



Biomassa voor Energie- en Voedselzekerheid, een uitdaging voor iedereen!

Patricia Osseweijer
BE-Basic
Delft University of Technology

Overview

- Drivers, challenges and opportunities
- Innovation agenda
- Support for sustainability?
 - Rational – versus – emotional
 - Emotions on Biobased economy
 - Cultures and norms
- Implementation?



Global drivers for a BBE ?

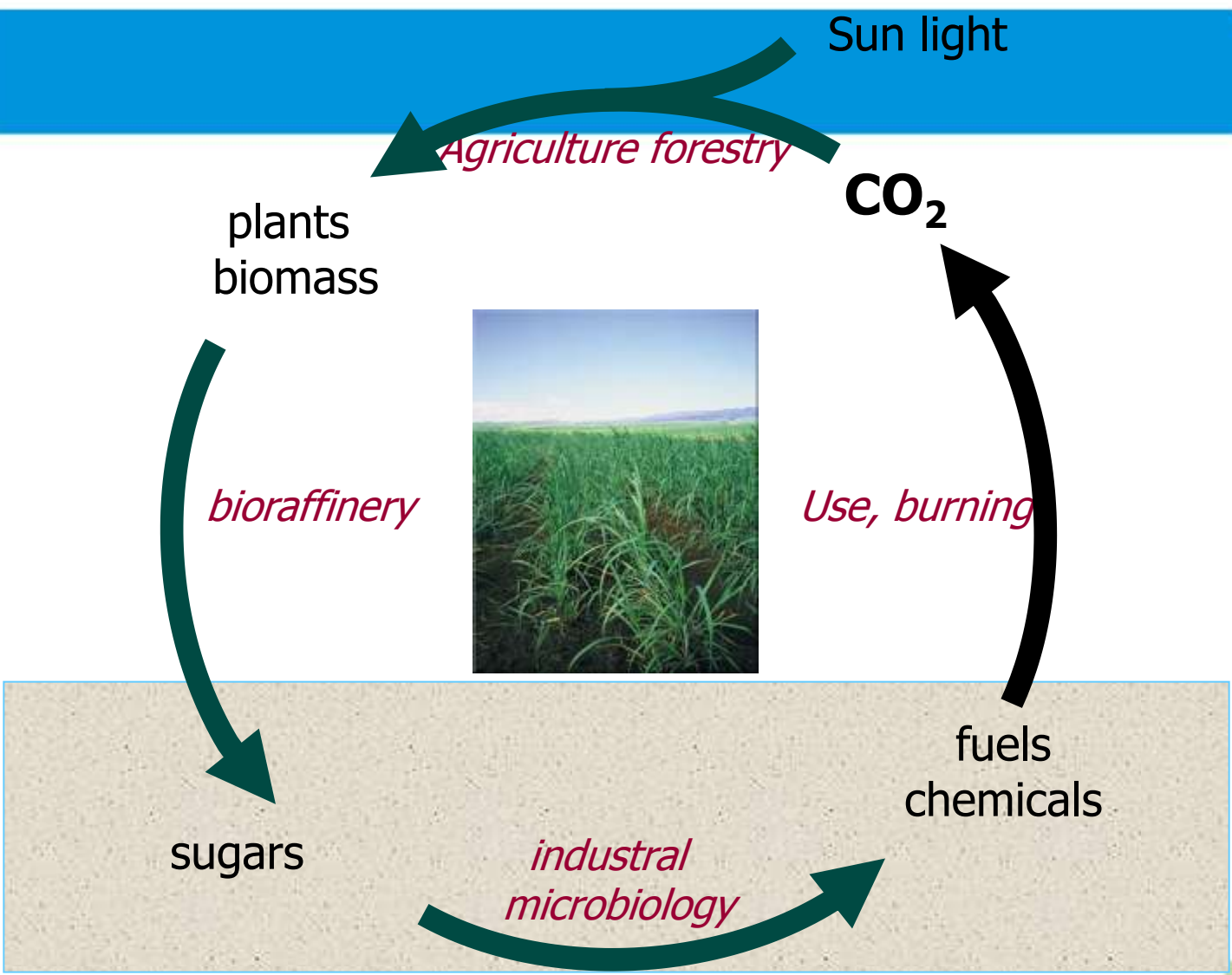


- more people with more wealth
- less **nett** GHG emission (global warming) and/or climate adaptation
- politics (security of oil/gas supply)
- innovation, rural income and economic development
- increasing (*and decreasing*) prices of resources
- in time*, limited fossil reserves
- **add sustainability to food chain**
- **add value to food chain and prevent hunger**

Pick your personal selection !



Industrial Biotechnology: Balans in de Carbon cycle



Life in a Delta is ...

River erosion



Settlement



Leaking earth dams



Dike breach

Bioenergy: challenges

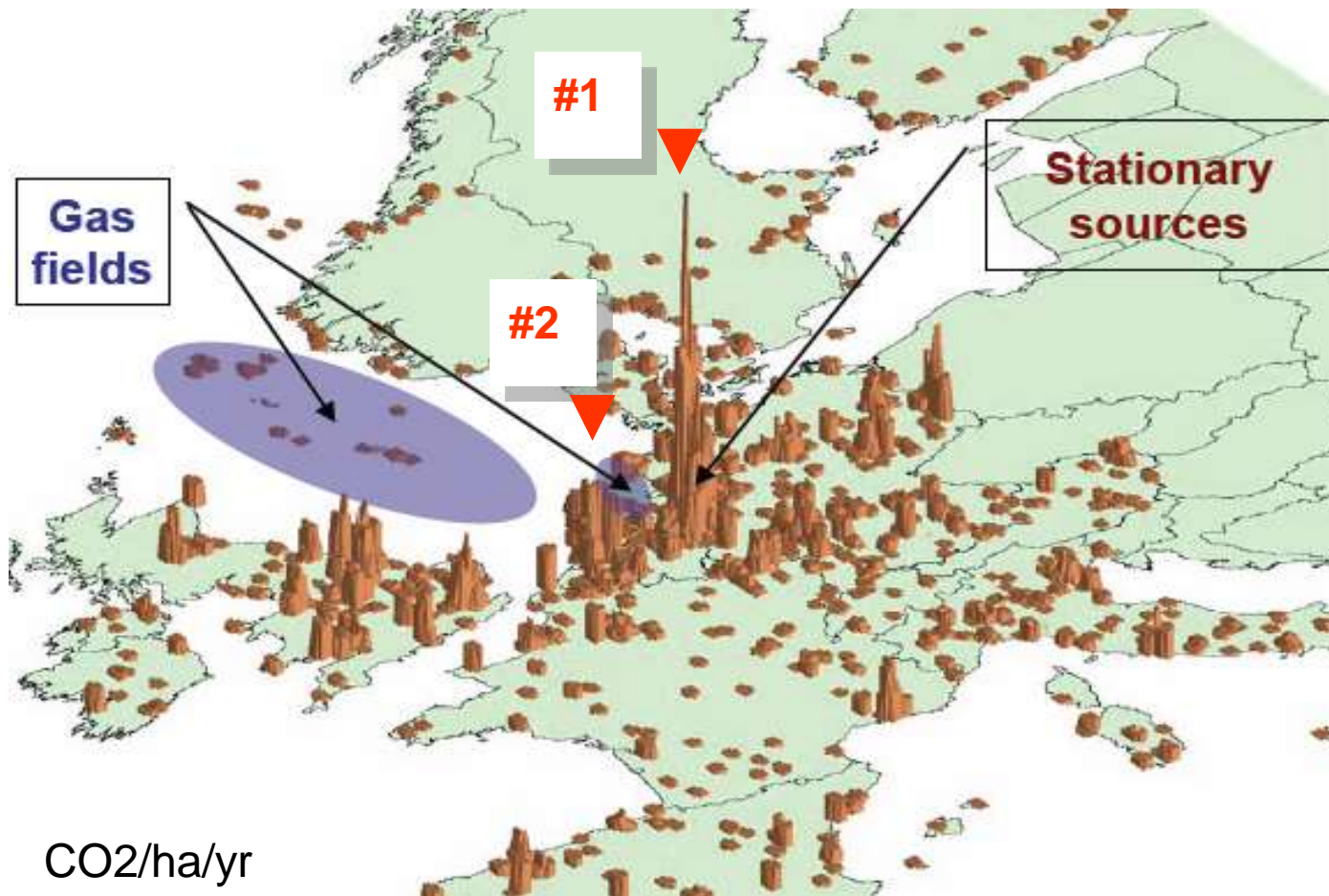
Macro-economic studies indicate*:

- With current oil price biofuels not competitive (except Brazil?)
- **Shale gas and economic situation** is challenging this even further
- Depends strongly on fossil price and **bioenergy/biofuel policies**
- **Volume dependent on policies/directives**, such as subsidies for fossils and EU directive



* Hans van Meijl, LEI-WUR

NRW and NL are #1 and # 2 in Europe



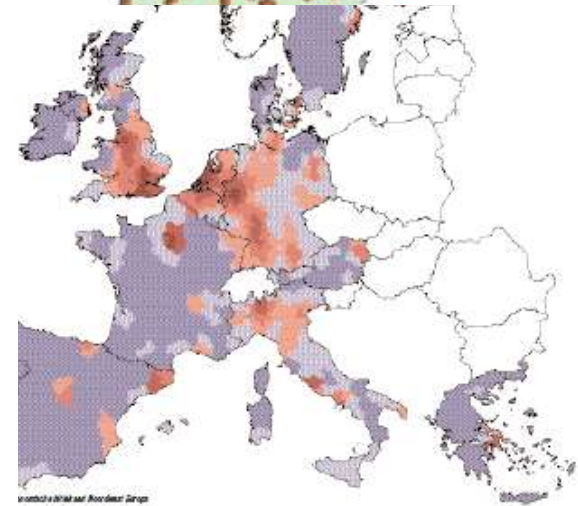
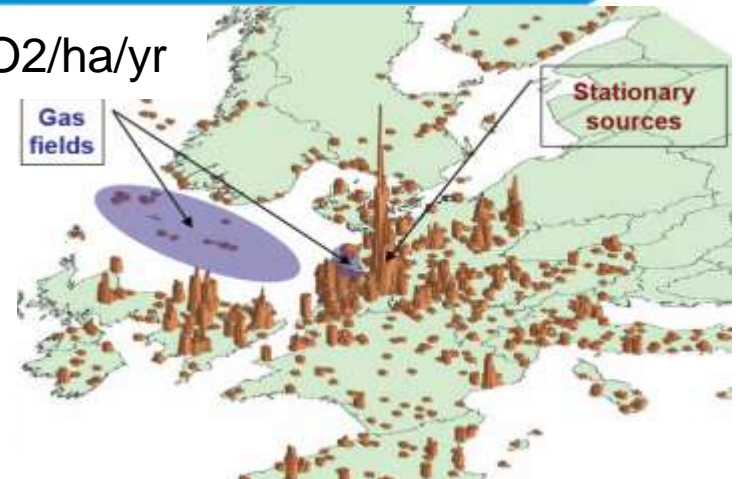
... in CO2 production !

Two sides of the coin in NW EU*

GDP € 512 bn (#20 in 2010) 
chemicals €13bn / 3% of GDP
€47bn sales / 20% export
energy **€30bn sales**
imports 150 MT oil/ gas / 30% EU
emissions 224 MT CO₂e/yr

GDP € 2500 (#5)  543 bn (#19) 
chemicals €46bn / 8% of NRW GDP
€145bn sales / 20% export
energy **€33bn** of GDP
chemical €109bn exports / €87bn imports (12%)
emissions 827 MT CO₂e/yr

