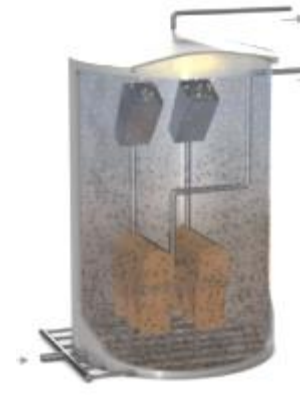
Paques has recently very successfully launched its 3rd generation anaerobe reactor, the Biopaq® ICX



UASB



IC



ICX

- New development team !
- 8 years from idea to market breakthrough
- Very structured, systematic development approach

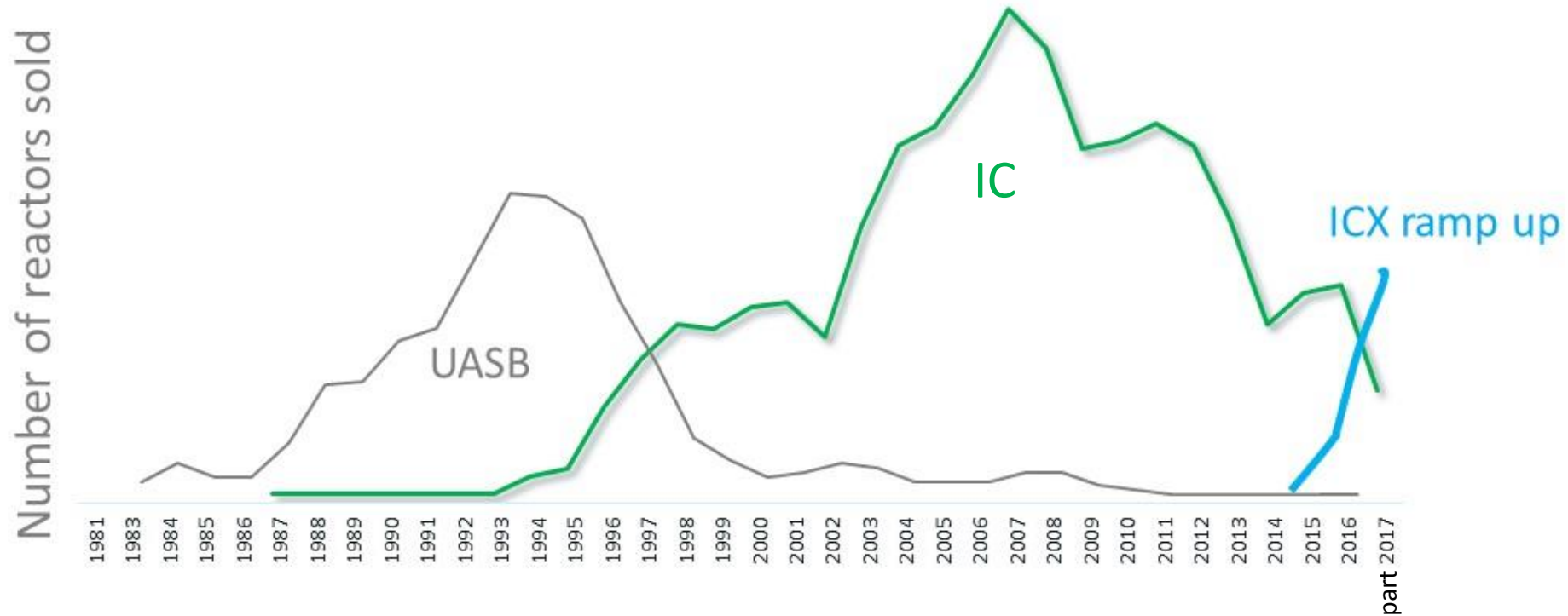
BIOPAQ®ICX incorporates the best of all its predecessors!

- Excellent properties of the BIOPAQ®IC
- The modular flexibility of the BIOPAQ®UASBplus
- Unparalleled cost competitiveness

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The anaerobe product life cycles could almost be straight out of a marketing textbook

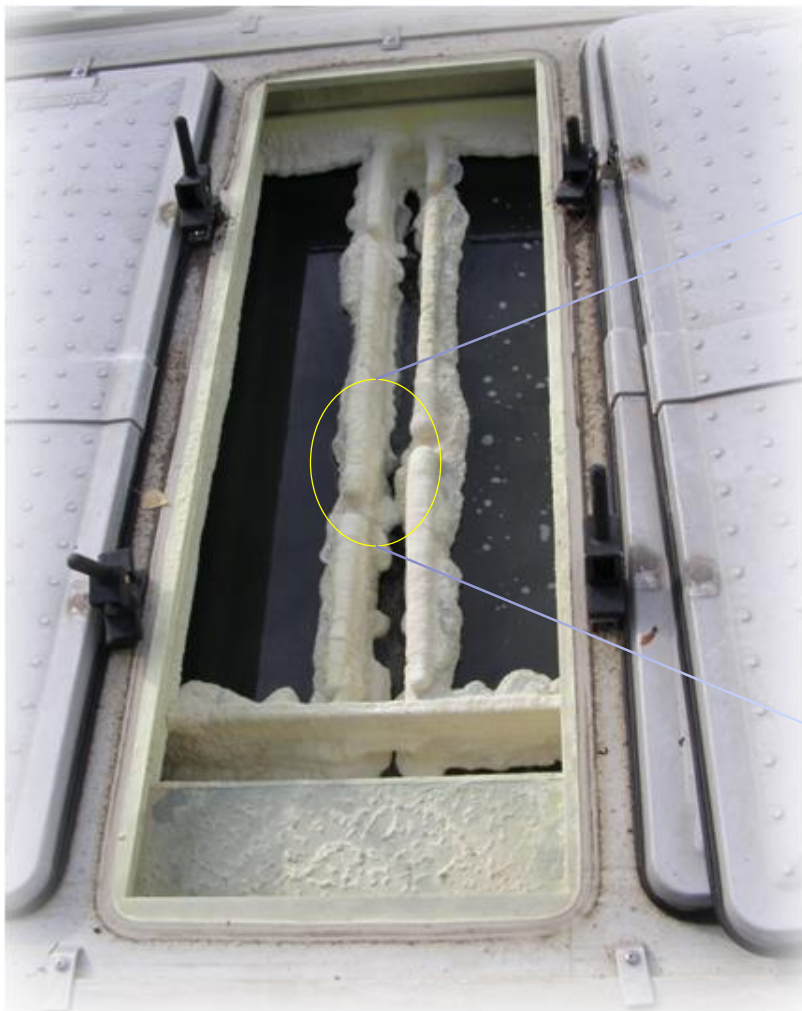


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Attentive eyes had noticed that not only biogas was being formed in the Anaerobe reactors



Wat is dat?



