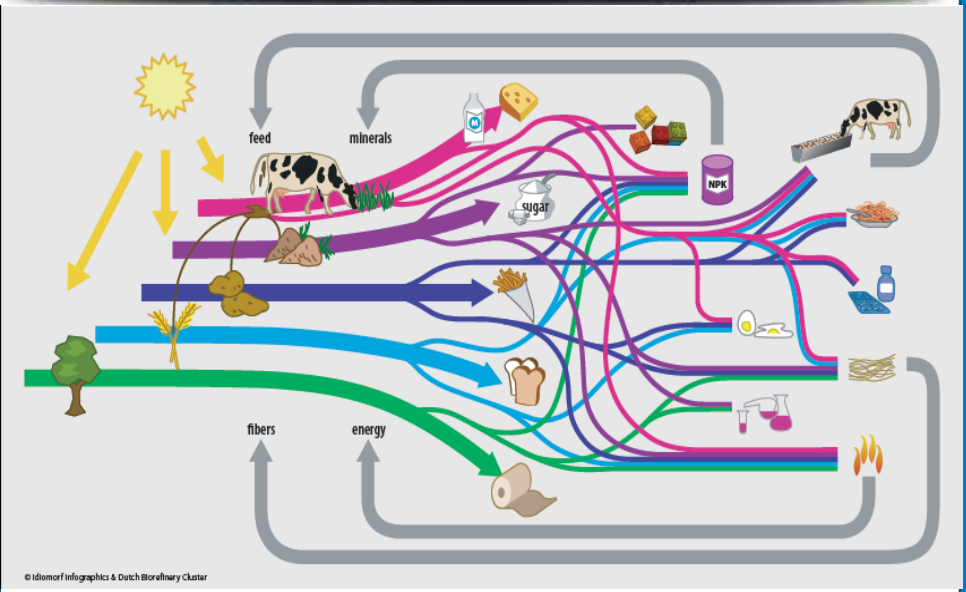
Netherlands Enterprise Agency



Sustainable valorisation of (biomass) residue in industry leads to a Biobased Economy

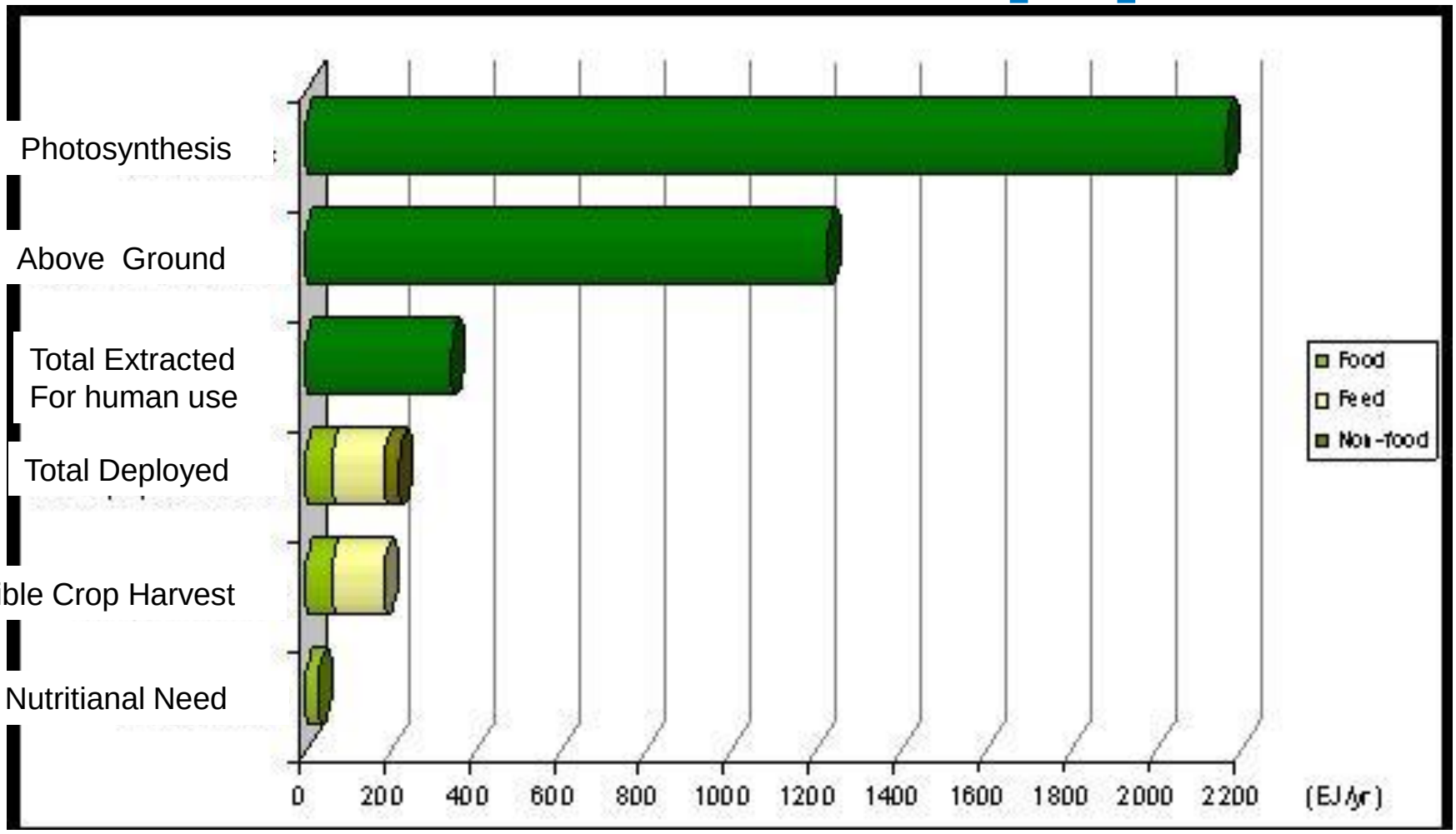
Ir. Kees W. Kwant

Contents

- Biobased Economy
  Industrial approach
- Present use of biomass in the Netherlands
- The Biorefinery approach
- Examples of projects