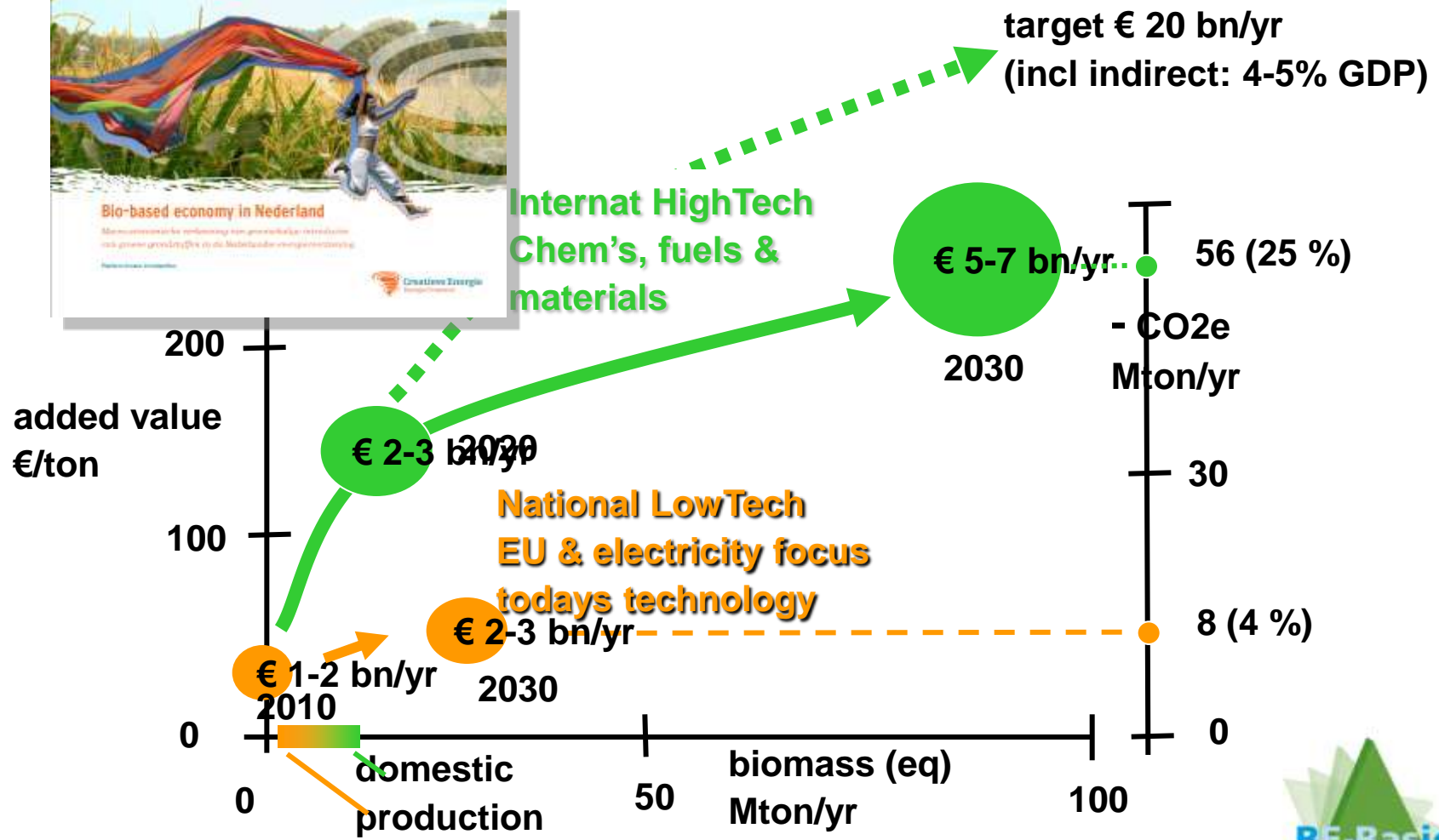
CO₂/ha/yr



jobs/ha (red-high)
Rhine corridor

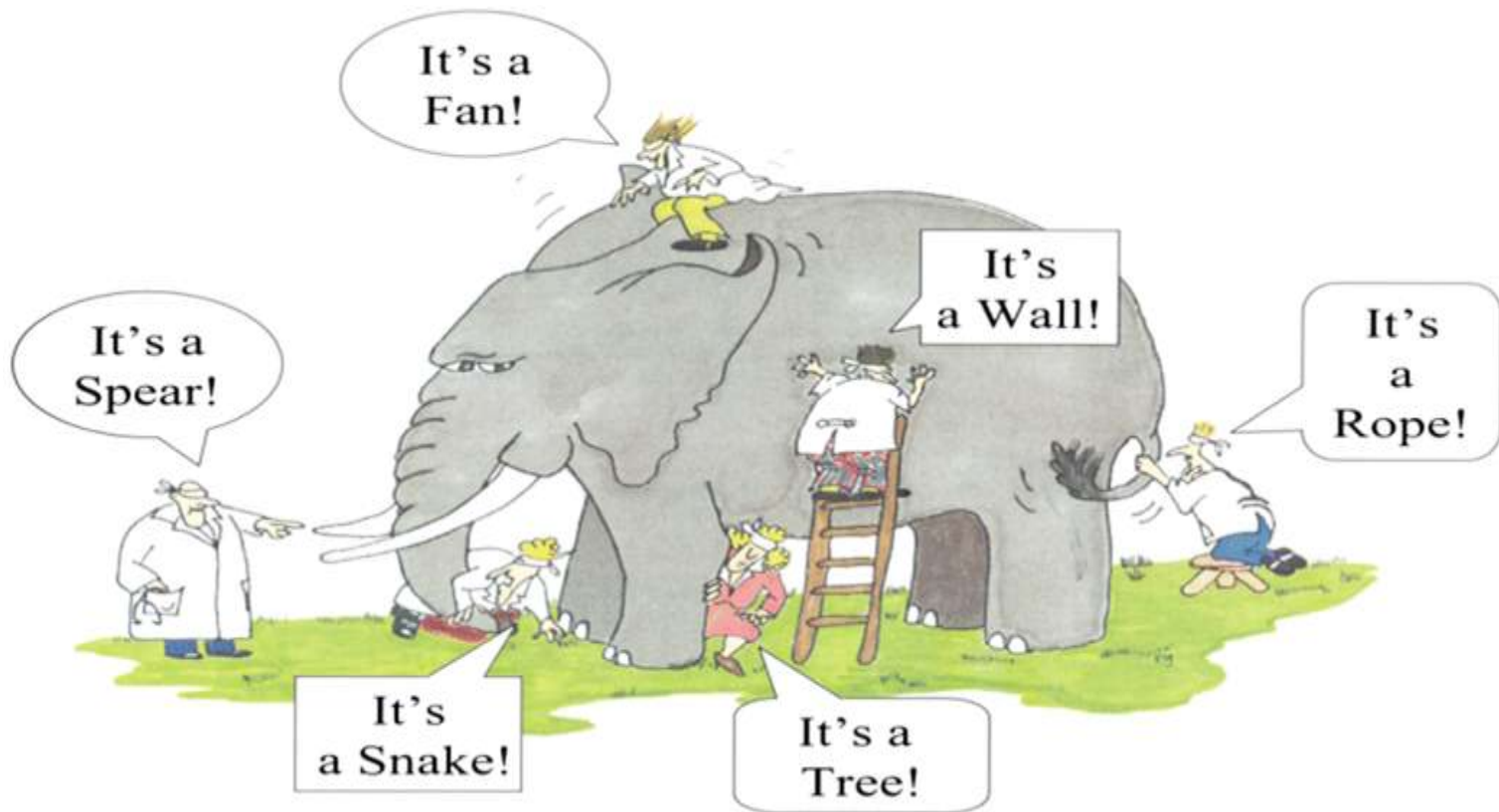


Technology roadmap and (direct) economic impact ('08)



NL: chemistry 2010: € 13 bn GDP (3%) / € 47 bn sales / 20% export ; energy € 30 bn sales

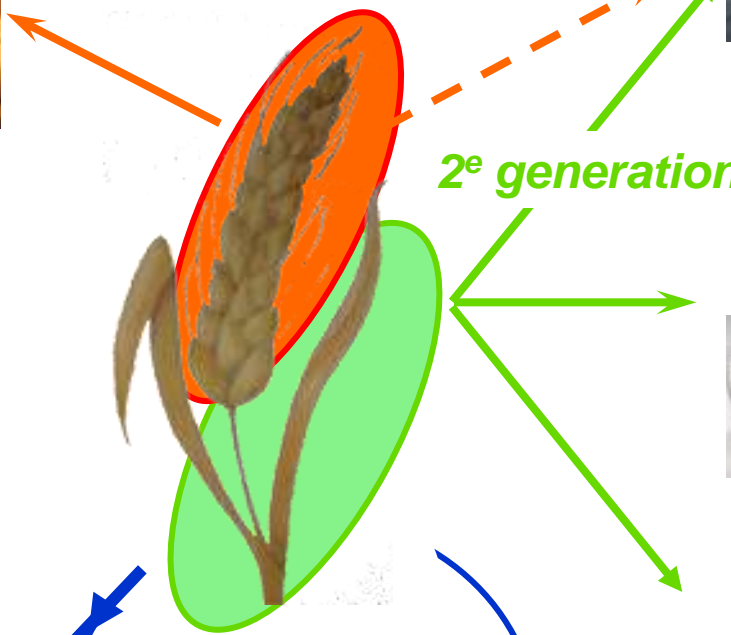
Bioeconomy



BBE : full economic bio-mass-utilisation



“CO₂”
1^e generation



2^e generation



bioplastics



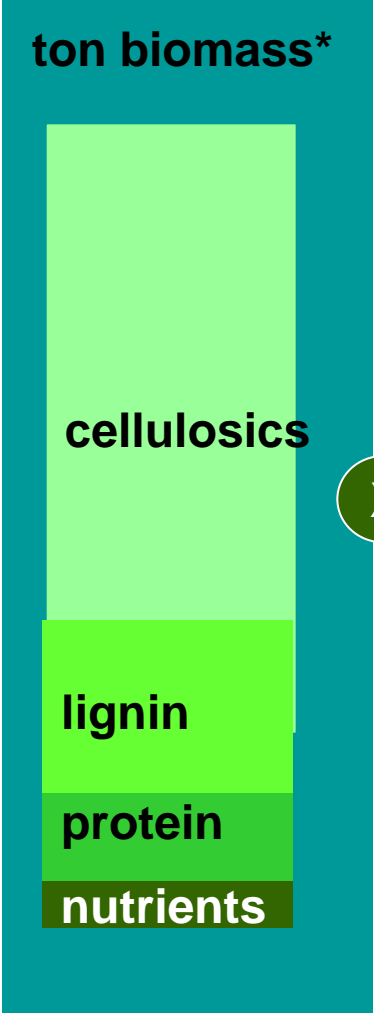
biobricks

agro-emissions
(run-offs, N₂O)

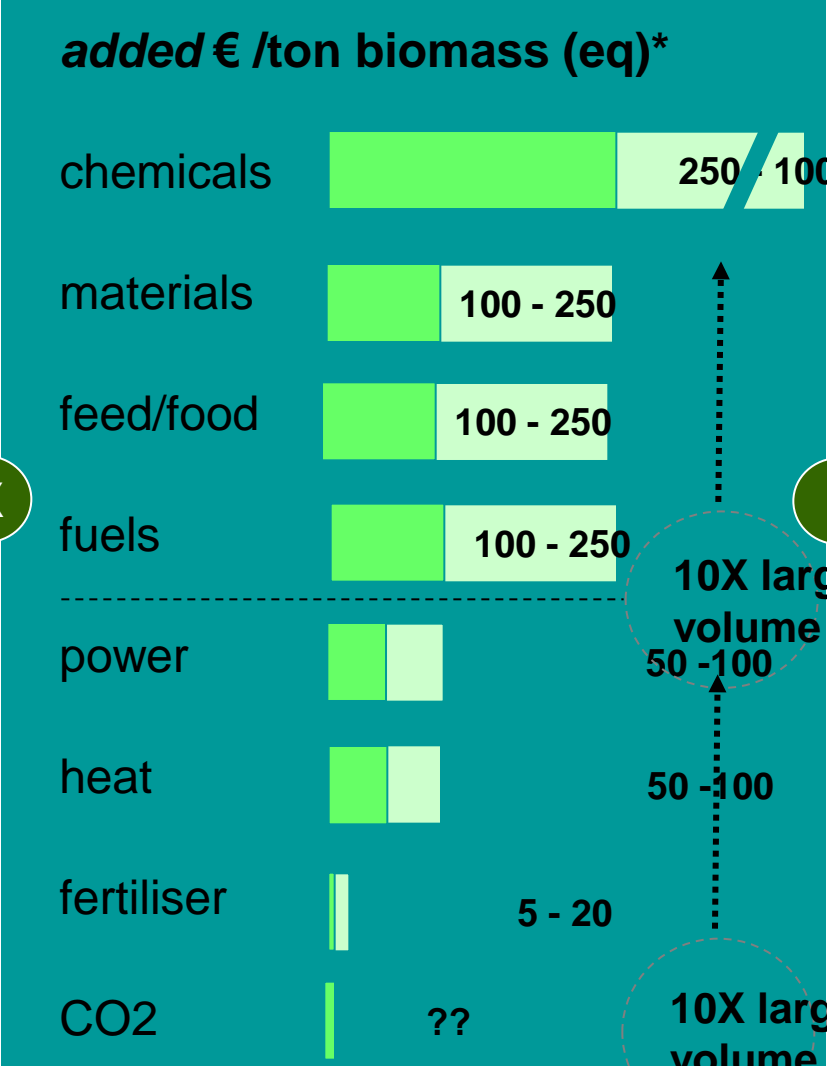
nutrients

BE-Basic

S&T for higher added value portfolio



X



by

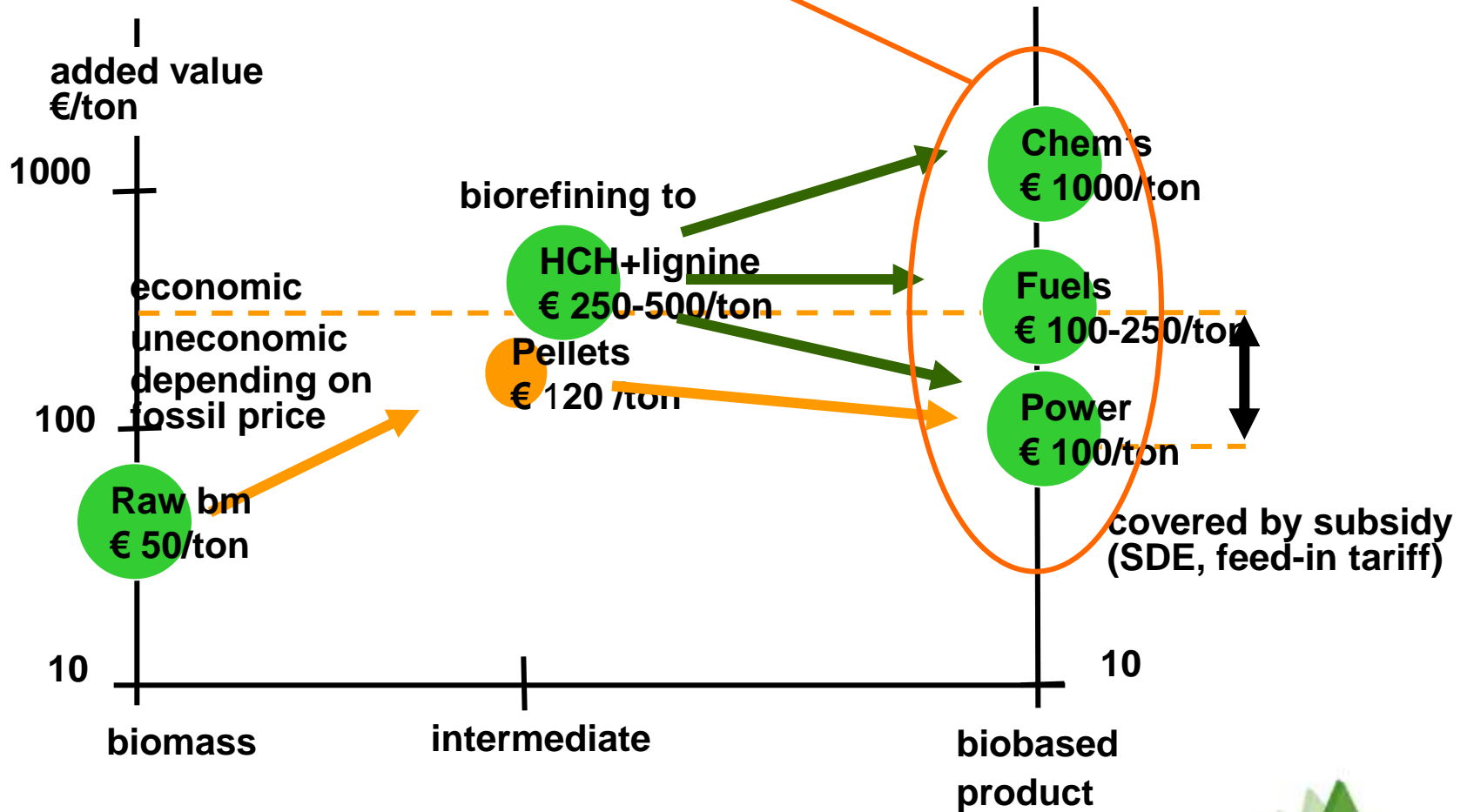
10X larger volume

10X larger volume

- science & techn. fields**
- agro-forestry (A&F)
 - biorefinery (C,E)
 - thermal conversion (E)
 - chem/cat conversion (C,E)
 - indus/env. biotech (C,E,A)
 - process eng. (C,E)
 - feed/food (A, E)
 - chem's/materials (C, E)
 - fuel efficiency (E,M)
 - power & heat (E)
 - socio-econ./ecologics** (all)
- now € 130-180 mio/yr**
- (50 % gov, 25 % private)**