Theo the Thiopaq®

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An analysis of the biogas revealed that it was probably related to Hydrogen sulphide

Compound	Vol%
Methane (CH ₄)	50-90
Carbon dioxide (CO ₂)	10-45
Water (H ₂ O)	0-5
Hydrogen sulphide (H ₂ S)	0-3.5





A PhD student solved the riddle

The Entrepreneur meets the Innovator



Prof. Cees Buisman

“The Innovator”

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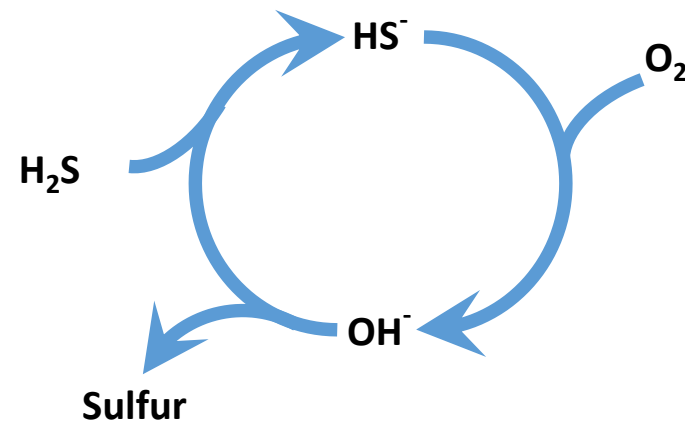
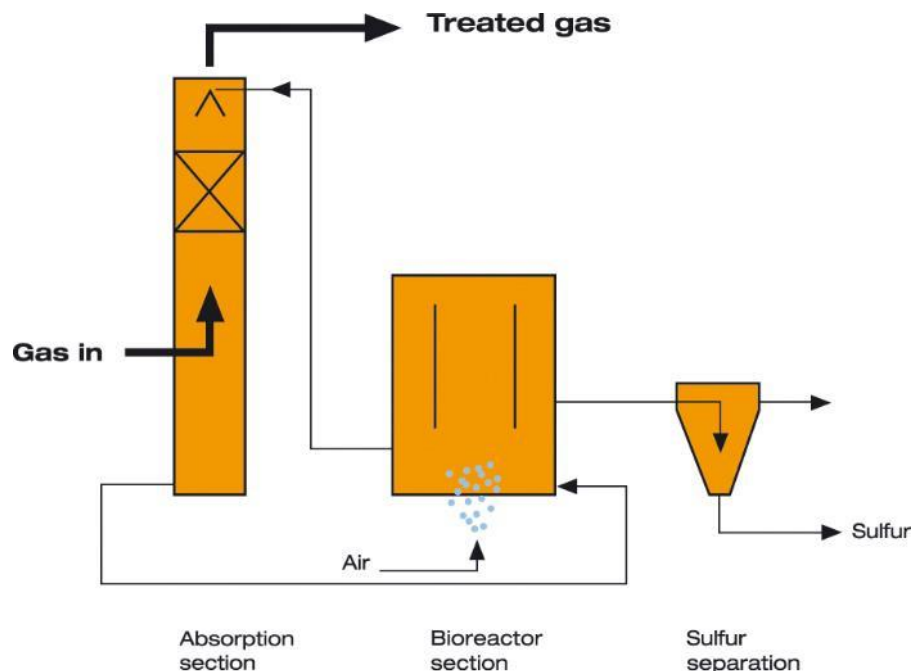
Good-
looking !
(don't ask about
the smell)





The Thiopaq® process was developed to convert H₂S to sulphur

“Caustic scrubber with wash-liquid regeneration”



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0.02 ton S per day



0.5 ton S per day



0.9 ton S per day



2.8 ton S per day



4 ton S per day



13 ton S
per day



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For petrochemical applications, Paques and Shell have set up a Joint Venture



Gas desulphurisation with recovery

Paqell.

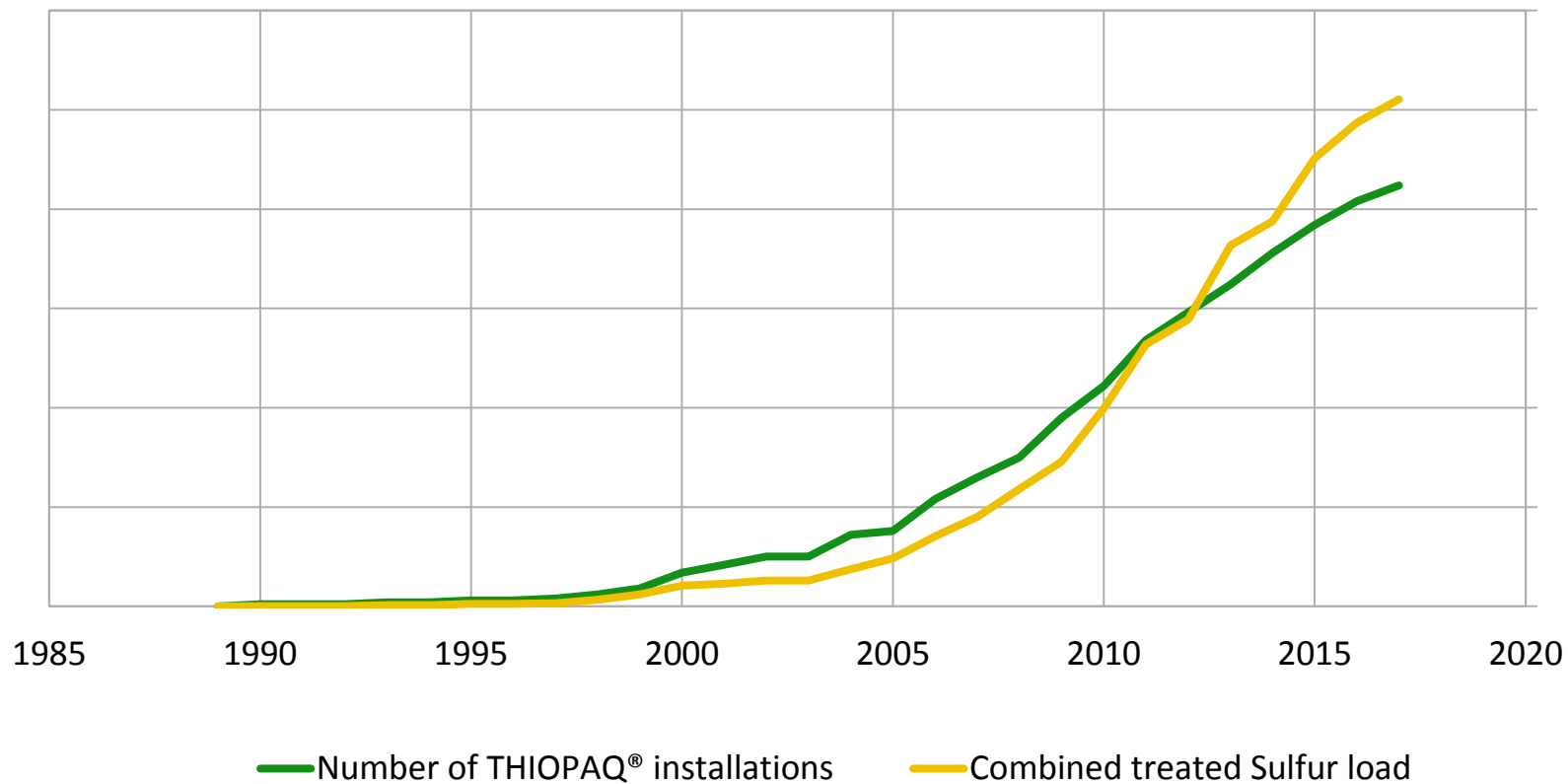
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THIOPAQ® has grown into a mature technology