Global Biomass Resources [EJ]

- Photosynthesis
  - Above Ground
  - Total Extracted For human use
    - Total Deployed
      - Edible Crop Harvest
      - Nutritianal Need



World Carbon based Resources (2010) [EJ]

[EJ]	Fossil		Biobased	
	Primary use	End Use	Primary use	End Use
Extracted	432		342	
Deployed	426		222	
Harvest			187	30
Feed			*124*	
El.&Heat	152	57	30	na
Fuels/others	275	235	6	na
non-energy	*33*		*na*	*na*

Ref: van Beeck, N., Moerkerken, A., Kwant, K.W., Stuij B. (2014).
"**An innovative perspective: Transition towards a bio-based economy**". In: Bundschuh, J. and Chen, G. (Editors). Sustainable Energy Solutions in Agriculture, Taylor & Francis Books, UK

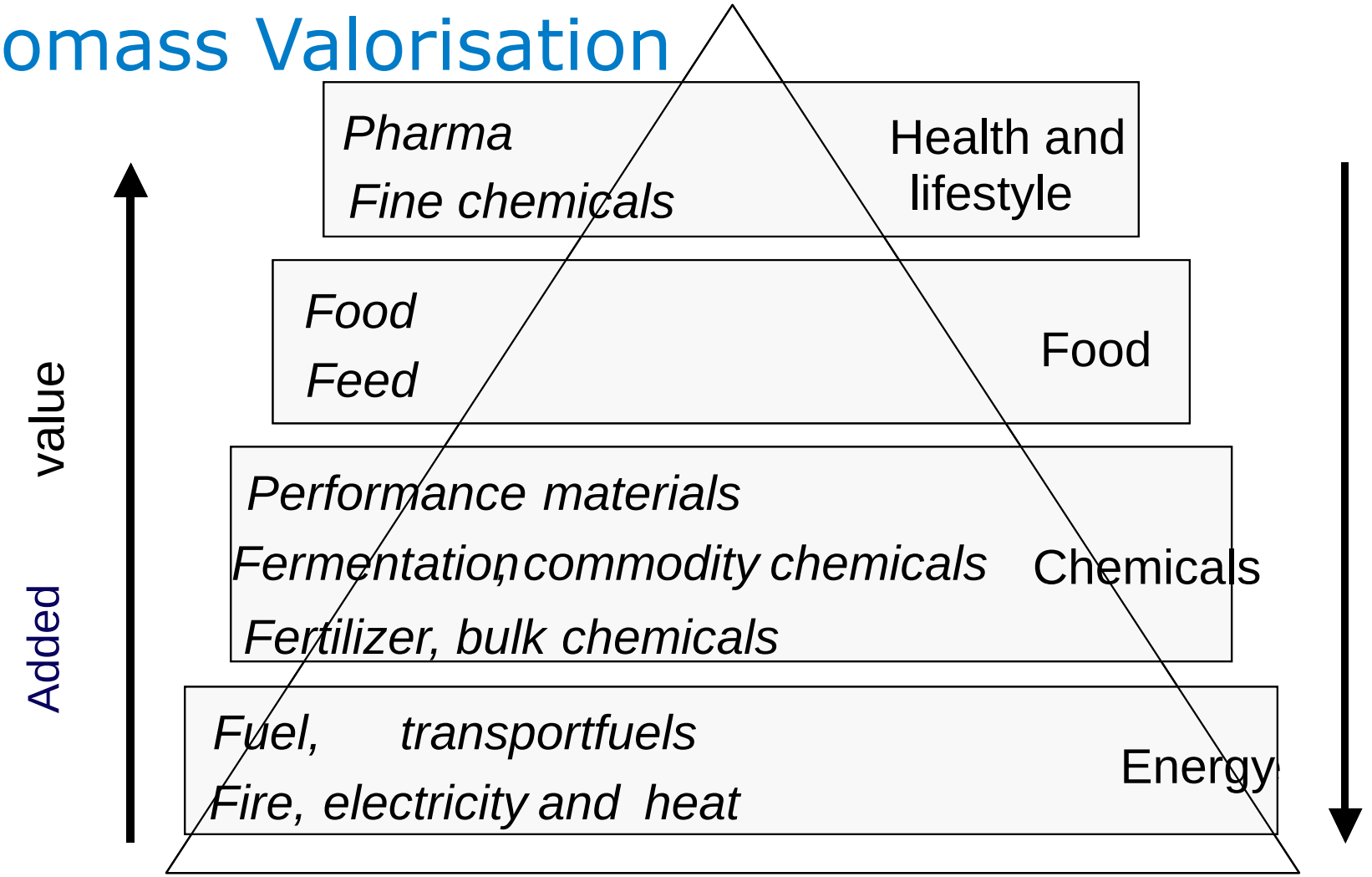
Vision Biobased Economy

Sustainable Production and Use of Biomass:

- *People*: food security, land rights, prosperity
- *Planet*: soil, water, air, GHG, biodiversity
- *Profit:* businesscases

Proven Sustainable Biomass does not come automatically

Biomass Valorisation



Sustainable Biobased Solutions

Integrated Food & Materials production

- Smart agriculture
- Increased prodution

Sustainable and Rural Development

- Local Resources and local use
- Tapping unused or abandoned land

Smart use of biomass

- Circular Economy, Cascading
- Biorefinery

Ref: http://www.sahyog-europa-india.eu/images/D2_3_Strategic_Advise_on_Biobased_Research_based_on_Sahyog_inventory_V3.pdf