*eq: domestic, imports, derivatives (estim, Mck)

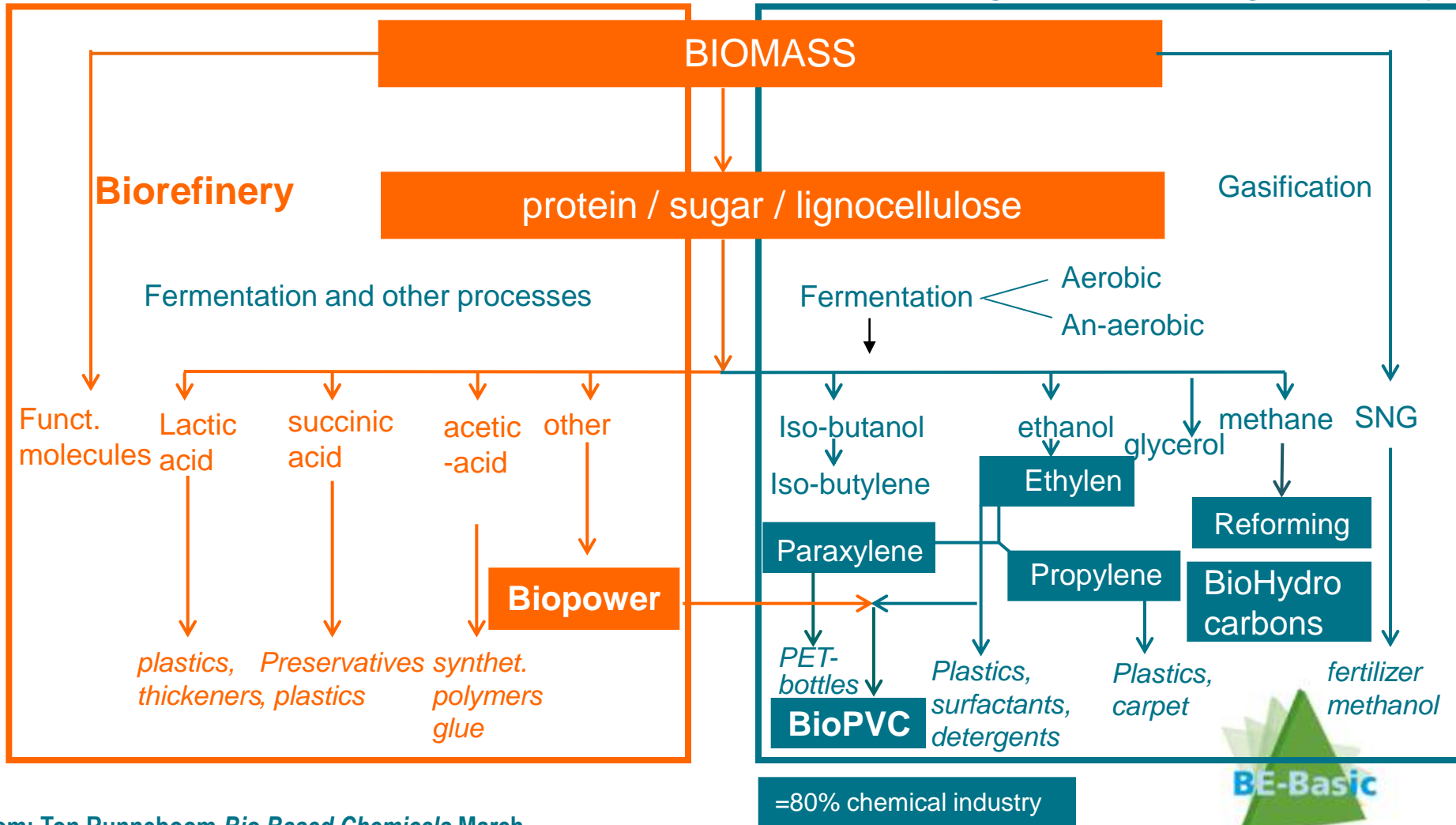
Package of energy **AND** chemicals products gives highest average added value per ton biomass



“Drop-in Greenification” of Chemical Industry

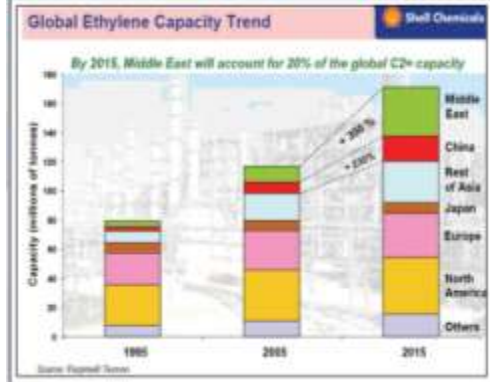
Innovation with added value

Building blocks existing Chemistry

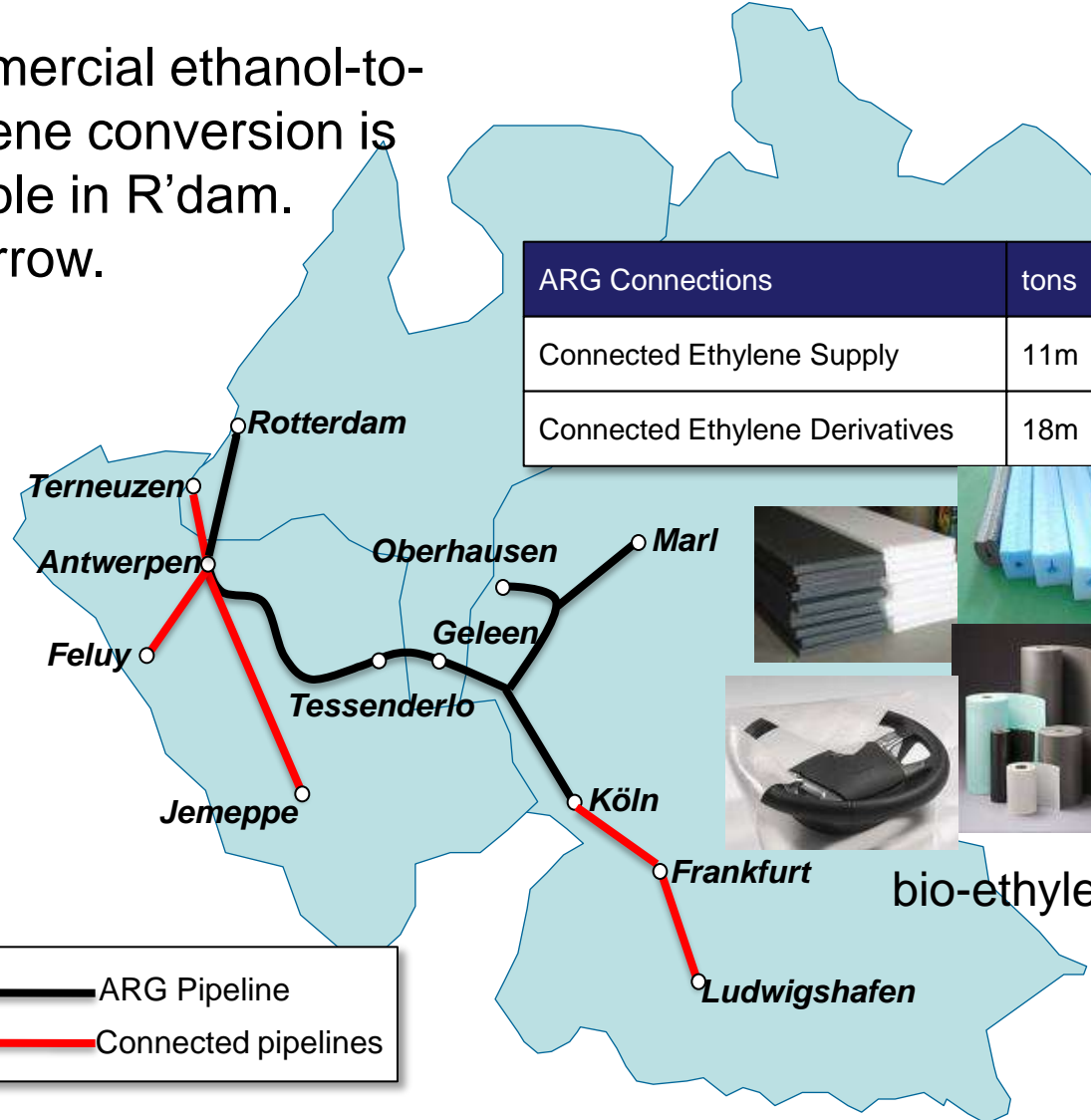


sustainable ethanol can green EU plastics industry fast

Commercial ethanol-to-ethylene conversion is feasible in R'dam. tomorrow.



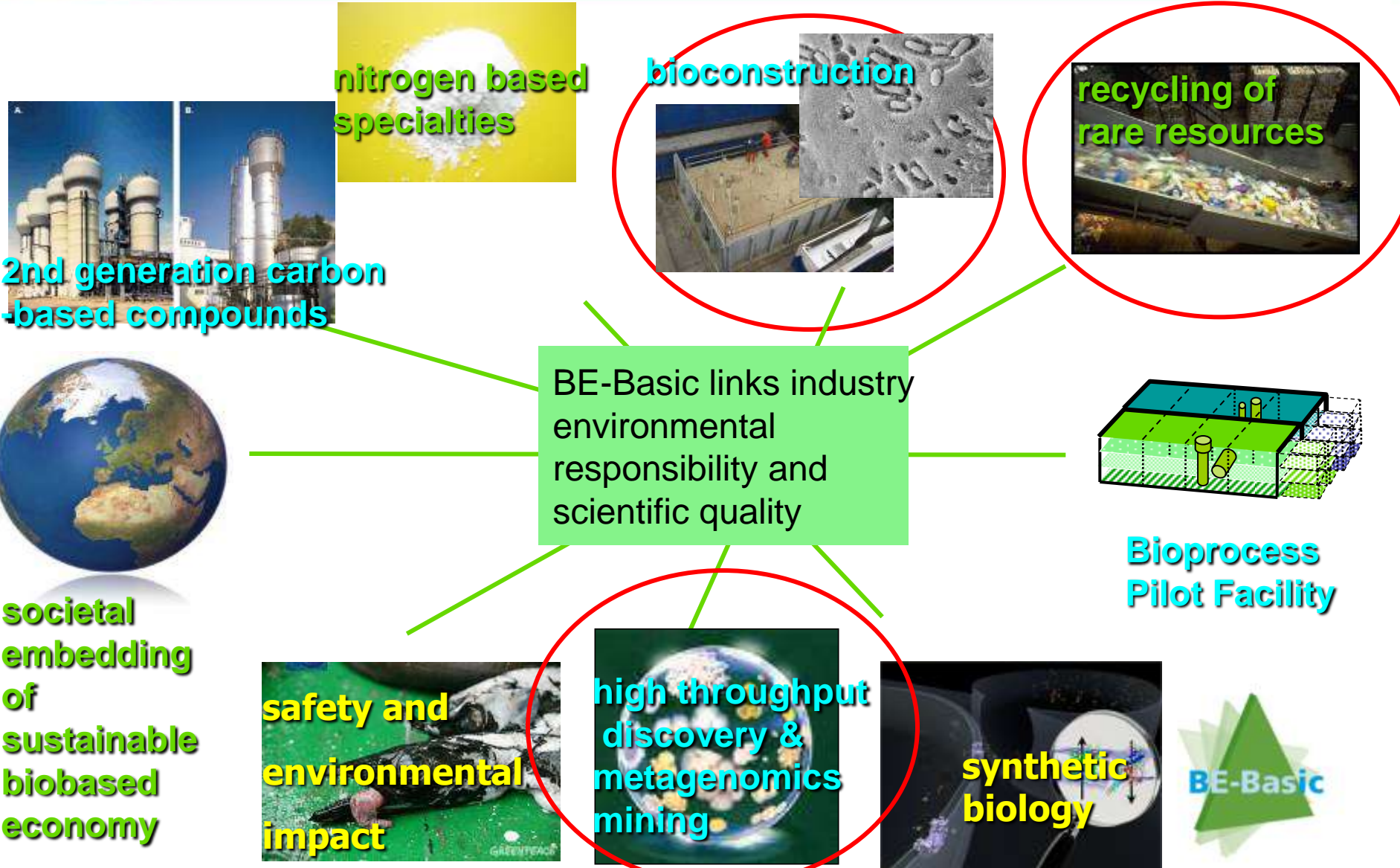
ARG Connections	tons
Connected Ethylene Supply	11m
Connected Ethylene Derivatives	18m



bio-ethylene products



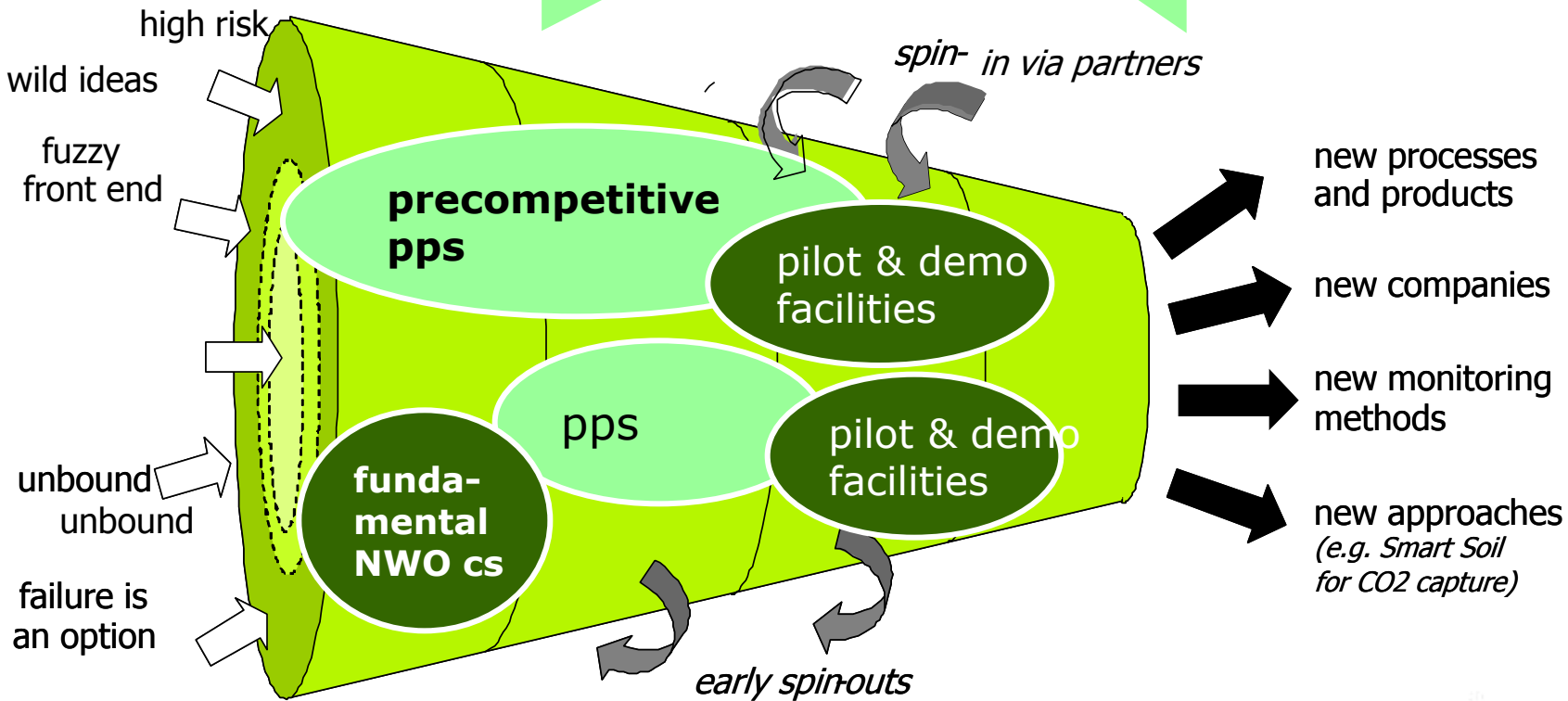
BE-Basic: same sciences basis leads to new inspiration