- More than 25 years on the market
- Present on all 5 continents
- >200 references treating > 125 tS per day



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The success of THIOPAQ® is due to its superior technology and clear added value

High removal
efficiency
<20 ppm H₂S

High **reliability**
>99%

Watch this space
for new
developments

Low
operational costs
<0.5kg_{NaOH}/kg_S

High biogas **quality**
No dilution with air

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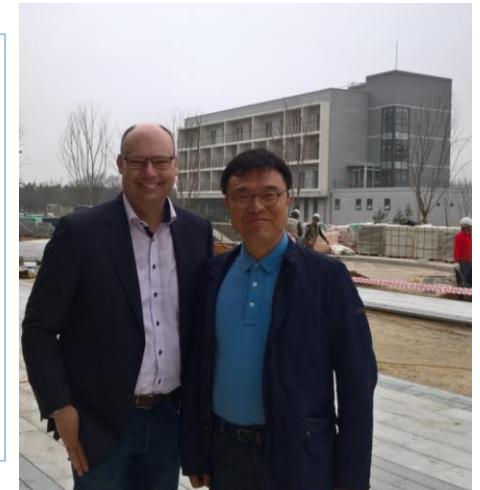
FERTIPAQ® sulphur fertilizer has been launched



 **FERTIPAQ**
Natural Solutions

- Many market entry challenges need to be overcome
 - Unmatched demand and supply location/time
 - Biocide and Fertilizer regulations set high hurdles for new entrants.
 - Farmers request total solutions, not only Sulphur
 - Biosulphur incompatible (too small, wrong form) with traditional sulphur distribution channels
 - Research into best applications needed
 - Etc., etc.

Co-operation
and JV between
Paques & EcoBio
in Korea on
application research
& distribution of
Biosulphur



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Innovation is the basis of Paques' existence



International patents:

Granted & active patents Globally: **28**
(individual patents active in various countries)

Pending patents globally: **11**



Patent submissions increased due to increased investment in R&D



Chinese utility model patents: **46**



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Applications 2005 – 2016 Paques/**Paqell**



and to remain at the cutting edge of innovation,
Paques partners with prestigious institutions.



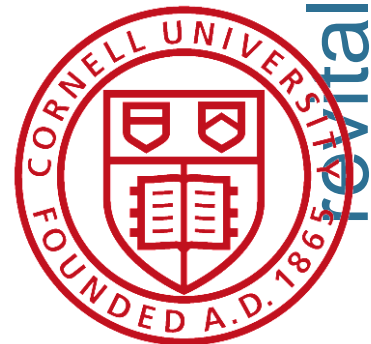
UNIVERSITY OF TWENTE.

Paqell.

TKI•BBE



TU/e



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Curiosity as to why a mass and energy balance did not add up let to the discovery of Anammox



TU Delft Delft University of Technology

- Prof. Mark van Loosdrecht:
 - Lee Kuan Yew Water Prize
 - Spinozapremie
 - Simon Stevin leermeester
 - Etc.



Radboud Universiteit Nijmegen



- Prof. Mike Jetten
 - Spinozapremie



NWO



NWO

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GRANULES AGAIN!

Anammox[®]
Granules

Anaerobe
Granules

I'm Ana
the
Anammox[®]

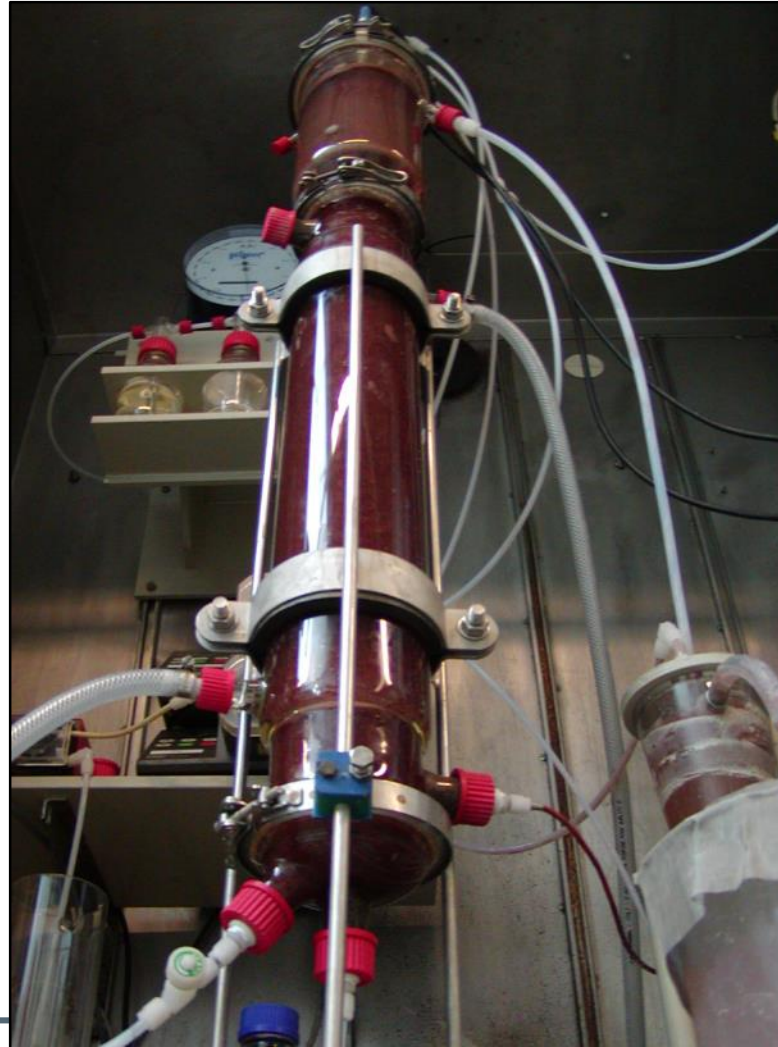


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And from a lab scale unit



Nieuwe technologie
mogelijk maken



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Directly to full scale !