Principles to improve the use of Energy and Biomass

Trias Energetica

- Energy Savings
- Renewable Energy
- Efficient Use

Trias Biologica

- Decarbonise resources
- Replace fossil with Biobased
- Cascading, Circular chains

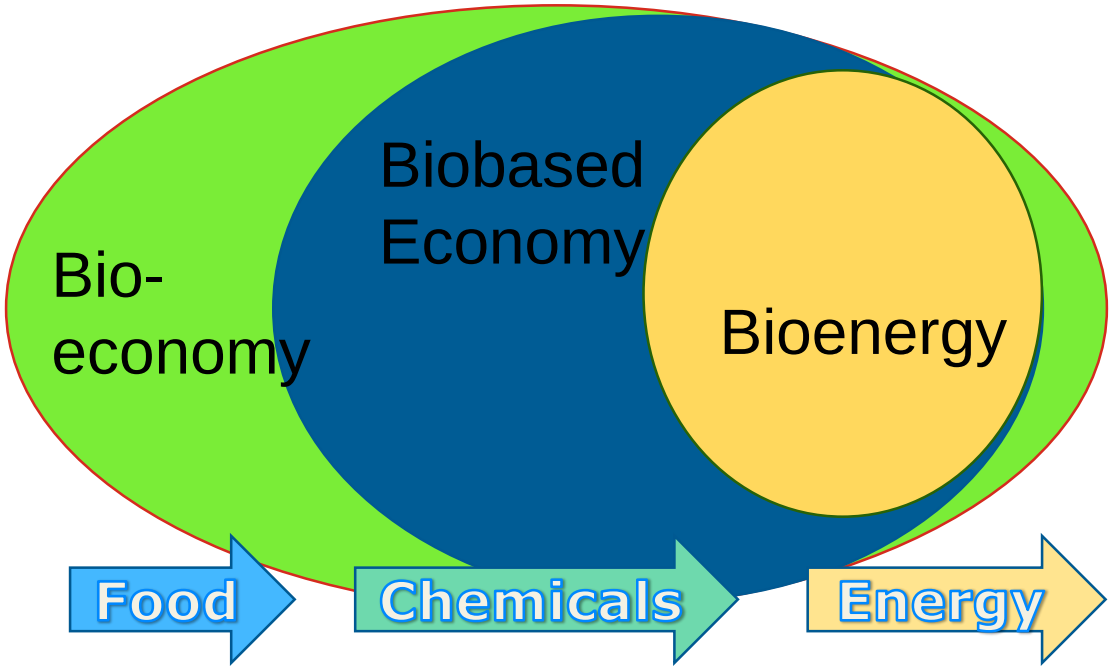
Biobased Economy part of Bioeconomy