Innovation strategy

Science & Technology push

market demand



DISCOVER DEVELOP DEMO DEPLOY



Delft pilot facility for innovations in sustainable bioprocesses

Research consortium BE-Basic has chosen Delft as the site for a unique facility where companies and knowledge institutions can develop new sustainable production processes. These processes serve many purposes, such as converting biobased residues into useful materials or fuels. The facility has been specially designed to enable the transition from the laboratory to production on an industrial scale. It allows users to construct complex operations by linking separate process modules.

Pre-processing and treatment

In this module, dry and wet residues are hydrolyzed and prepared for the fermentation phase.



Training

The facility is also a centre of expertise where students, researchers and technologists can be trained.

Permanent crew

The facility has a permanent and experienced crew whose services are available to every user.

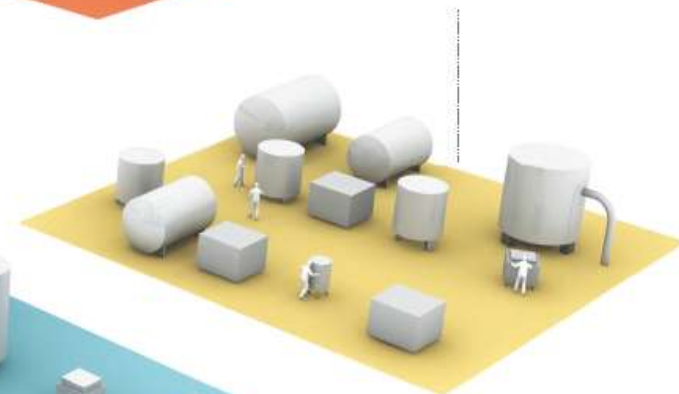


Fermentation

In the fermentation module, enzymes and bacteria are added to the waste to convert it still further. This process takes place in bioreactors with a capacity of up to 8000 litres.

Third-generation bioprocesses

These modules are designed to increase efficiency and lower costs in the production of biofuels and biochemicals.



Downstream processing

This is where products are extracted and refined. The modules can be combined at will to produce all kinds of products, such as raw materials for the construction sector, chemicals for biofuels or raw materials for the chemicals and pharmaceuticals industry.



More information: www.be-basic.org

International network leading biorenewables centers

CLIMATE KIC

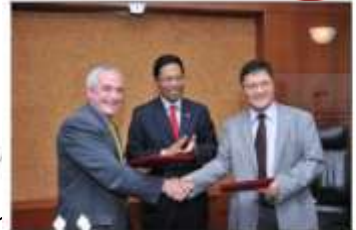
CLIB
2021
CLUSTER
INDUSTRIELLE
BIOTECHNOLOGIE

COLLABORATION BETWEEN UTM AND TUDELFT IN BIO-BASED ECONOMY

Thursday, 20 November 2009 09:01



TU Delft

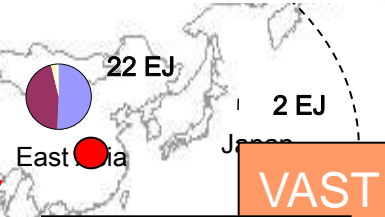
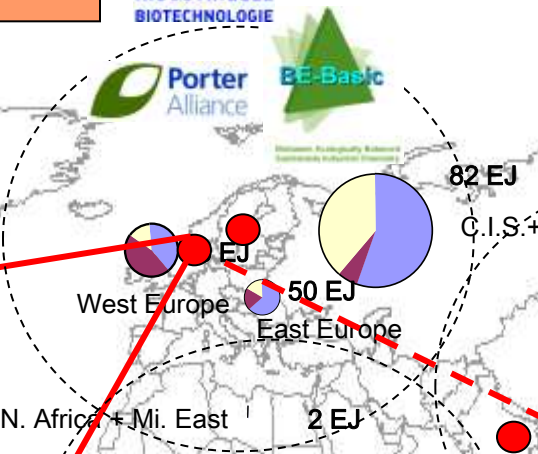
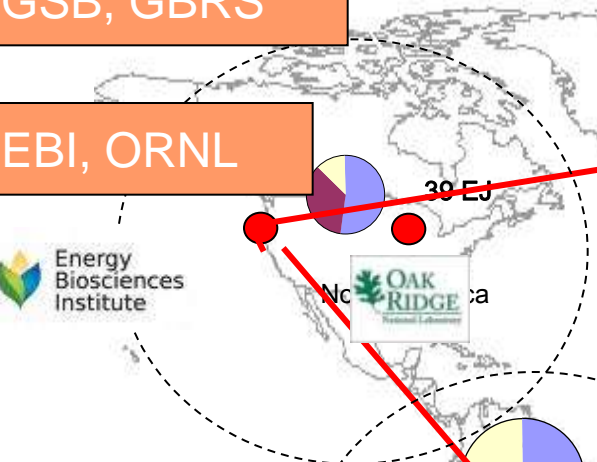


Skudai, November 26th, 2009: Universiti Teknologi Malaysia (UTM) and Technical University Delft (TU Delft), Netherlands plan to collaborate on increasing bio-based economy research and educational activities internationally.

The Deputy Vice Chancellor (Research & Innovation) Prof. Dr. Marzuki Khalid said that the research will be the basis for a world-class infrastructure in the Biotechnology industry, Biofiltering technology, and the development of Bioproducts for both universities.

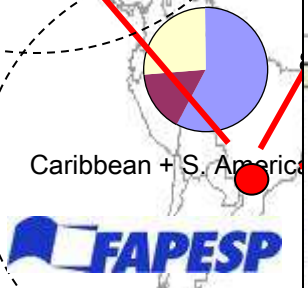
GSB, GBRS

EBI, ORNL

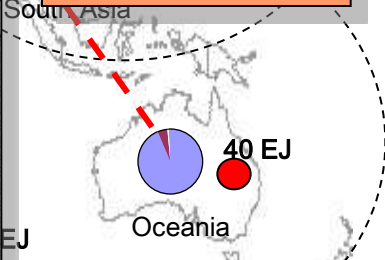


VAST

OPBC



BR-Basic

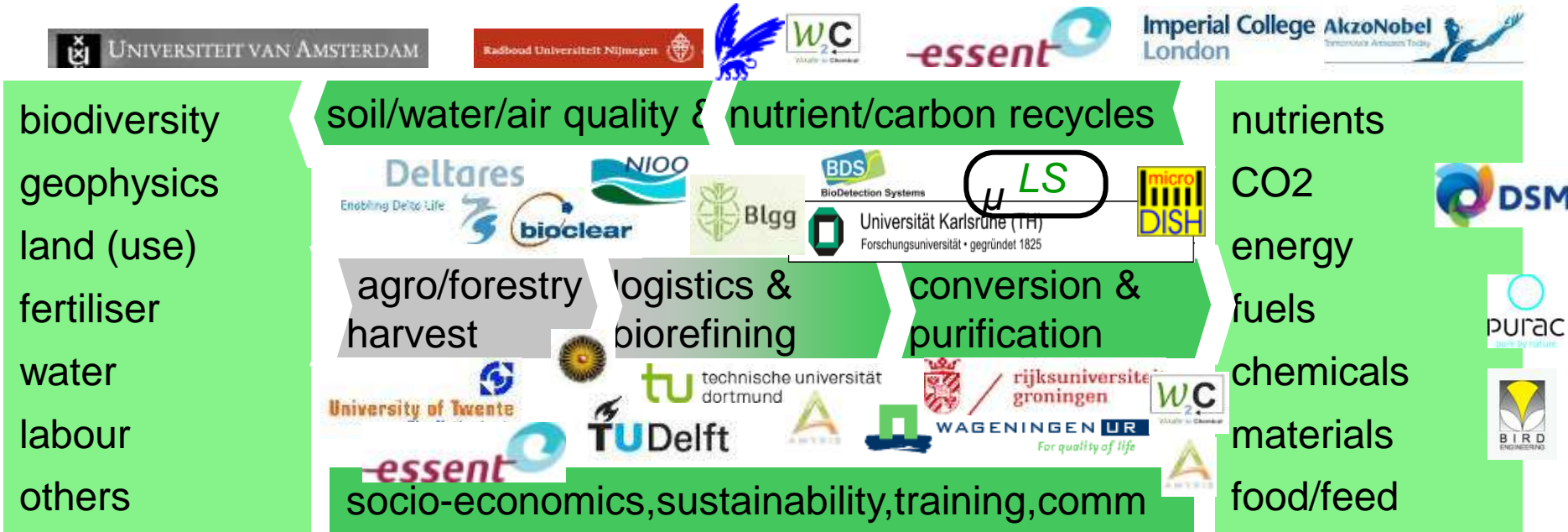


International network leading biorenewables centers



Partners in the program and affiliates: integral approach

structured around integral biomass value / sustainability



Breakthroughs in lignocellulosics

key industrial player:
“best yeast on the planet”

- 25-50% of (lignocellulose) agro-residue is the C5 sugar xylose
- yeast produces ethanol from “normal” sugars, but **not** from xylose
- various breakthroughs ('03/'06)
- introduction of *xylose** isomerase gene from fungus in yeast, *ibid arabinose*
- optimised for efficient production of ethanol from *xylose, arabinose, acetate*
- new **substrates** and products to come
- **C4 portfolio, glycerol, bio-furanics, others**

* *Kluyver Center*



Synthetic Biology in the real world?

glucose

xylose

arabinose

acetate

glycerol

furanics

APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Jan. 2010, p. 190-195
0099-2240/10/\$12.00 doi:10.1128/AEM.01772-09
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Vol. 76, No. 1

Elimination of Glycerol Production in Anaerobic Cultures of a *Saccharomyces cerevisiae* Strain Engineered To Use Acetic Acid as an Electron Acceptor^{V†}

Victor Guadalupe Medina,^{1,2} Marinka J. H. Almering,^{1,2}
Antonius J. A. van Maris,^{1,2} and Jack T. Pronk^{1,2*}

Kluyver Centre for Genomics of Industrial Fermentation, Julianalaan 67, 2628 BC Delft, the Netherlands,¹ and Department of Biotechnology, Delft University of Technology, Julianalaan 67, 2628 BC Delft, the Netherlands²

APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Feb. 2009, p. 907-914
0099-2240/09/\$08.00+0 doi:10.1128/AEM.02268-08
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Vol. 75, No. 4

Novel Evolutionary Engineering Approach for Accelerated Utilization of Glucose, Xylose, and Arabinose Mixtures by Engineered *Saccharomyces cerevisiae* Strains^V

H. Wouter Wisselink,^{1,2} Maurice J. Toirkens,^{1,2} Qixiang Wu,^{1,2}
Jack T. Pronk,^{1,2} and Antonius J. A. van Maris^{1,2*}

Department of Biotechnology, Delft University of Technology, Julianalaan 67, 2628 BC Delft, The Netherlands,¹ and DSM, P.O. Box 5057, 2600 GA Delft, The Netherlands²

Accepted 5 December 2008



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www.dsm.com

All you can eat yeast

commercial product
based patent portfolio

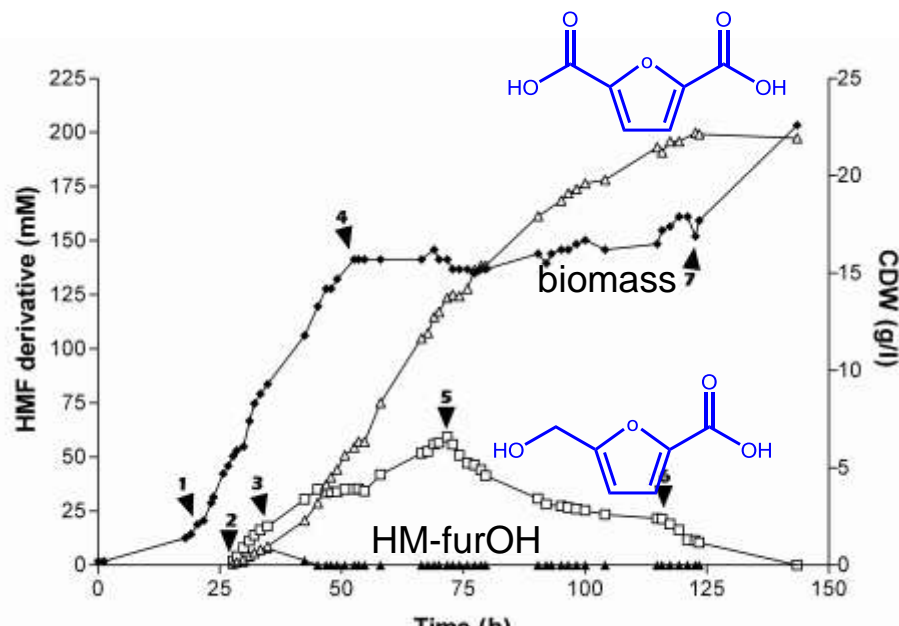


The other 70% : FDCA for “BioPET”