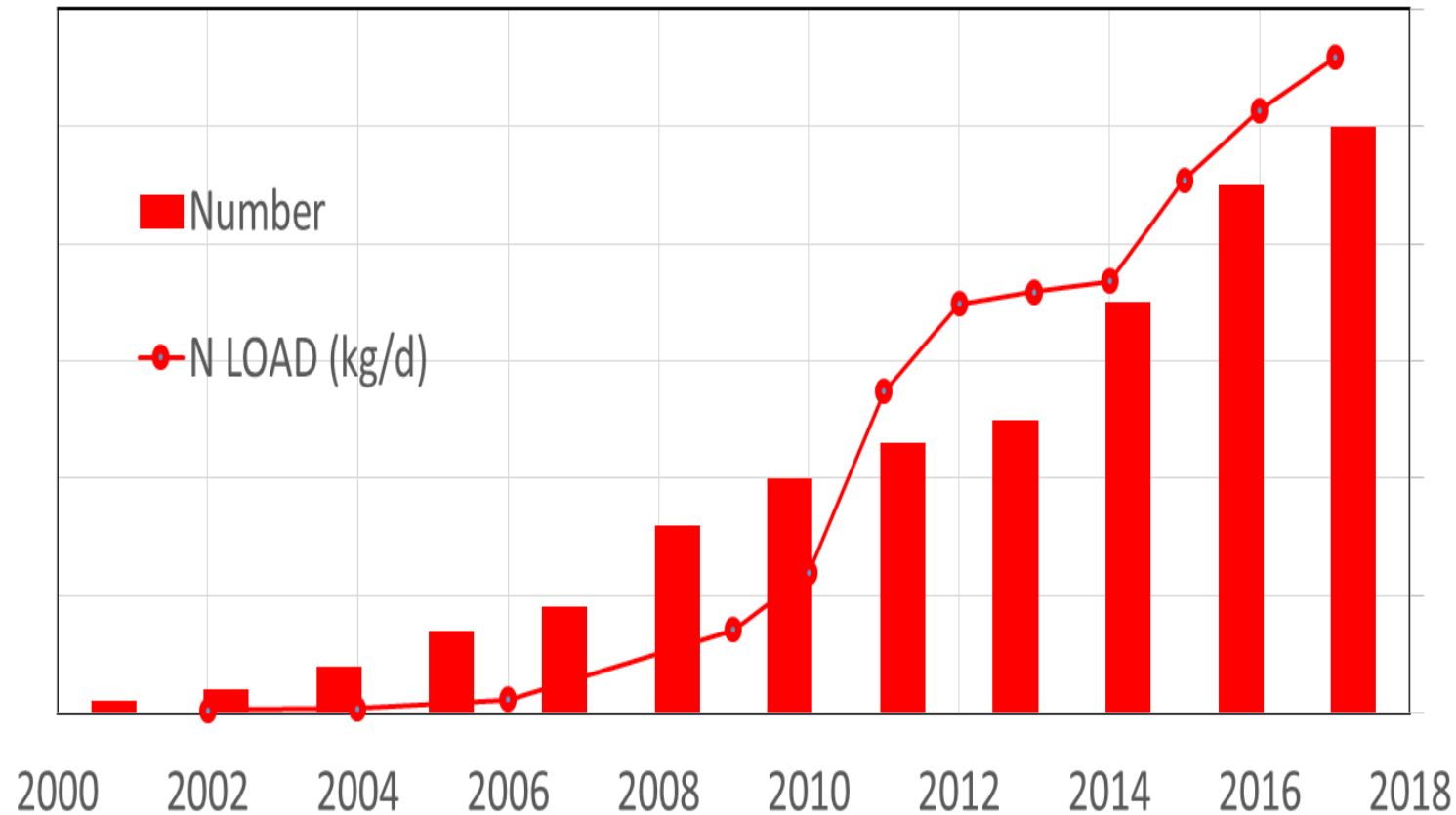
WSHD
STP Dokhaven
Rotterdam (NL)
500 kg N/day (now: 700 kg N/day)

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Paques' has installed over 65% of the entire world's Anammox technology, and growing



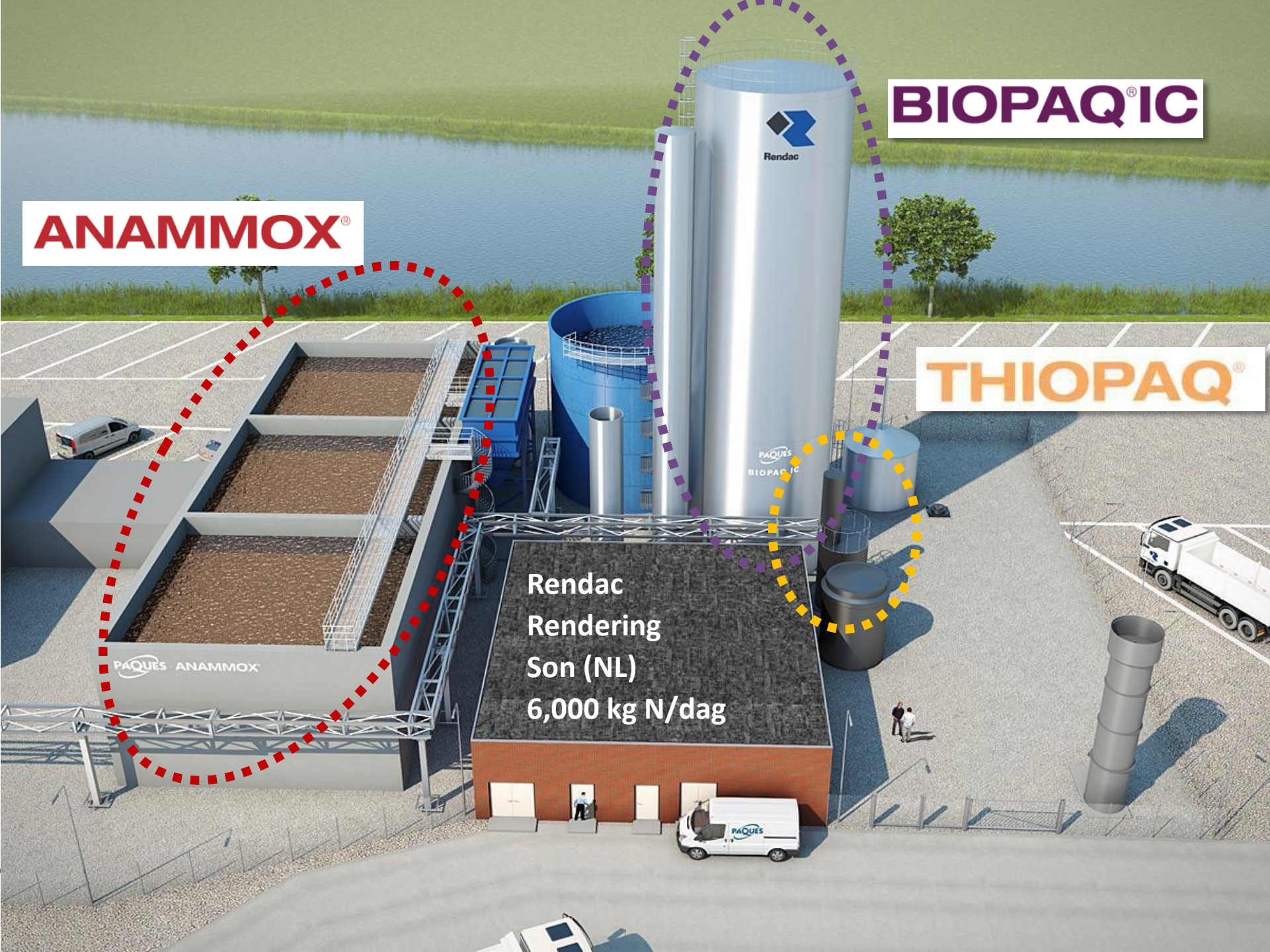
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Largest Anammox[®] in the World:
MEI HUA Group (China)
Glutamate production
11,000 kg N/day