A Biobased Economy

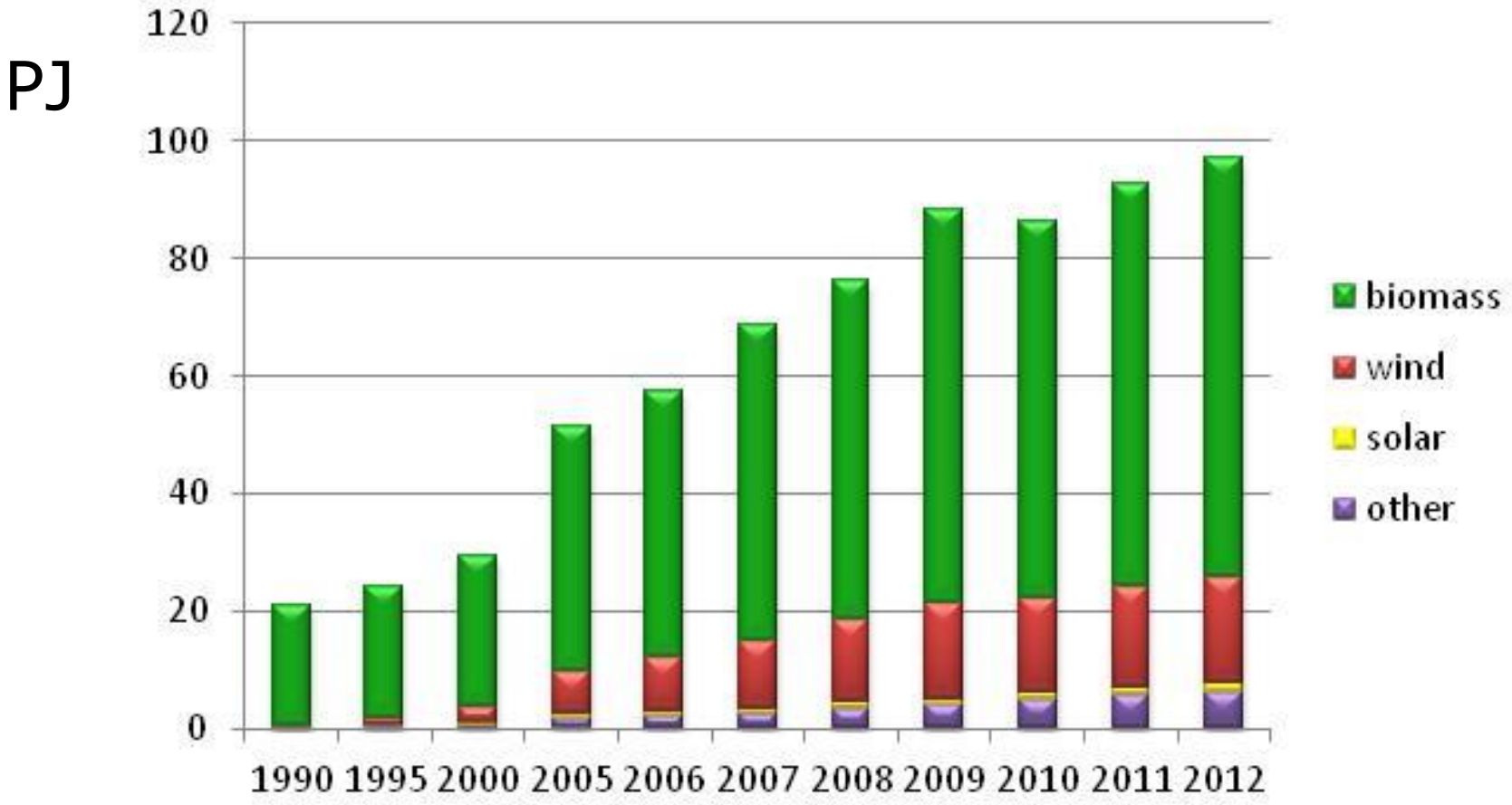
is a sustainable
Economy,

optimising
Economic value and
Natural value of biomass

by
Replacing Fossil
Resources

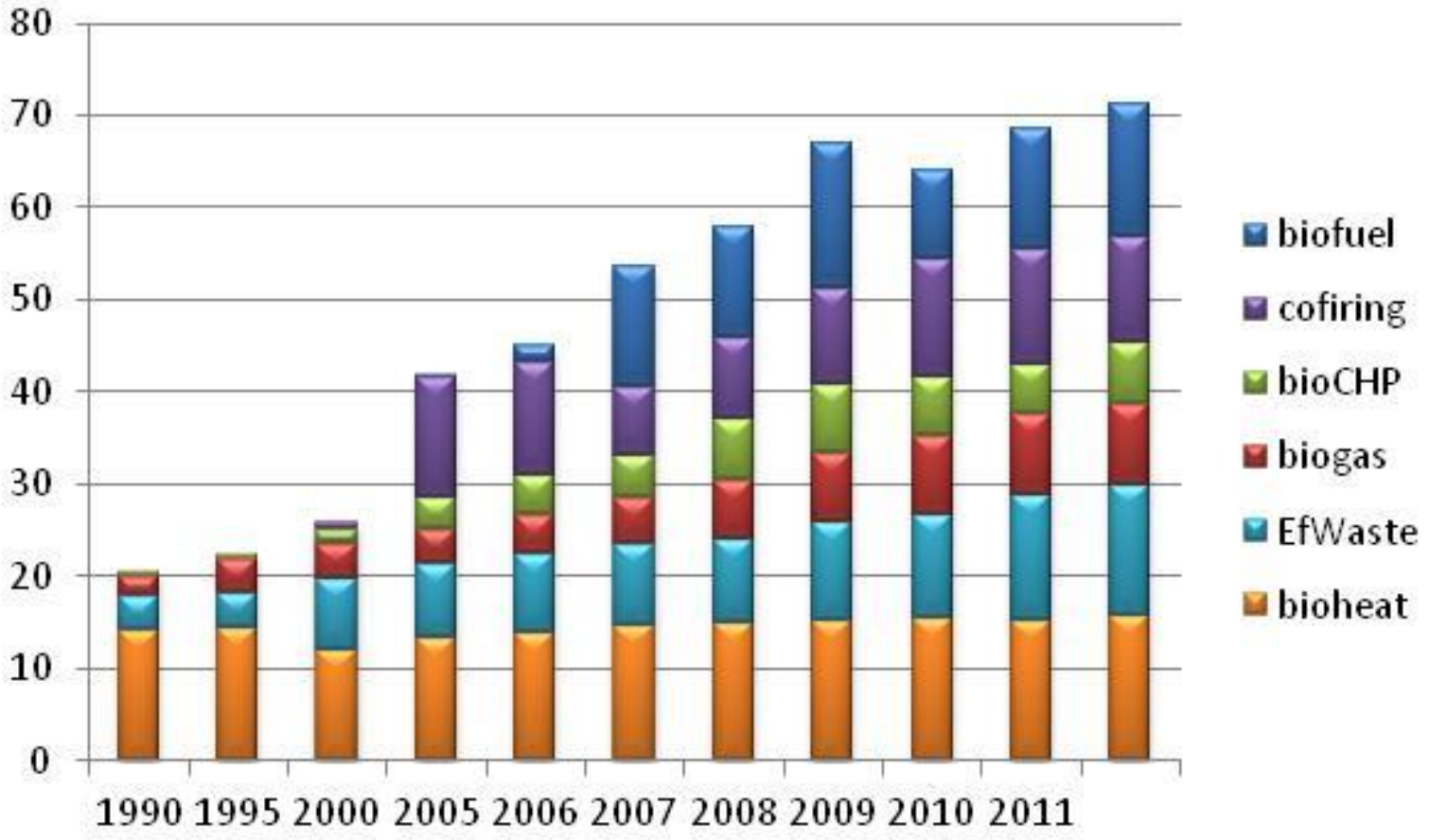


Results: About 70% realised with Bioenergy

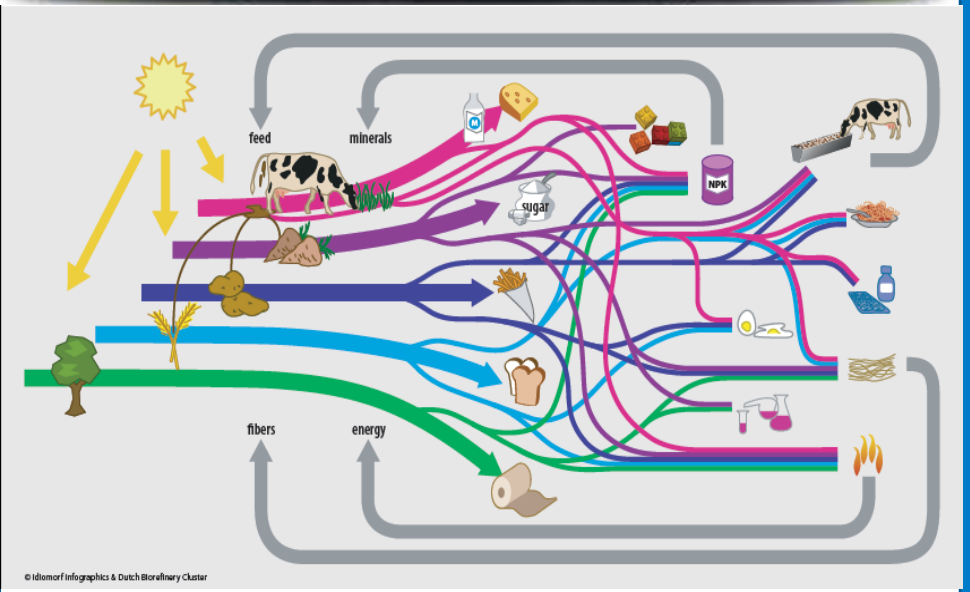