- Top-12 value-added chemicals from biomass
- Platform chemical - market size 4-12 bn \$/yr
- Replacement for terephthalate in polymers
- Concept in B-Basic (TUD/TNO - '09) – direct production from lignocellulosics
- indust biocat (BIRD Eng /TUD-'09) – bioprocess (BIRD –'10) – invest round - piloting (BE-Basic-'11)



kg-scale process



TU Delft

DSM

BIRD
ENGINEERING

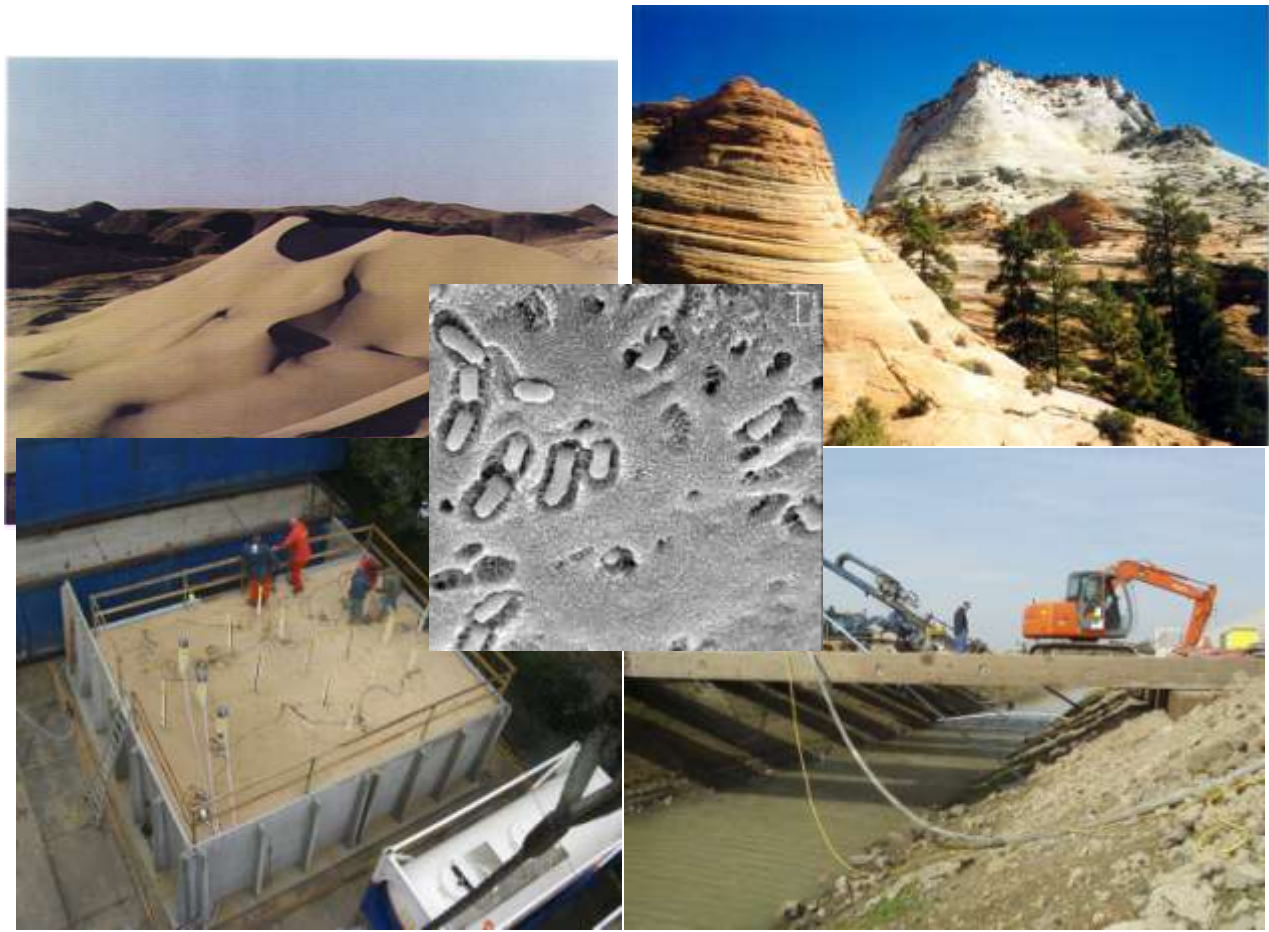


plantbottle®

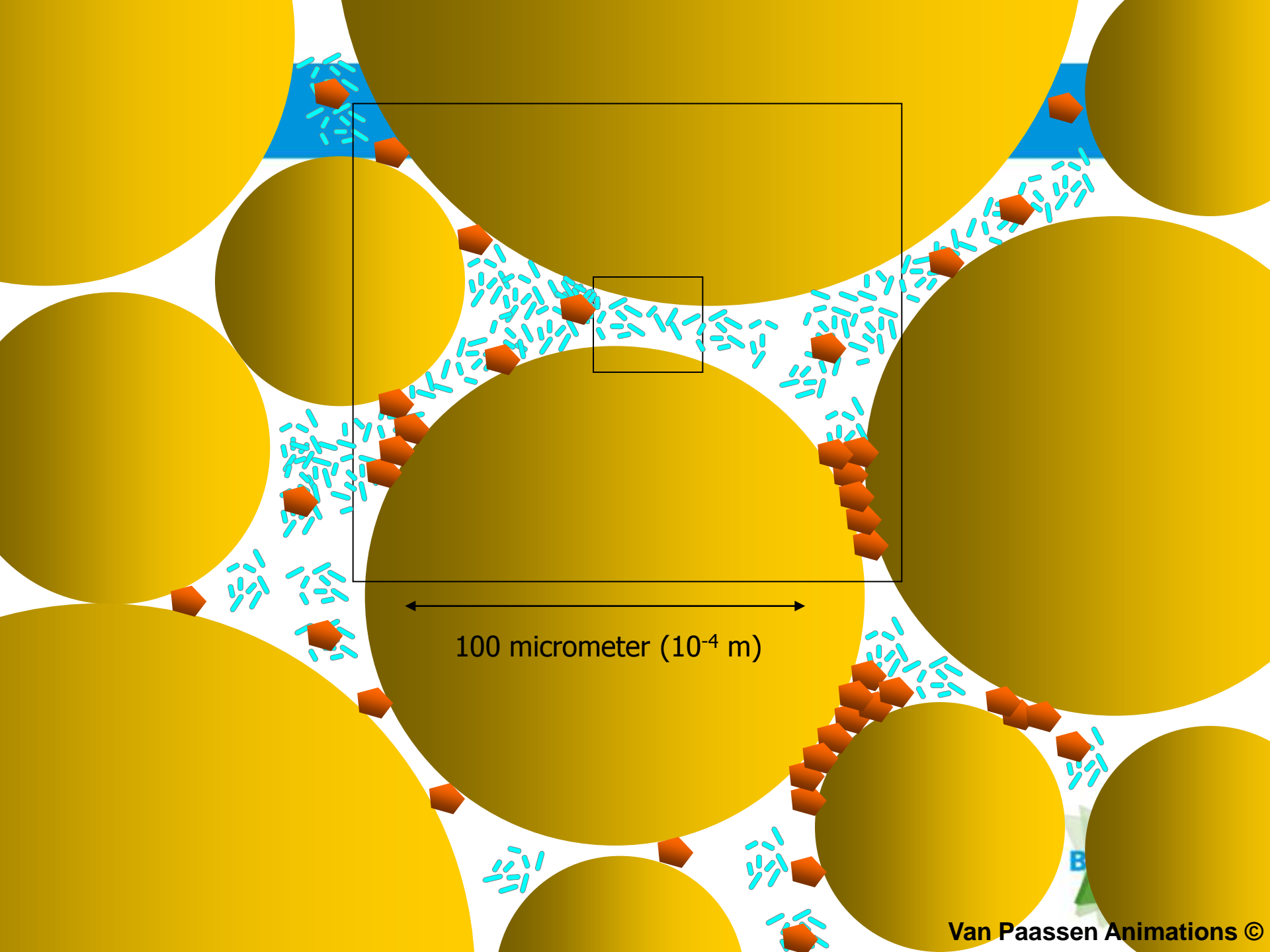
100% reciclable, elaborada hasta con un 30% a base de plantas.

MÉXICO
Coca-Cola
VIVIENDO POSITIVAMENTE

Biogrout & bioconcrete: from soft soil to rock solid



In-situ concrete by carbonate fixation



100 micrometer (10^{-4} m)

Bioenergy: challenges

Macro-economic studies indicate*:

- **Effects:** Biomass utilisation can reverse long term trend of declining food prices
 - Agricultural land use
 - Different effects on countries being
 - Oil exporters/food importers
 - Oil importer/food exporters
- **Cascade model** for efficient use biomass **more competitive and sustainable!** But requires novel collaborations and level playing field



* Hans van Meijl, LEI-WUR

Conclusions (1)

- Various drivers
- Global transition
- Technology developing rapidly
- Local drivers are different
- Economics risky
- Link with chemistry important economic advantage
- Implementation will effect environment-social well being
- Sustainability becomes a bigger driver!