ANAMMOX[®]

BIOPAQ[®] IC

THIOPAQ[®]

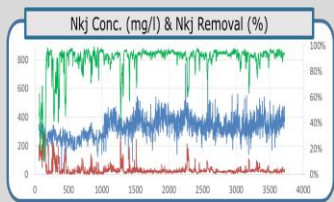
Rendac
Rendering
Son (NL)
6,000 kg N/dag

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Superior technology – particularly its robustness - with favorable economics explains the success of Paques' ANAMMOX[®]



Most robust process



Easy use of granular BioCatalyst



Lowest energy demand

15 YEARS

Proven Technology



Smallest footprint – Compact installation



Single source supplier for N & P

115,000 kgN/d

Largest installed base



Create 'Resource factory' in combination with PHOSPAQ

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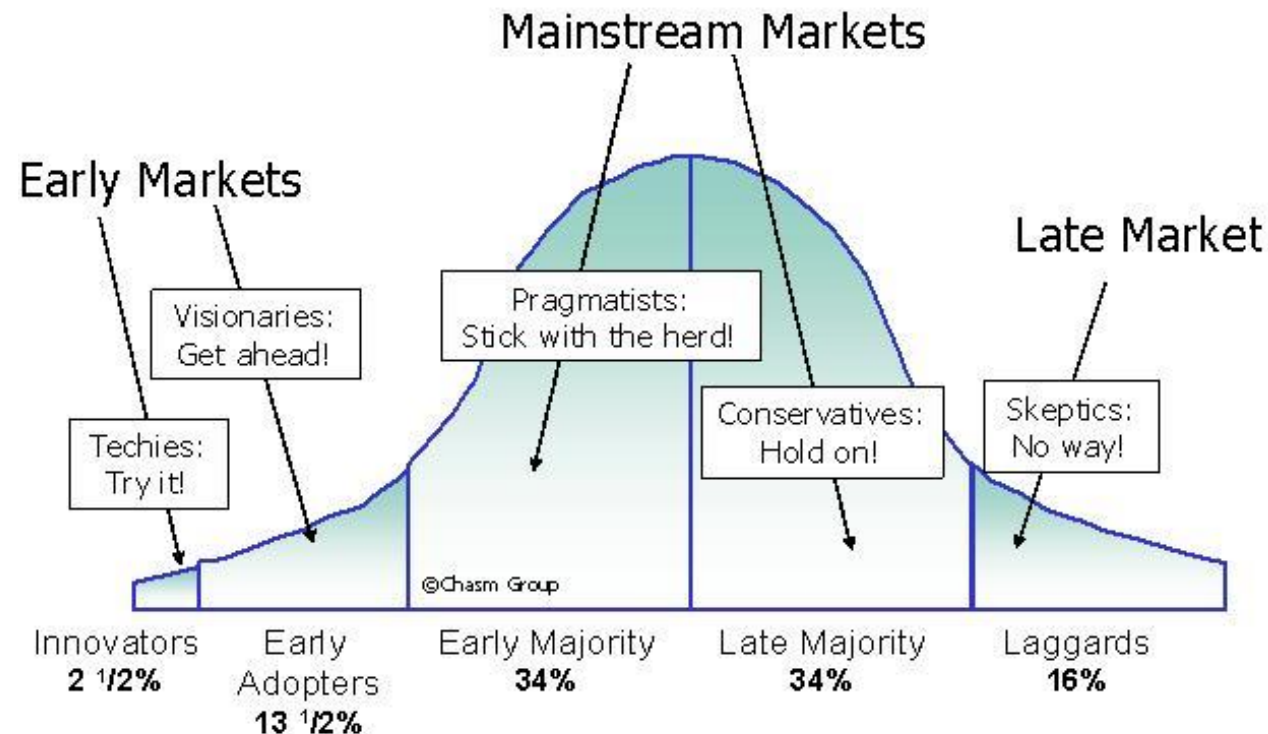
Amonnia recovery is generally neither cost nor energy competitive !



Now, if you have found a launching customer, the rest of market may follow, but.....