Bioenergy implementation Netherlands

PJ



Netherlands Enterprise Agency



Industrial Approach

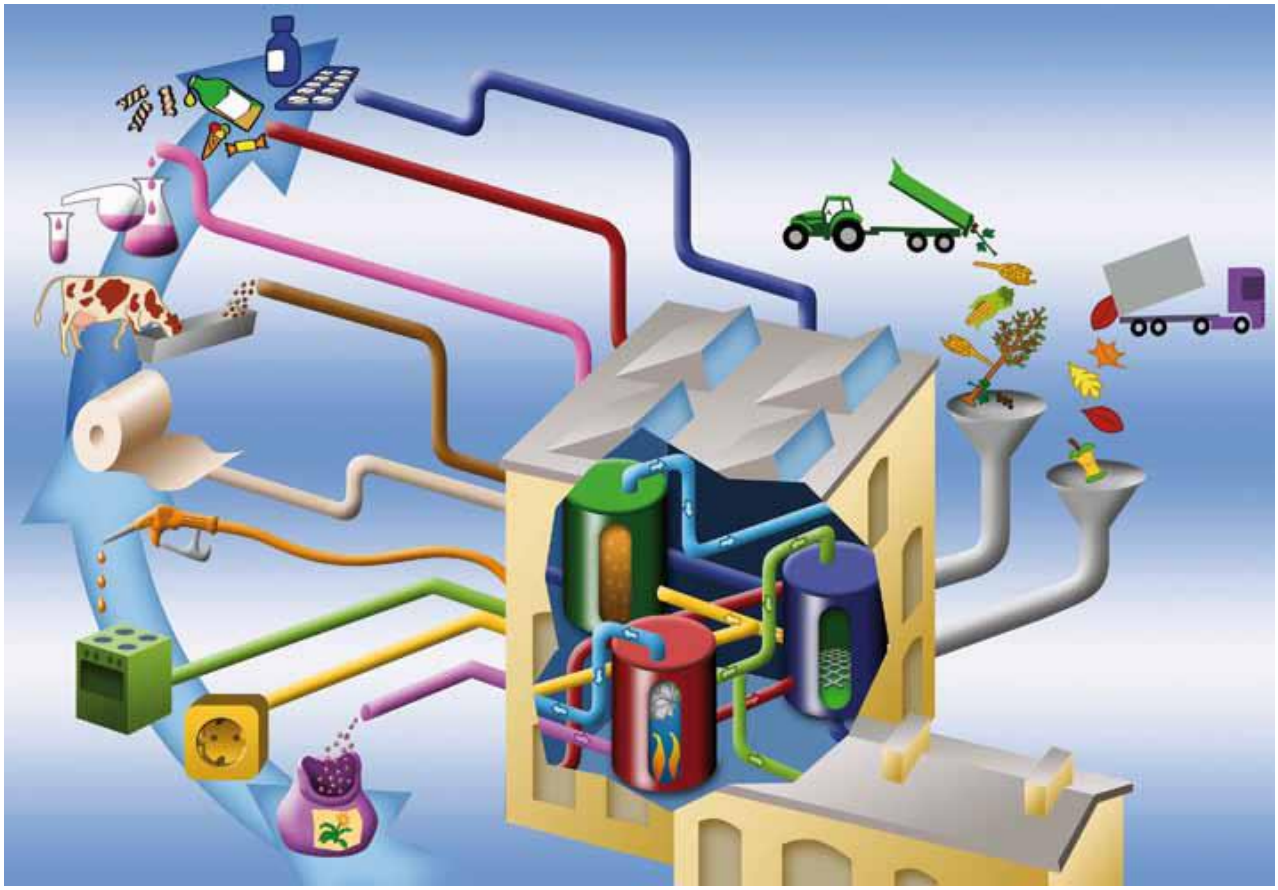
Sector Integration

Biorefinery

Biorefineries in the Netherlands

Biorefinery pilots the Netherlands 2010 - 2013

1. Dutch Crops
2. Residues
3. Import in harbours
4. aquatic biomass