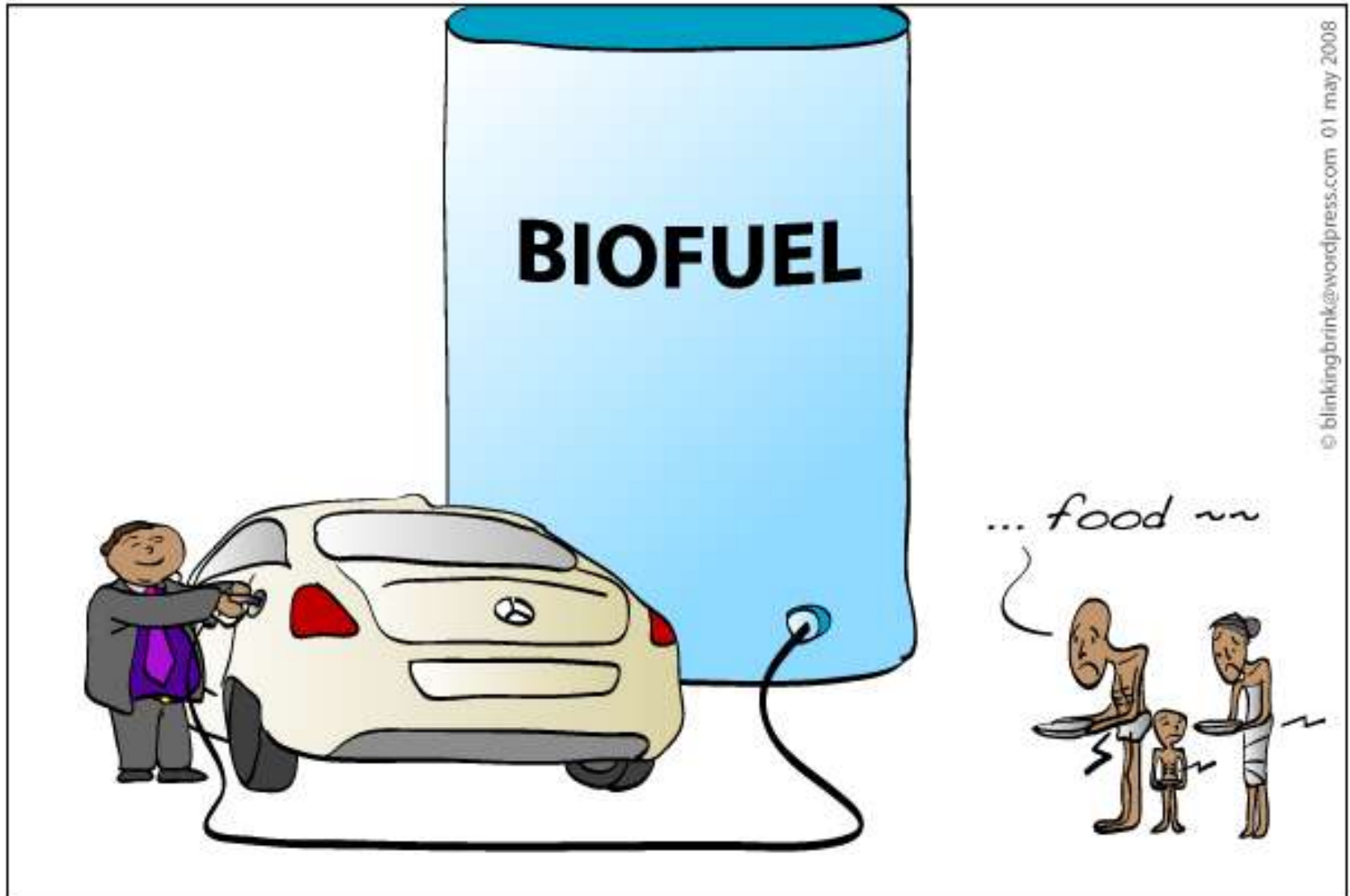


Overview

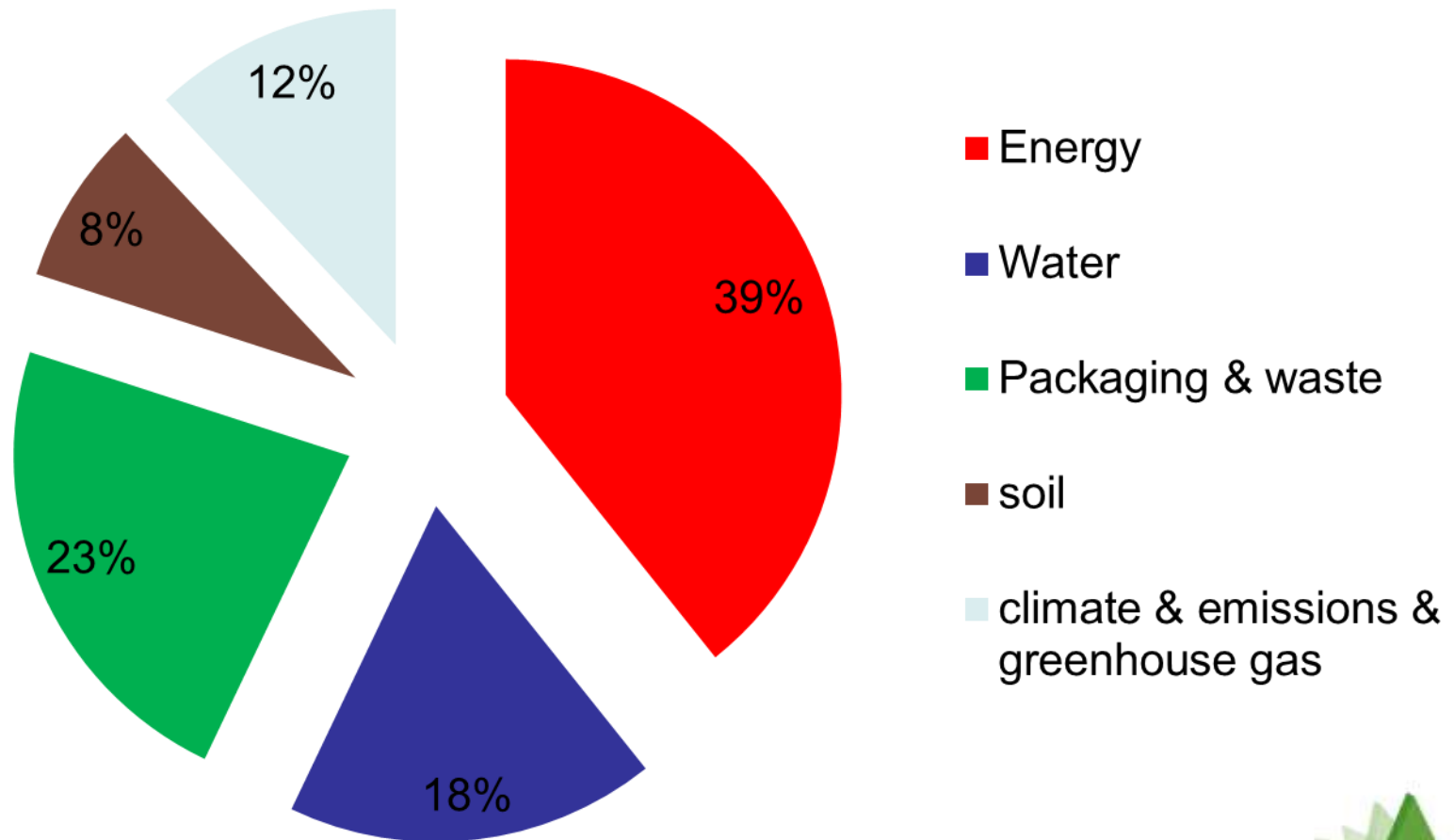
- Drivers, challenges and opportunities
- Innovation agenda
- **Support for sustainability?**
 - Rational – versus – emotional
 - Emotions on Biobased economy
 - Cultures and norms
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Newspaper headlines



Top 5 indicators for sustainability in industry *

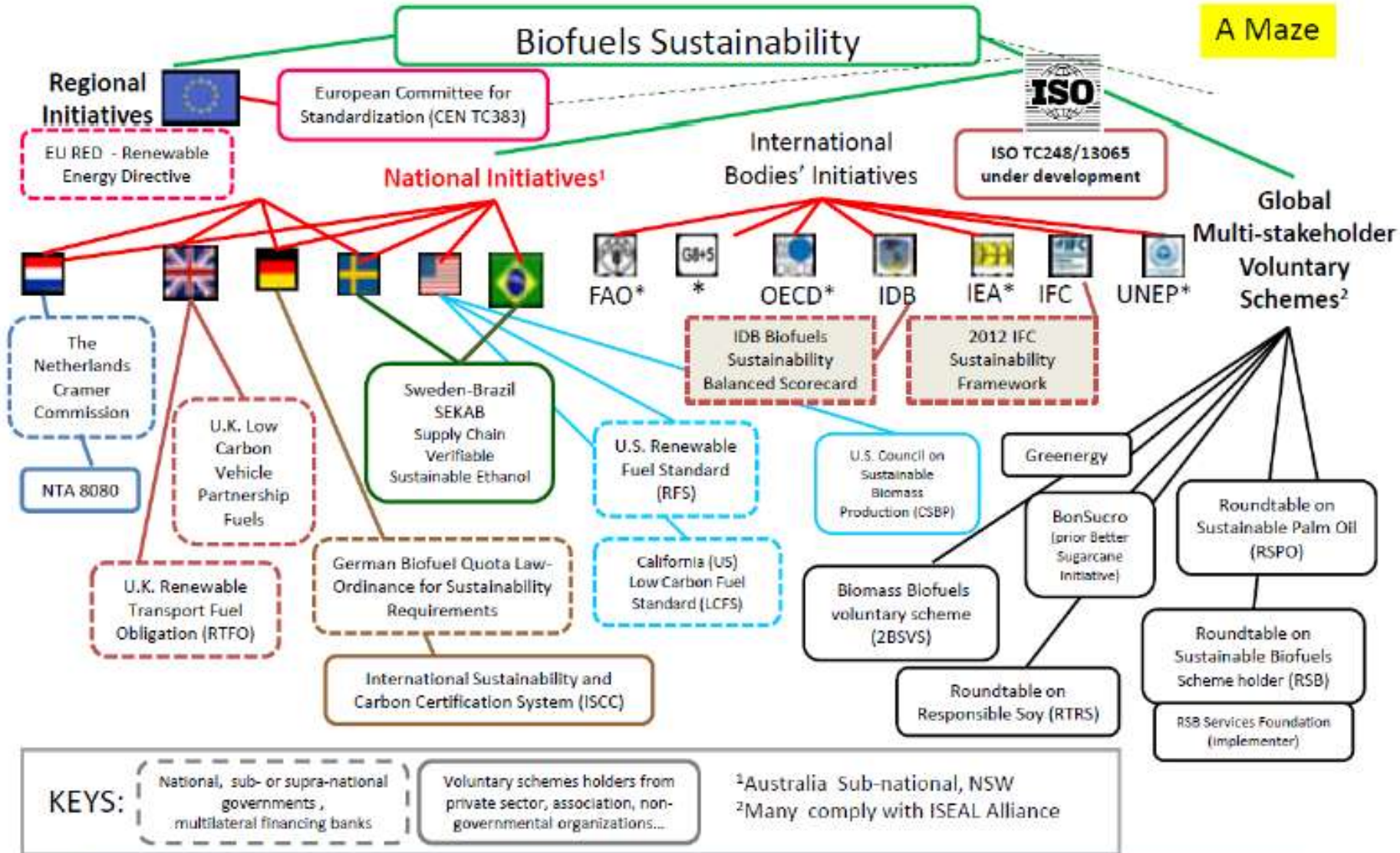


* Olenyi, Based on interviews, comparative study. Forthcoming



Biofuels Sustainability

A Maze



*Enabling entities: IEA Bioenergy tasks (multiple countries) LCA methodologies and sustainability expertise; Global Bioenergy Partnership (GBEP) 2011: Sustainability themes and indicators; FAO-Germany: 2012 Bioenergy and Food Security Criteria and Indicators (BEFSCI) tools

Preliminary results*, certification and labelling

- Of the low percentage of certified biofuels, social criteria play a minor role
- Industry representative priorities on environmental, not social aspects
- Sustainability attitudes and certification might follow media hypes and stakeholder pressure instead of scientific priorities (e.g. biodiversity seems underrepresented)

* S. Olenyi, Based on interviews and public survey, comparative study. Forthcoming



Bioenergy and policies: From an NGO point of view

Practice:

- **Sustainability criteria**, such as Cramer criteria **not used** by politicians and companies
- Agreements incl **RSB only marginally implemented**
- **Volume of advanced** (2nd generation) biofuels **disappointing**
- **Climate effect worse** than expected

→ **ACTION!**

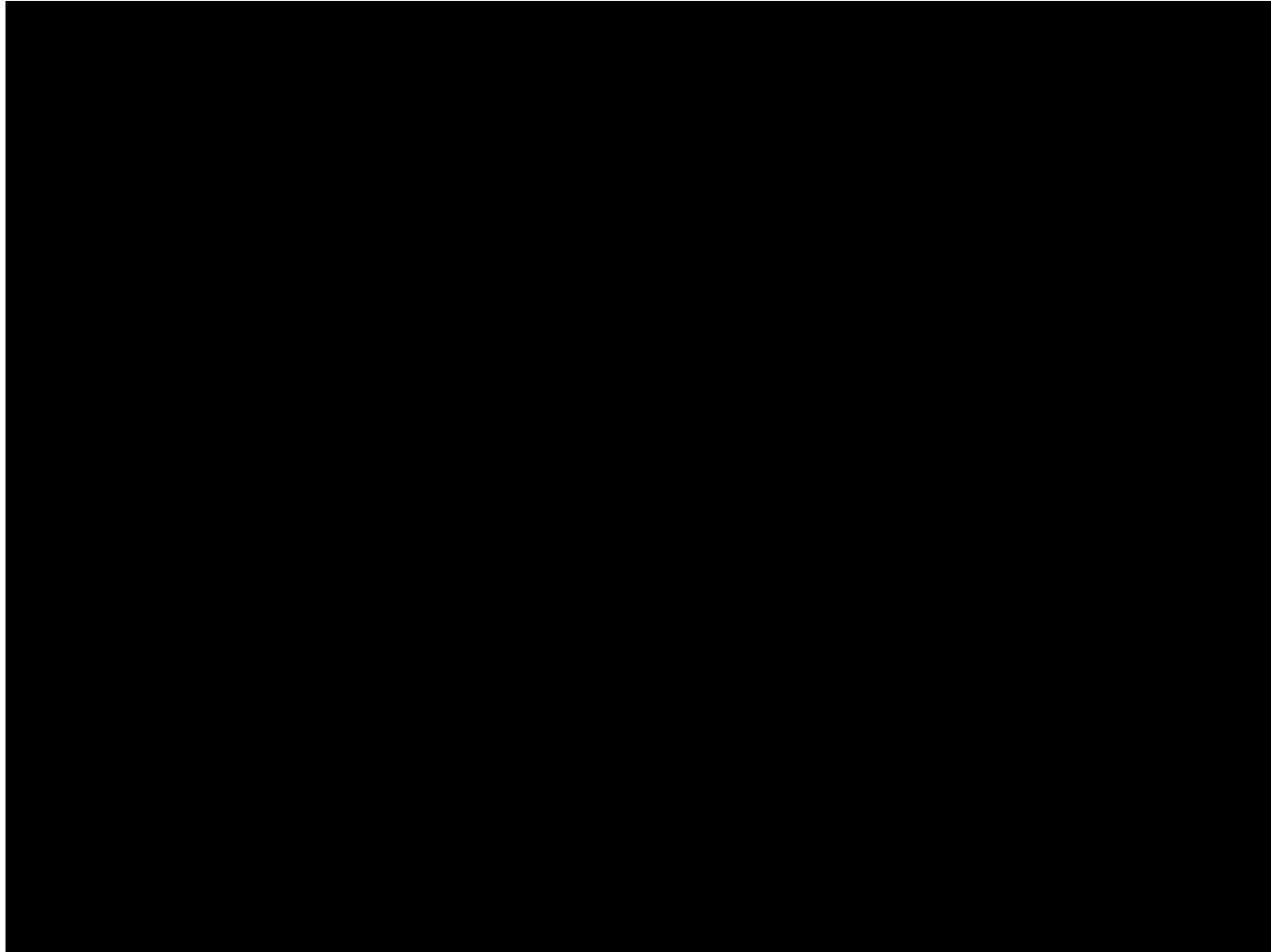
Oxfam Novib: started campaign*

“EU Biofuel target could feed 127 M people!”



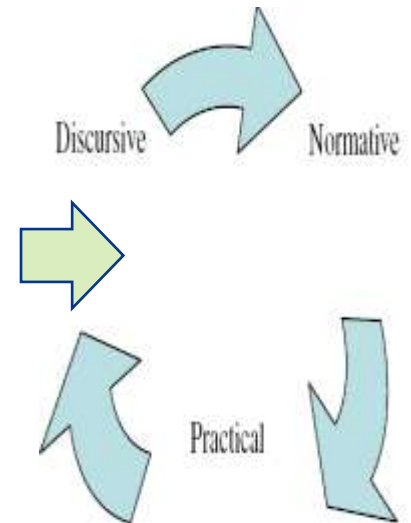
* <http://www.oxfam.com>

Challenges on policies: public support



Major societal debates*

- Biofuels versus food
- Sustainability of biofuels and bio-energy
- Marketisation and commodification of nature
(Nature Inc. -- is nature for sale?)
- Scale debate (economy of scale vs. 'small is beautiful')
- Precautionary principles vs. learning by doing
- Land, water, resource grabbing -- neo-colonisation debate



* F. Mukhtarov, 2012 (forthcoming)

NATUUR
& MILIEU



National Committee
of The Netherlands



GREENPEACE



Uitnodiging

SEMINAR

BIOMASSA OP HETE KOLEN

Over grootschalige import van biomassa voor groene stroom

Donderdagavond 4 april 2013, 19:00 uur - 21:30 uur

Café Dudok, Hofweg 1a, Den Haag

Aanmelden vóór 22 maart bij Sandra van den Brink, Greenpeace: sandra.van.den.brink@greenpeace.org

Het kabinet heeft zich ten doel gesteld om in 2020 een aandeel van 16% duurzame energie te realiseren. Om dit doel te halen heeft het kabinet aangegeven in te willen zetten op grootschalige bijstook van biomassa in kolencentrales. Natuur & Milieu, Greenpeace, het Wereld Natuur Fonds, Milieudefensie en IUCN NL willen met dit seminar meer kennis en inzicht verschaffen in wat deze keuze precies behelst. Waar moet al die biomassa vandaan gaan komen en is dat wel duurzaam? Wat betekent grootschalige bijstook voor de energietransitie en de *biobased economy*, tot 2020 en op de langere termijn?

Voorlopig programma

18:30 – 19:00 Inloop met een drankje en een lichte versnapering

19:00 – 20:00 Presentaties van:

- **Martin Junginger, Universiteit Utrecht Copernicus Institute of Sustainable Development**
De internationale biomassahandel: Waar komt het vandaan en waar gaat het heen?
- **Eric Arets, Alterra Wageningen UR**
De koolstofbalans bij biomassa uit bossen en wat dat betekent voor de klimaatwinst van bio-energie
- **Wolter Elbersen, Wageningen UR Food & Biobased Research**



Conclusions (2)

- ✓ We need policies to implement a *sustainable* biobased economy
- ✓ Effective policies depend on *public and stakeholder* support

Overview

- Drivers, challenges and opportunities
- Innovation agenda
- Support for sustainability?
 - Rational – versus – emotional
 - Emotions on Biobased economy
 - Cultures and norms
- Implementation?