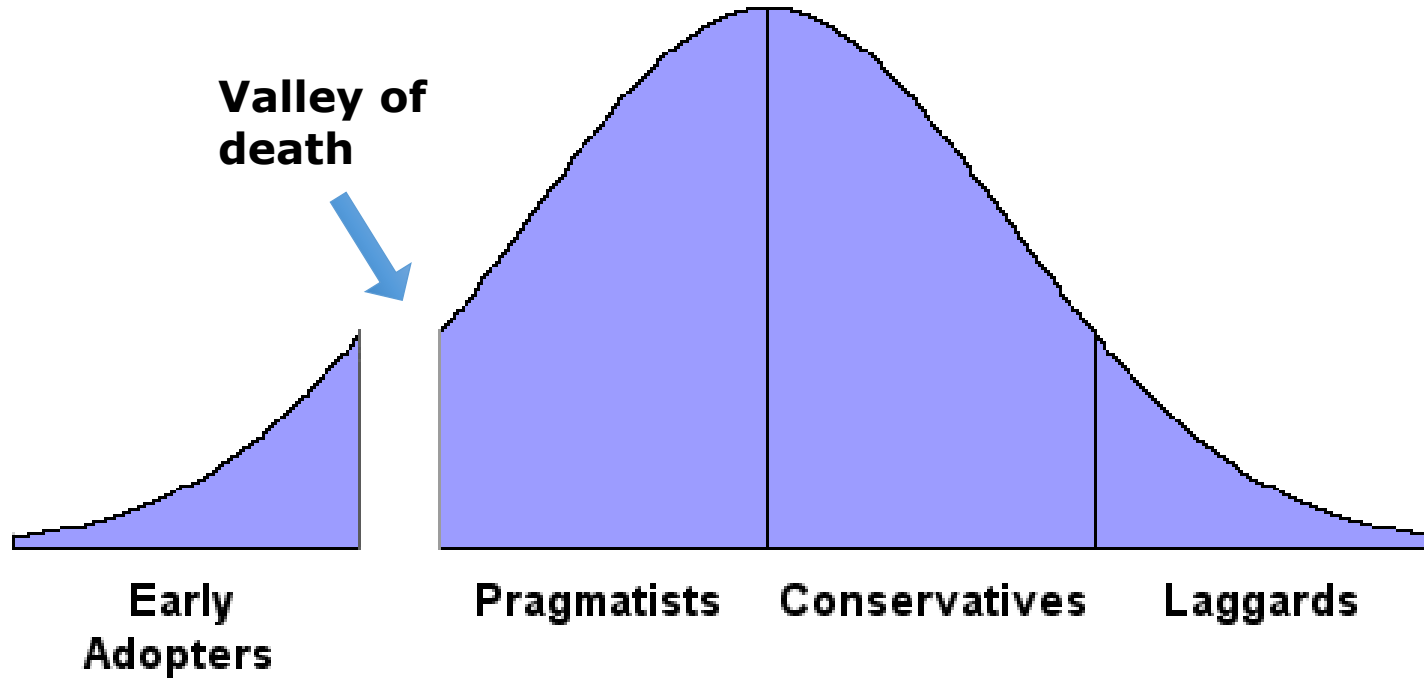
Technology Adoption Life Cycle

Groups are distinguished from each other based on their characteristic response to discontinuous innovations created by new technology



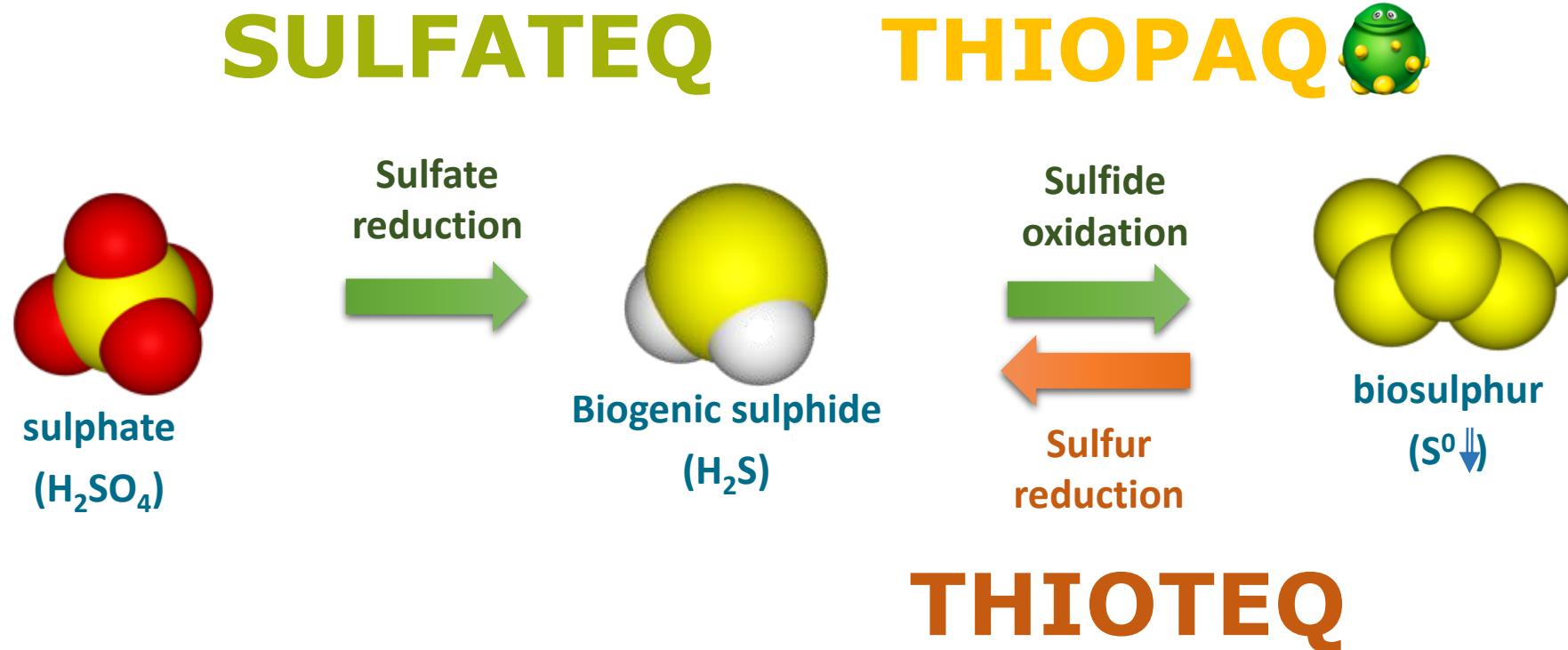


.....beware of the “valley of death”





Paques has been providing solutions to the mining industry since 25 years...using the biological conversions of the sulfur cycle.



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The World's First Gypsum-Free Zinc Refinery In 1992



Paques built two tailored biological systems to reduce high sulfate load



SULFATEQ™





THIOTEQ™

The largest bioreactor producing 20 ton H₂S/day worldwide to produce copper



BARRICK

Pueblo Viejo Dominicana Corporation (PVDC)

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Very slow sales cycles and perceived distraction at customers, leads to commercial failure



Barrick is leading global player in mining.



First **THIOTEQ** was a tailored solution to produce copper when chemical process was not suitable)



First reference sold in 2006 in the Dominican Republic.



- ✓ Pilot 1996
- ✓ Sold 2006
- ✓ Start up 2014



The project execution and investment in mining is long



Bioprocesses are:

- Foreign in the mining industry
- Perceived as unstable and complex

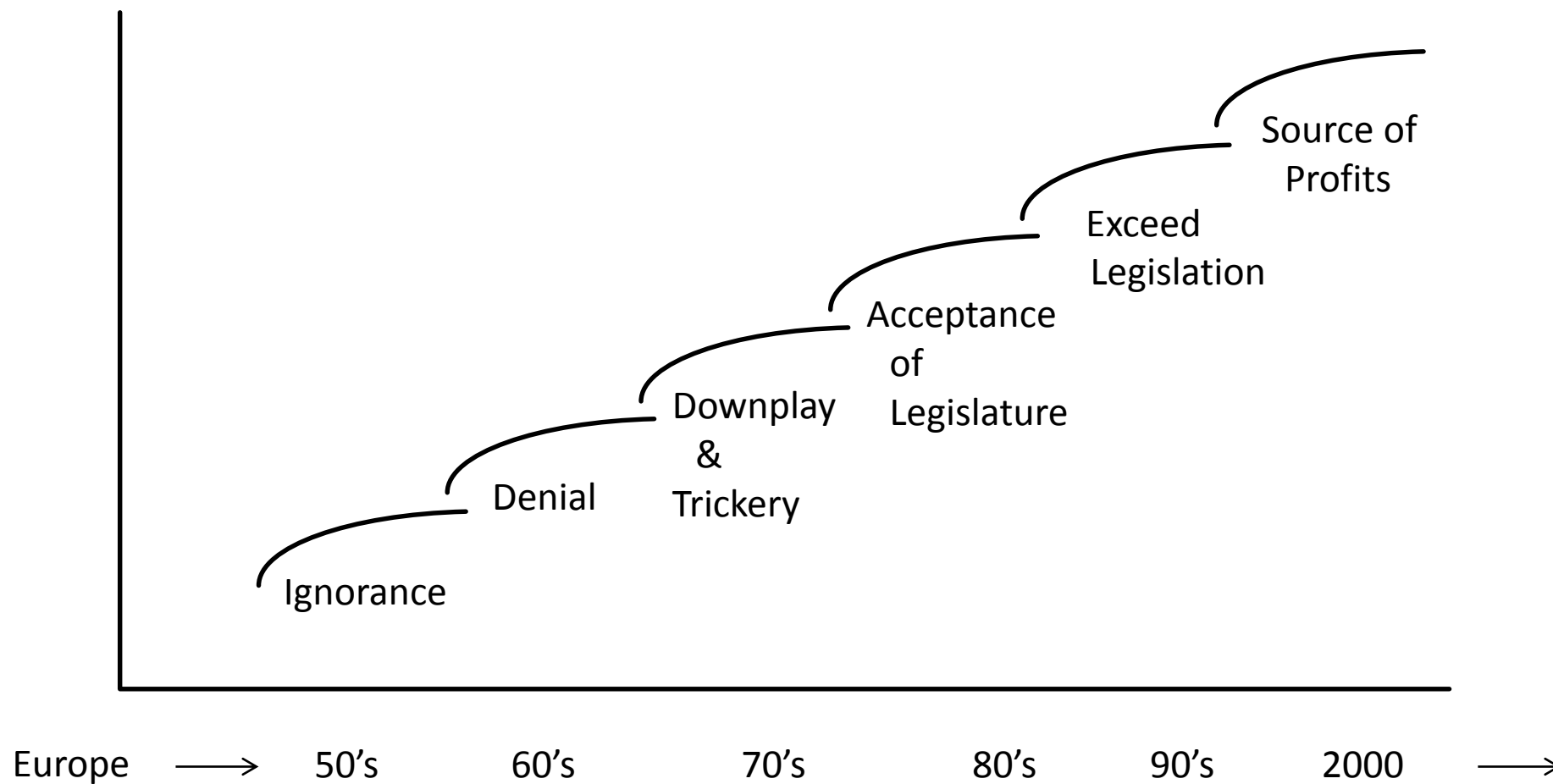
The value added, was "only" 15 Mio USD/year, not worth the effort in a Billion USD/yr mine



The potential to find the same water composition and customer needs in a gold mine was calculated of 1 in 1000.



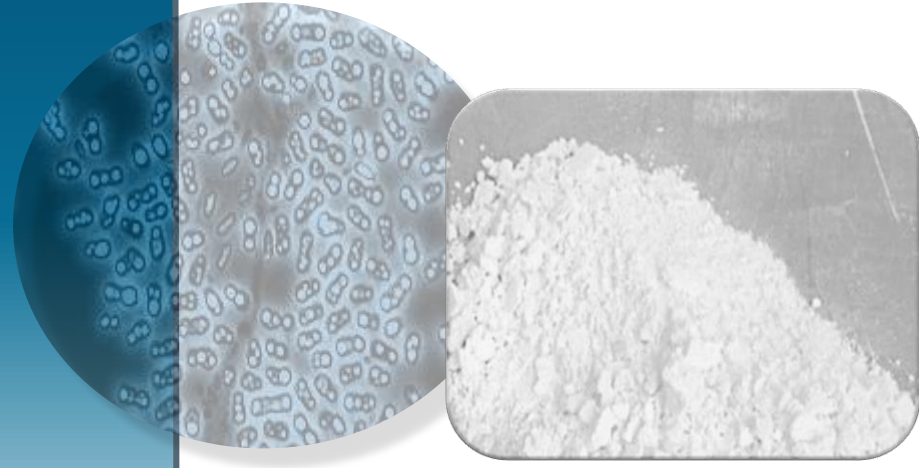
Netherlands is ahead of the curve in its approach to the environment



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Together with TU Delft, Paques is developing the wastewater treatment plant of the future: BIOPLASTIC PRODUCTION (PHA).



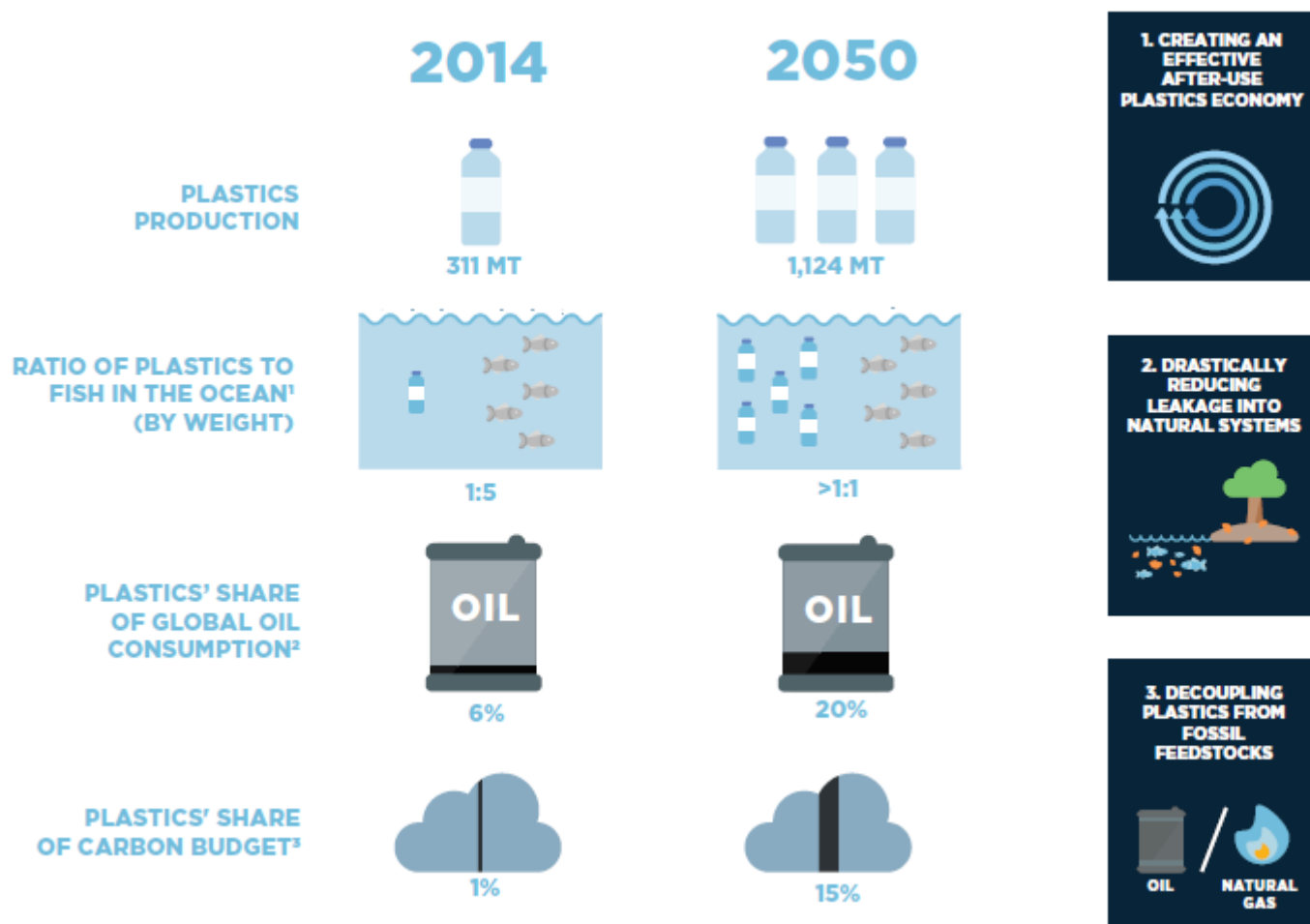
Common and widespread storage material in microorganisms. Properties similar to petrochemical plastics