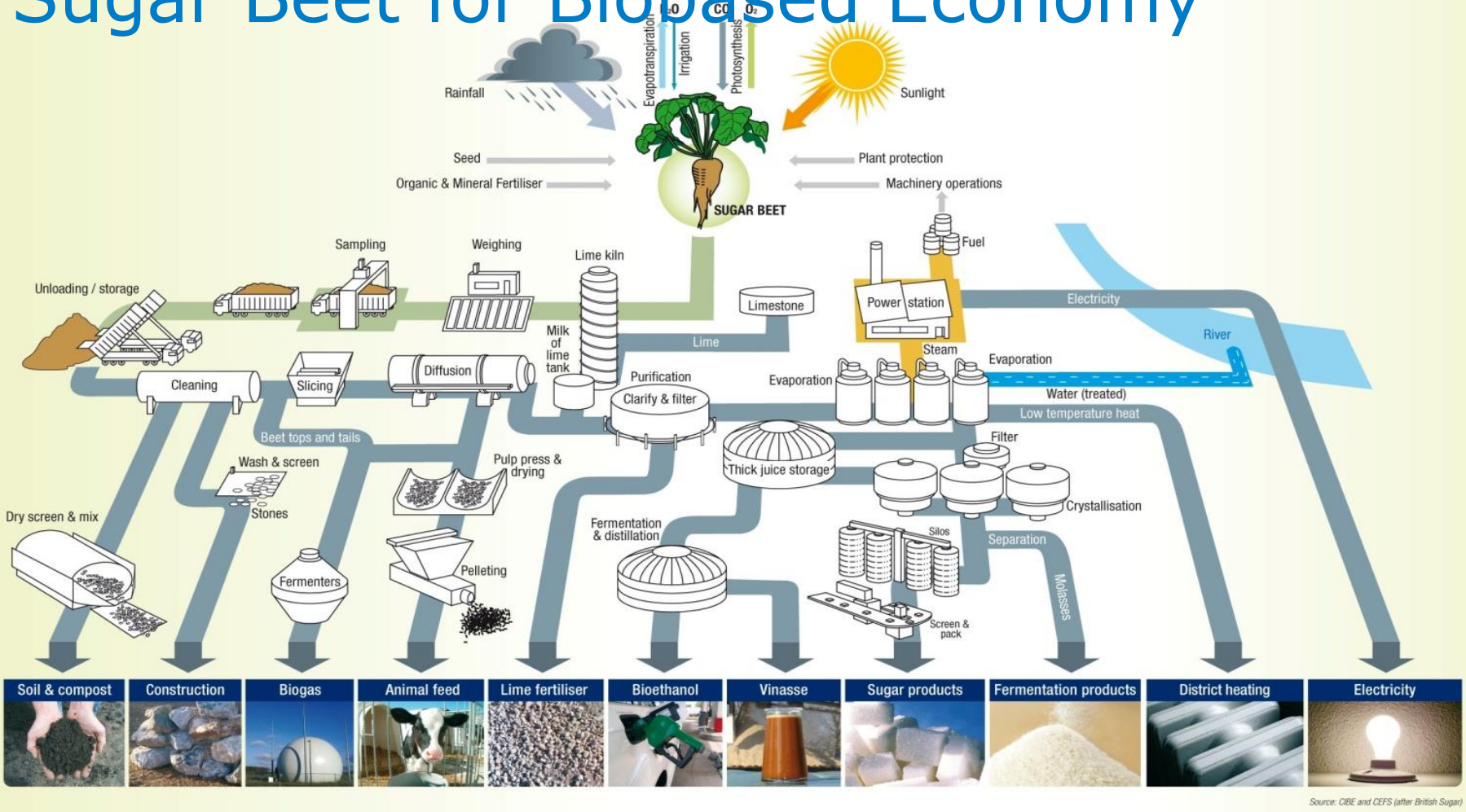
Unbeatable beat

Biorefinery

- Create value for farmer
-
22 – 25 ton/ha
-
Use beat, leaf, root

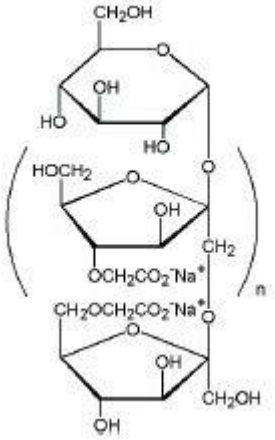
-Pilot products for chemical industry

Sugar Beet for Biobased Economy



Source: CIBE and CEFS (after British Sugar)