In public debates:

Rational quantified data on environmental impact
✗ = answer emotional concerns

Questions: What is good? Who is in charge?

- **Moral concepts**
- **Cultural differences**
- **Public emotions**

Drivers for sustainable implementation

- **A little bit deeper...**



From debates: Four key ethical concepts

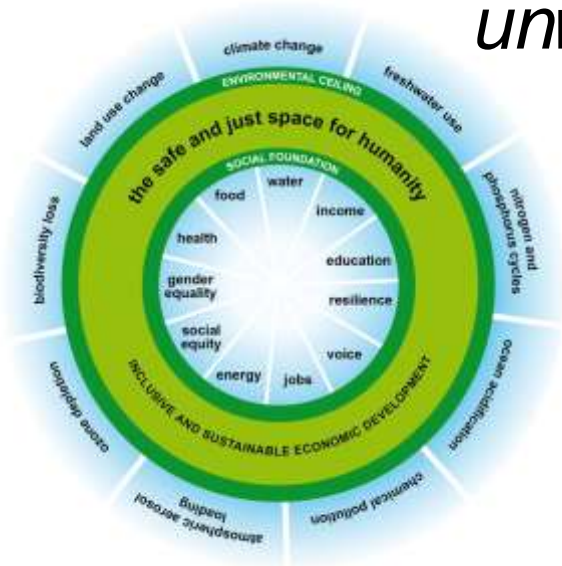
- **Sustainability**
 - What is sustainable?
- **Trust and confidence**
 - Who to trust and who takes initiative?
- **Naturalness**
 - Value of nature and 'natural ingredients'
- **Just distribution**
 - Is it fair and does it give value to all?



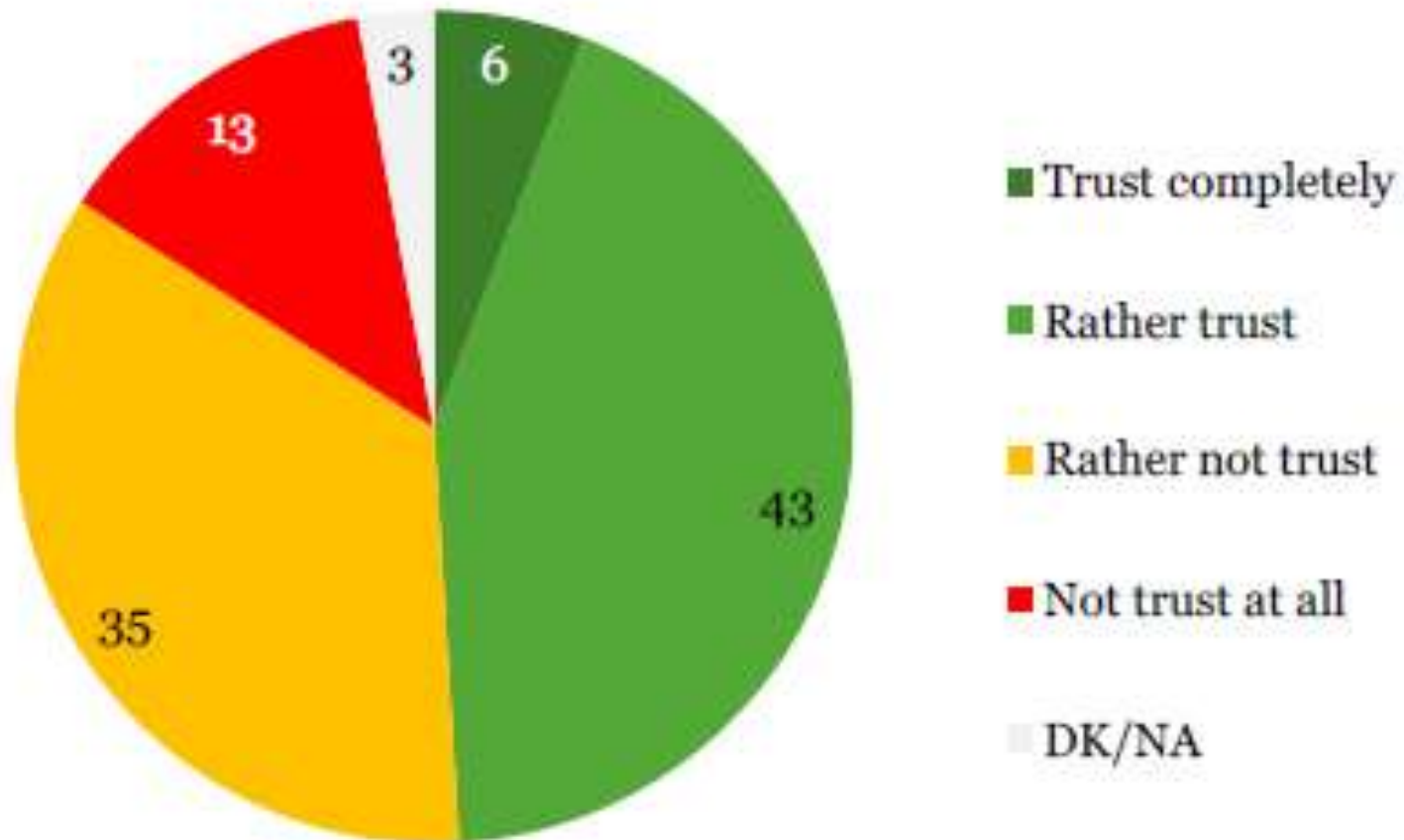
What is sustainability?

- Durable, biodegradable, environmentally friendly, fair, non-GM, organic, economically viable, natural, ...

Both: measurable specific standards AND *unmeasurable* general concepts-philosophi



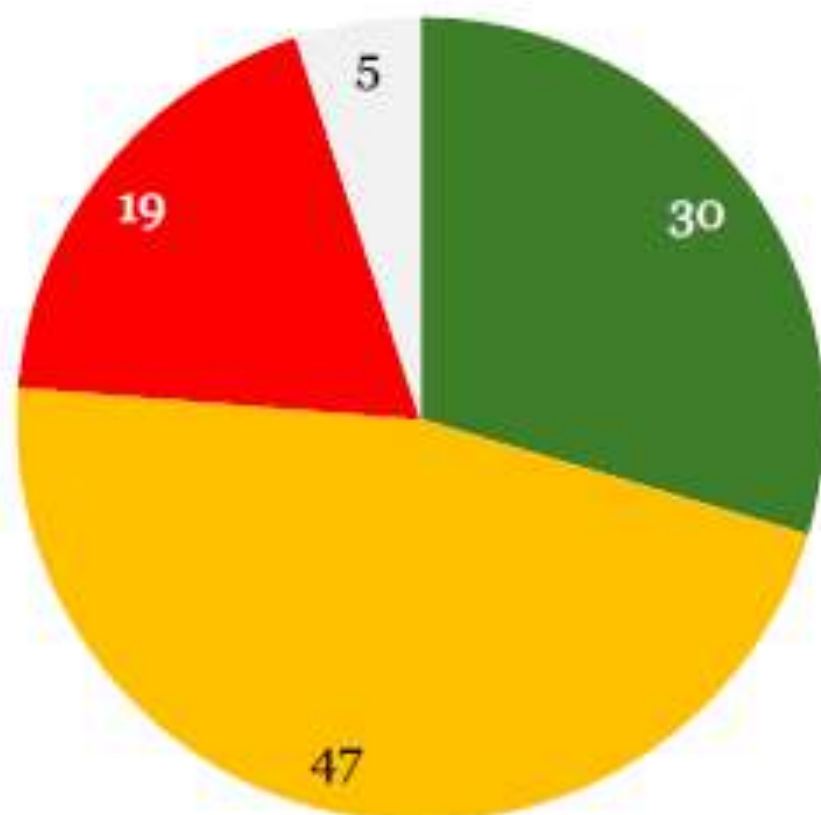
Trust in producers' claims about the environmental performance of their own products



Q10. How much do you trust producers' claims about the environmental performance of their own products?

Base: all respondents, % EU27

Trust in companies' environmental and social performance reporting



- I trust the reporting of companies' own environmental and social performance
- I do not trust the reporting of companies' own environmental and social performance
- Companies' reports on their environmental and social performance are of no interest to me
- DK/NA

Q11. Which statement best reflects your view on current reporting by companies of their own environmental and social performance:

Base: all respondents, % EU27

Who to trust?*



EPREUVE par la BAGUETTE.
The rhabdomancer

1: science-sceptsis

- Push from quality assessment to quantification >> creates false sense of certainty
- The impact of growing biomass for biofuels is difficult to predict. Is of great complexity > uncertainty.
 - Source of biomass (switch grass, maize, etc.), process (1st generation, 2nd etc.), place where it is grown
 - Problems with ‘modeling’ (for predicted land use, GHG emissions etc.).

* L. Landeweerd, P. Osseweijer, R. Pierce (Delft-BTS)
J. Kinderlerer (Cape Town Univ. - Law)
l.landeweerd@tudelft.nl

Trust and Just distribution?*

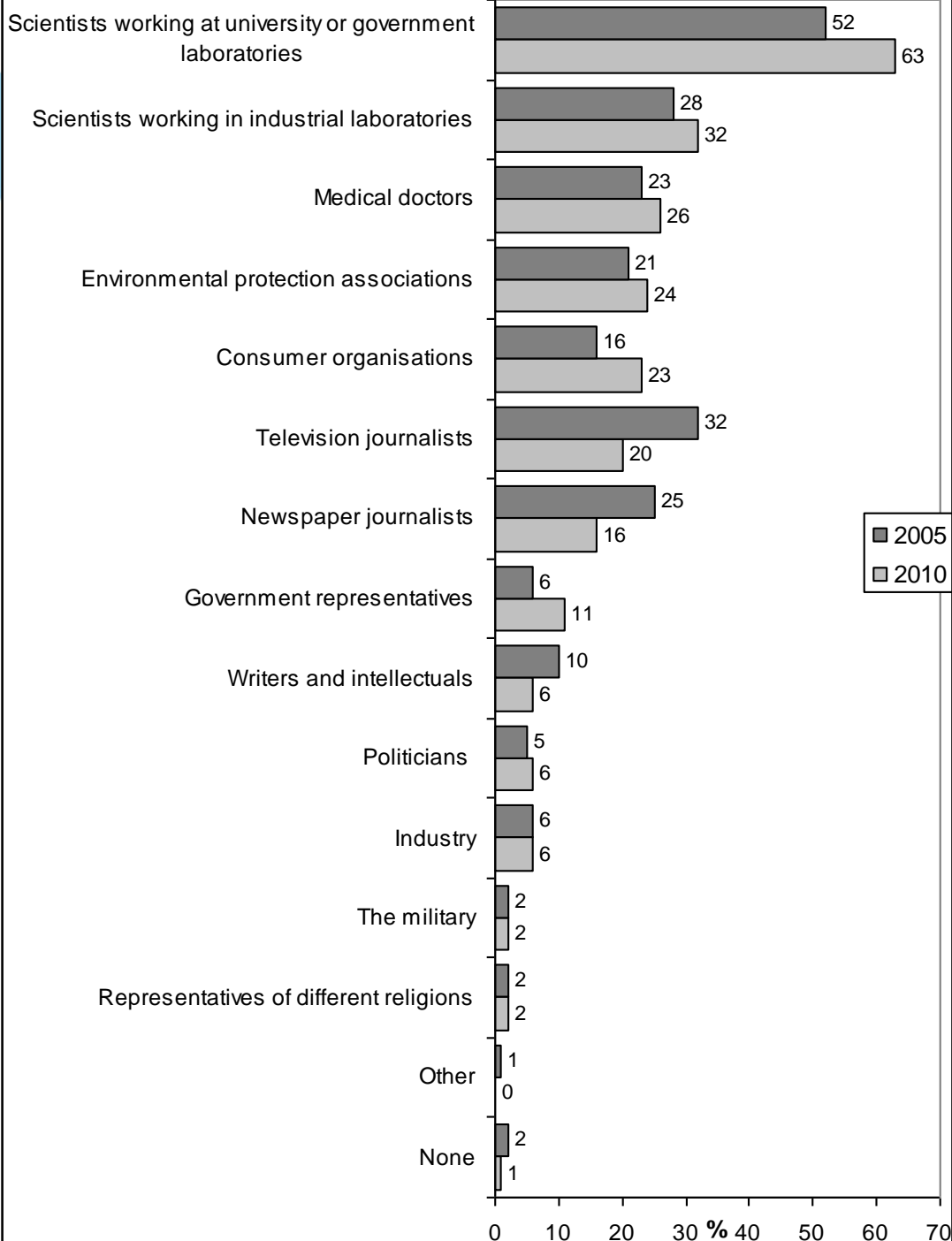
2: Technology-scepsis

A warning to the optimists:

- ETC group: socio-economic impact of NEST. New technologies don't have to be efficient or effective to be profitable, they are often disruptive, specifically for developing countries and emergent economies
- Biotech in agriculture was profitable (patents) but not effective for solving world hunger. SB >> who controls biomass
- Scientific success \neq humanitarian success



Best qualified to explain the impact of scientific and technological developments on society, *Europeans, science and technology (2010)*, Eurobarometer 340



Traditional worldview*

- **Ontology:** Nature as God's Creation humans cannot interfere in
- **Epistemology:** Moral reasoning
- **Anthropology:** Human being as subject to God-created order
- **Societal vision:**
Technological intervention in nature a-priori unacceptable.

Mankind has no right to play God!



* Hedlund-de Witt, A., (2012). Exploring worldviews and their relationships to sustainable lifestyles: Towards a new conceptual and methodological approach. *Ecological Economics*, 84, 74-83.