Biodegradable and made from
renewable resources!





Drivers for the New Plastic Economy



Ref. World Economic Forum, 2016, The New Plastic Economy

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The bioplastic production has been demonstrated on wastewater in different industries.



2012-2014
(NL) Chocolate
Wastewater



2014-2015
(NL) Paper
Wastewater

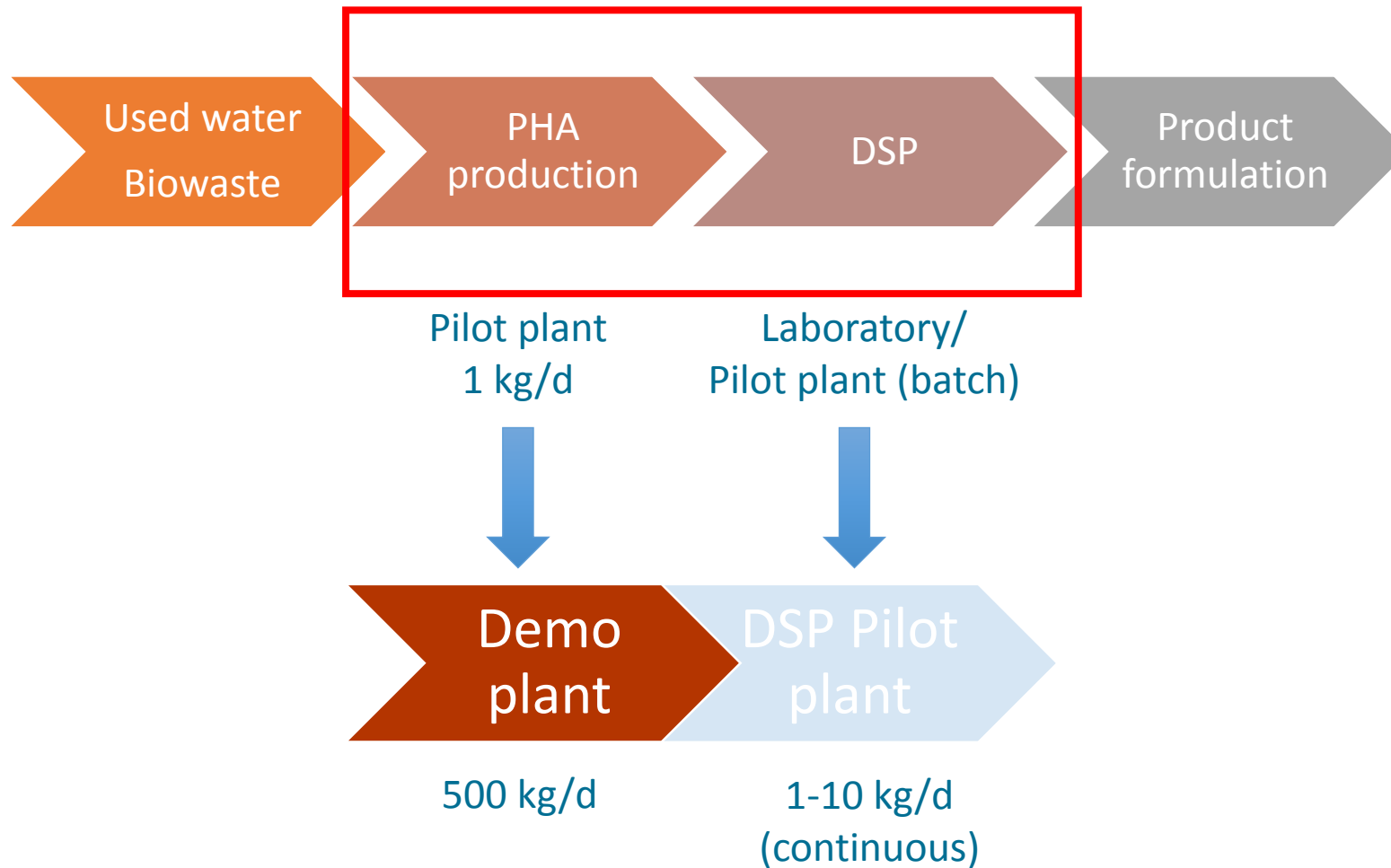


2016-
(NL) Organic Waste

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In 2018 we hope to scale-up to demo-scale



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It is relatively straightforward to get the early phases of research funded

- Paques is involved in many university driven R&D projects to build and maintain strong relationships in the academic world.
 - Co-funding on an in-kind or cash basis
 - In return Paques gets some form of IP rights ranging from a right of first refusal to a non-exclusive royalty free license (depending on the level of funding)
- From experience: industry involvement improves the success rate of a subsidy proposal.
- Up until pilot studies, funding opportunities are plenty and subsidies are relatively easy to acquire.



However, it is much harder when you get to demoscale...

- Very low success rates...
 - Sometimes feels like gambling, particularly if from the review comments it is evident that the “expert” jury member is clearly not experienced enough in the field
- Lead times (up to 1 year) from proposal submission until granting do not match with modern-day innovation speeds
 - If a project is not granted, a full year is wasted!
- Often awkward partner requirements
 - Minimum of 3 countries and 3 partners
 - For a successful demo project you need to be free to select your partners irrespective of country or number!
 - Complex, unnatural consortia creates inertia, which is not improving innovation!
- Once funded, project management can be **VERY** bureaucratic, particularly in EU projects.



Successful Innovation : passion, co-operation between complementary partners, understanding the market & luck



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Get your free Poppetje
afterwards

I have Andy the Anaerobe, too !