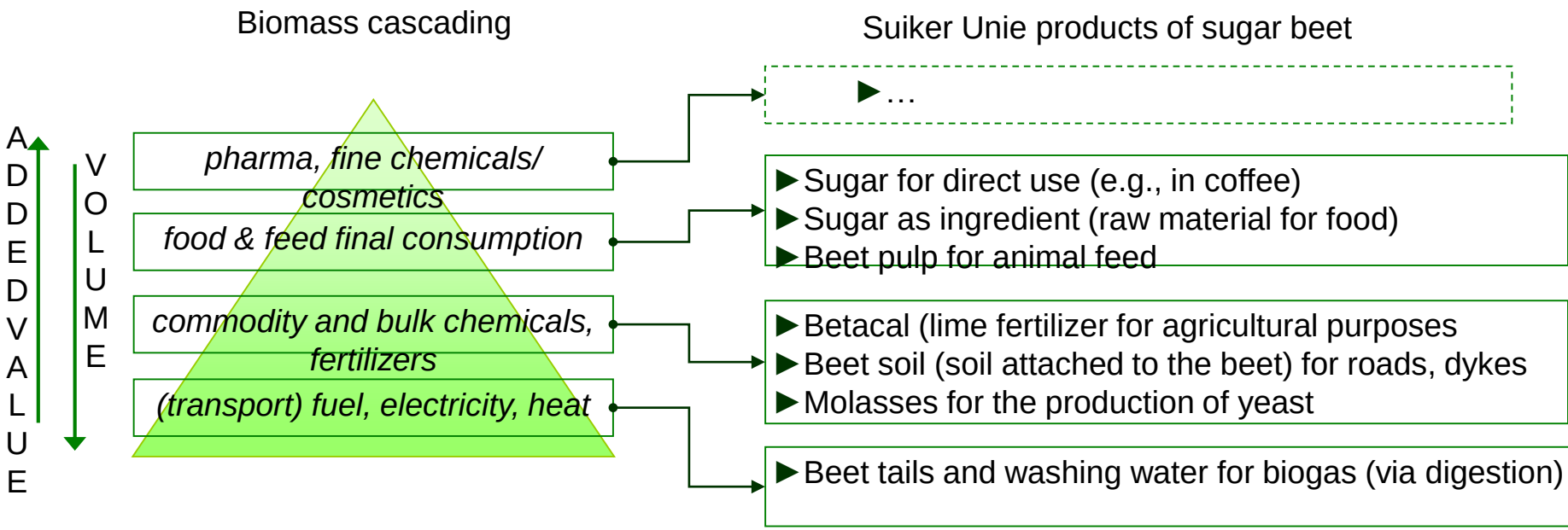
Cosun Biobased Products



->Carboxy*line* ® CMI (Carboxy Methyl Inulin), a green antiscalant for various industries;
->Beta*fib* ® MCF, natural fibers used in many different industrial products;
->CATIN ® (Cationic Inulin);
->Beta*well* ® special sugars, for application in cosmetic and personal care products;
->Biobased chemical building blocks, e.g. furane di-carboxylic acid;
Biobased plasticizers

http://cosunbiobased.com

Biomass Cascading and Valorisation



http://cosunbiobased.com

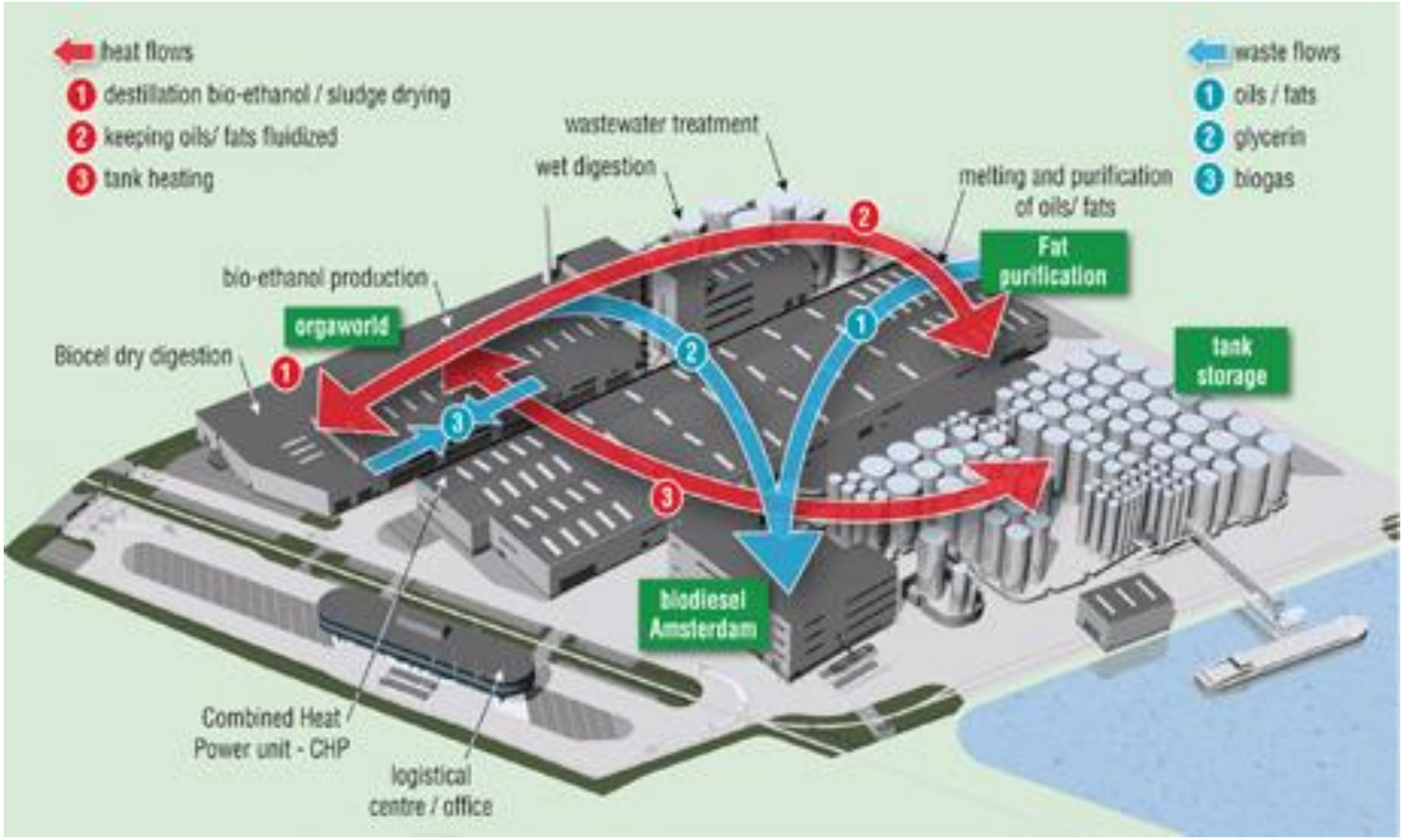
Orgaworld, Amsterdam

Recycling of organic residues (phosphates)