Modern worldview

- **Ontology:** Nature as resource
- **Epistemology:** Instrumental reasoning; trust in science and technology
- **Anthropology:** By mastering nature, the human being can find freedom
- **Societal vision:** **Technological optimism**



*What
nature can
do, we can
do better!*



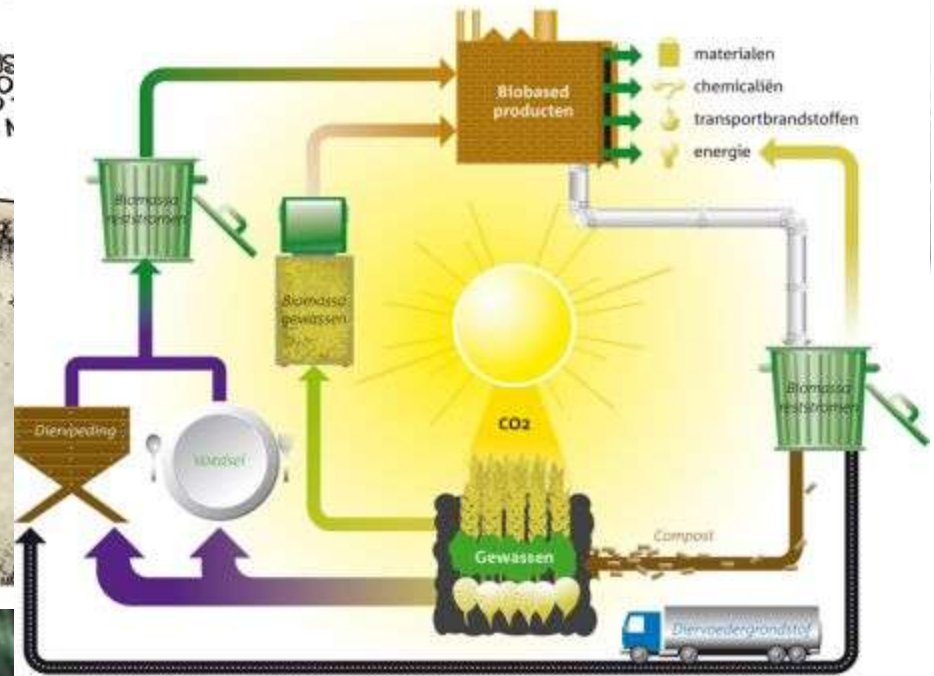
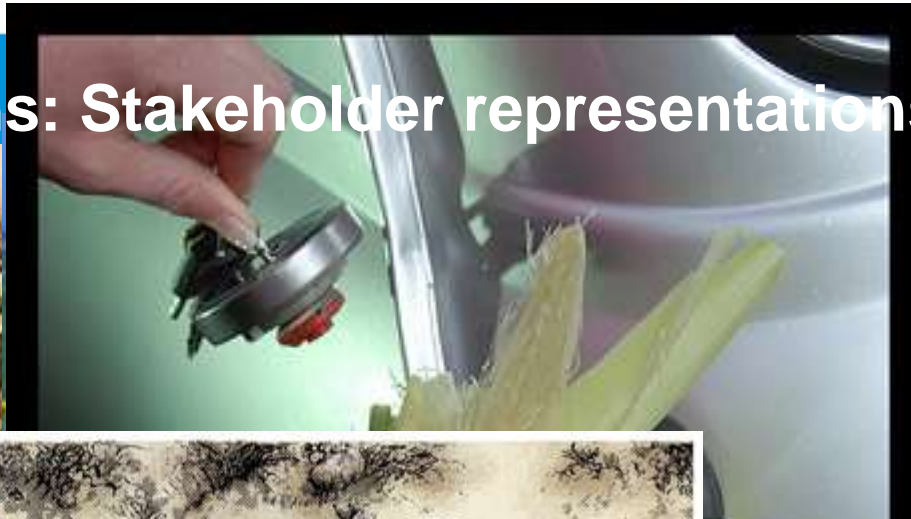
Postmodern worldview

Nature may be too complex for us to understand!



- **Ontology:** Nature as complex systems
- **Epistemology:** Pragmatic reasoning. Trust in NGO's, consumer organizations.
- **Anthropology:** Human being as part of larger, complex natural systems
- **Societal vision:** Technological intervention in nature not reprehensible per se; stresses uncertainty and complexity

Public emotions: Stakeholder representations of a BBE



BE-Basic

Dutch emotional views towards BBE

Compassionate Environmentalist

People with this viewpoint are hopeful, happy and affectionate towards their living environment.



Gives a positive emotion
They feel anger, sympathy and are concerned with their wider environment.



Gives a negative emotion

Cynical Environmentalist

People with this viewpoint are happy about - and interested in – the use of renewable resources and recycling.



Gives a positive emotion



Gives a negative emotion

They distrust and feel enraged about industry's and government's involvement.

Principle Optimist

People with this viewpoint are enthused, happy and optimistic about the production of bio-energy, -fuels and -plastics.



Gives a positive emotion



Gives a negative emotion

They are concerned, frustrated and angry about the idea that humanity will go bio-based at all costs.

Hopeful Motorist

People with this viewpoint are hopeful and feel reassured by the production of biofuels.



Gives a positive emotion



Gives a negative emotion

They despair and loathe the possible negative consequences of the use and development of biofuels.

Stakeholder's visual social representations of a Bio-Based Economy

'aim to make something unfamiliar familiar even unfamiliarity itself' (Moscovici 1984)



Represented in themata of:
Sustainability
First generation biofuels
Process and its products
Consequences

Emotionally objectified:

- + Hope, enthusiasm, compassion
- Fear, anger, frustration

Representation depends on stakeholder and context



Sleenhoff, S. & P. Osseweijer (2013) What the ^&*!@# is a bio-based economy? A study of visual social representations of a bio-based economy (forthcoming)

Microsociety 2030: a public qualitative study (NL)

4 Public meetings with lay panel (2012-2013)*

Biobased = unknown to public

++ association; but coloured by (partial) influences

Bioresources: ++; Bioenergy: - -

– People do not believe in limited oil

Circular economy: ++; 'rent-society: divided

– Recycling is ok; Not 'hiring' of resources

Own contribution? scepticism

– 'far away'; does it matter?

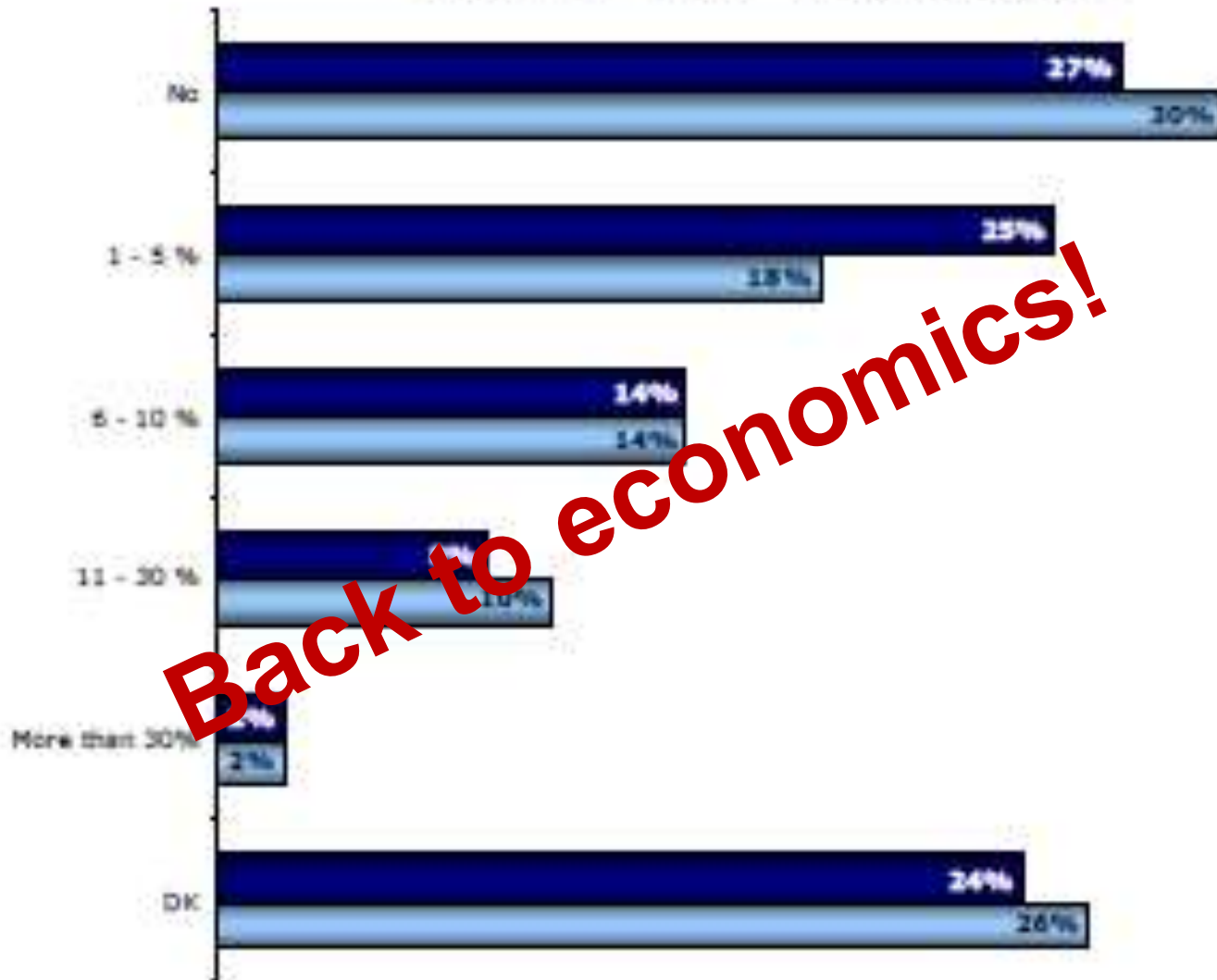
– Government/industry is put in lead



* Van der Veen et al., My2030s, Burgers over de Biobased Economy, 2013

QB7 Personally, how much would you be prepared to pay more for energy produced from sources that emit less greenhouse gases in order to fight the climate change? In average, how much, in percent, would you be ready to pay more? - % EU

■ EB72.1 Aug.- Sep. 2009 ■ EB69.2 Mar.-Apr. 2008



Conclusions (3)

- Complex science
- High level of **uncertainty** & predictability
- Social indicators are important
- Science and techno fixes not always trusted
- Different worldviews > define support
- Different emotions > define perceptions



Insight can:

- ✓ stimulate self-reflexivity among stakeholders
- ✓ Pave way to common support
- ✓ facilitate more reflexive policy-making

We need: Communication



**Scholieren project dat biotechnologie
naar ontwikkelingslanden brengt**



www.imagine-foundation.org

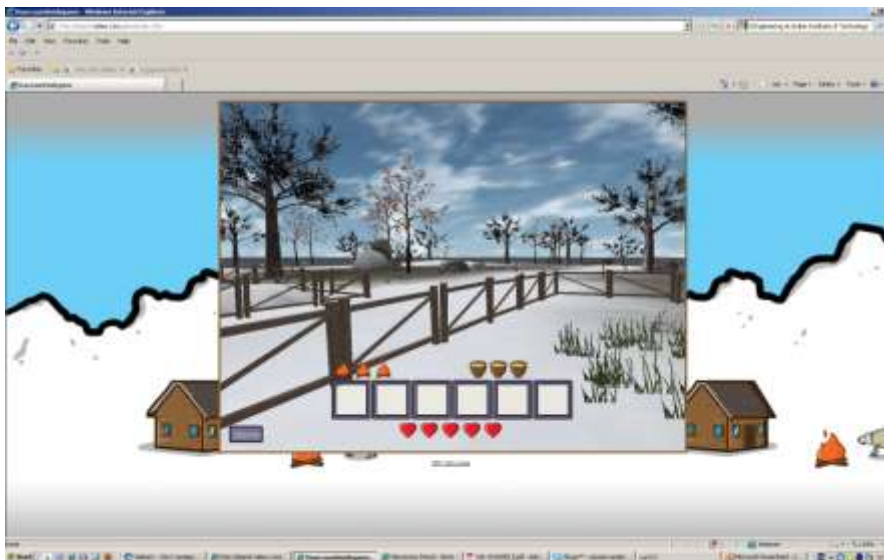
We need: Education



Serious game voor VMBO

Klas game voor 8 leerlingen

Keuzen maken in grondstoffen
Gelanceerd op 'Floriade'
April 2012



We need: Demonstrations

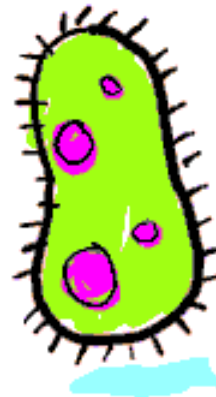
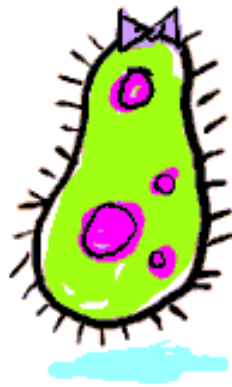


We need: Companies that support



We need: To understand the issues

The Evolution Of Man And Woman



Economy, Policy & Sustainability

Patricia Osseweijer

Hans van Meijl

Roeland Bosch

Gijs van der Starre



Stichting TKI-BBE

1. Topsector Policy organizes applied R&D scene in NL towards demand (industry & society) driven consortia (TKI – Topconsortium voor Kennis en Innovatie)
2. BBE is cross sectoral TKI from “*plant to product*” incl **strong societal program**
3. Annual planning (update) in Innovation Contracts (submitted nov 2011)
4. to be organised in **Stichting TKI-BBE** (foundation) under Topsector Chemistry with funding from various topsectors (Chemistry, Energy, Agro-Food, others)
5. total new funding ‘12-’13: M€ 150 (for *Biorenewables**) + M€ 30 (for rest)
6. Build/extend existing PPS’s (like BE-Basic) and pilot facilities (like BPF)
7. Pipe line to new NL initiatives
8. Dedicated internationalisation agenda: Brazil, SE Asia, Europe (SPIRE , Biobased Industries PPP, EIT)
9. Board of Directors (“Bestuur”) and Supervisory Board (“RvT”) appointed per 11/6
10. Main tasks: Implement 2012/13 plan and prepare for 2013/15 plan

partners



Universiteit Utrecht



vrije Universiteit amsterdam



rijksuniversiteit groningen



Themes

- **Economy & Market studies**
Siemen van Berkum, LEI-WUR
- **Optimalisation sustainability**
Andre Faaij, UU Copernicus
- **Social responsible innovation**
Robin Pierce, TUD
- **Communication & Education**
Jacqueline Broerse, VU



Global implementation of **sustainable** bioeconomy requires

- ✓ Integrative approach!
- ✓ Strong policies
 - Supported by aligned non-conflicting regulations*
- ✓ Based on better predictive models and cascade use
 - Increased certainty in models: technological change and 2nd generation, yields, R&D down (last decade), learning effects, public acceptance including for example GMOs*
- ✓ Operationalisation of sustainability
 - Environmental, **social** and economic*
- ✓ Public and stakeholder agreement
 - Identifying common grounds*
- ✓ Effective education, communication & impact evaluation
 - Understanding worldviews and emotions*

Meer info

EBD

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