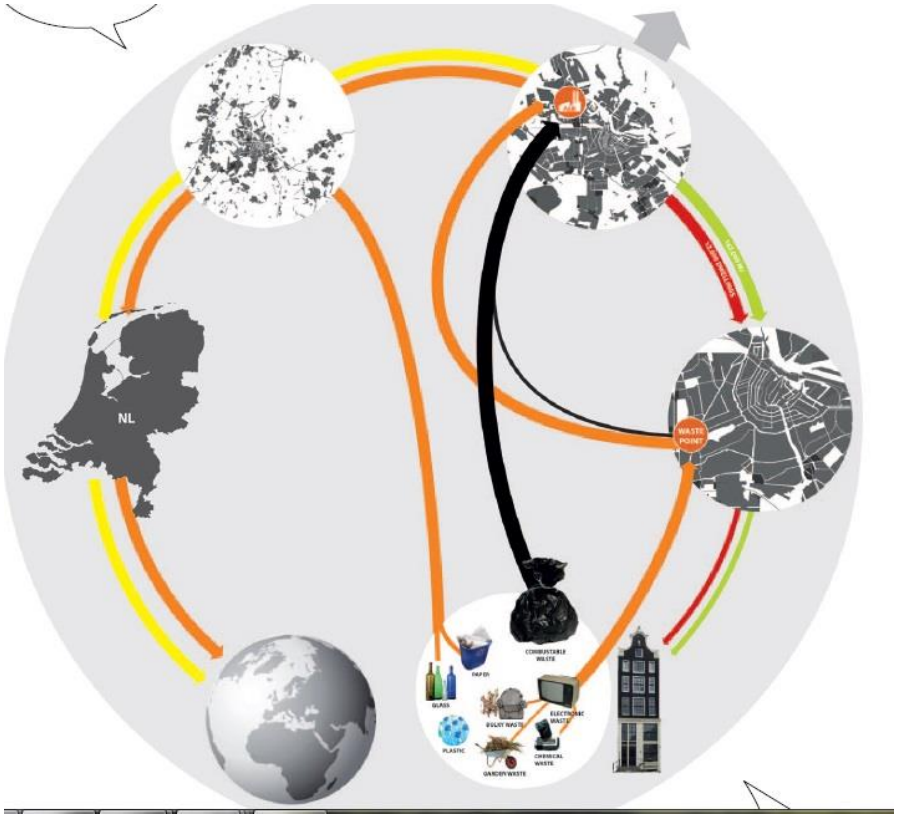
Complete the cycle

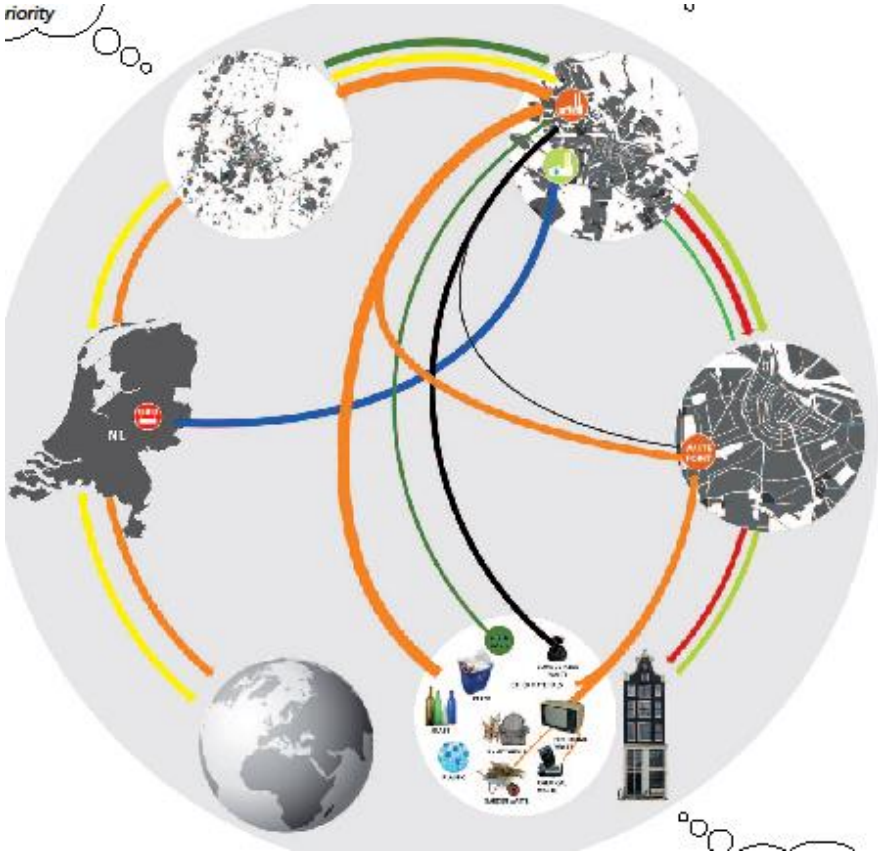
Waste heat utilization

Orgaworld: Utilisation of residues



Amsterdam Circular Economy





DSM

Frontrunner in bio-based materials and fuels

- Exciting partnerships established
  - *Roquette*: bio-succinic acid (10kt; start-up end '12)
  - *POET*: cellulosic bio-ethanol (~25 m gallon; start up end '13/early '14) (capex – US$ 250m)
  - *BP*: algae-based bio-diesel
- Leading technology position:
  - Yeasts (incl. acquisition C5 Yeast Co)
  - Enzymes
  - Algae
- Other renewable building blocks, such as adipic acid

ROQUETTE
Offering the best of nature

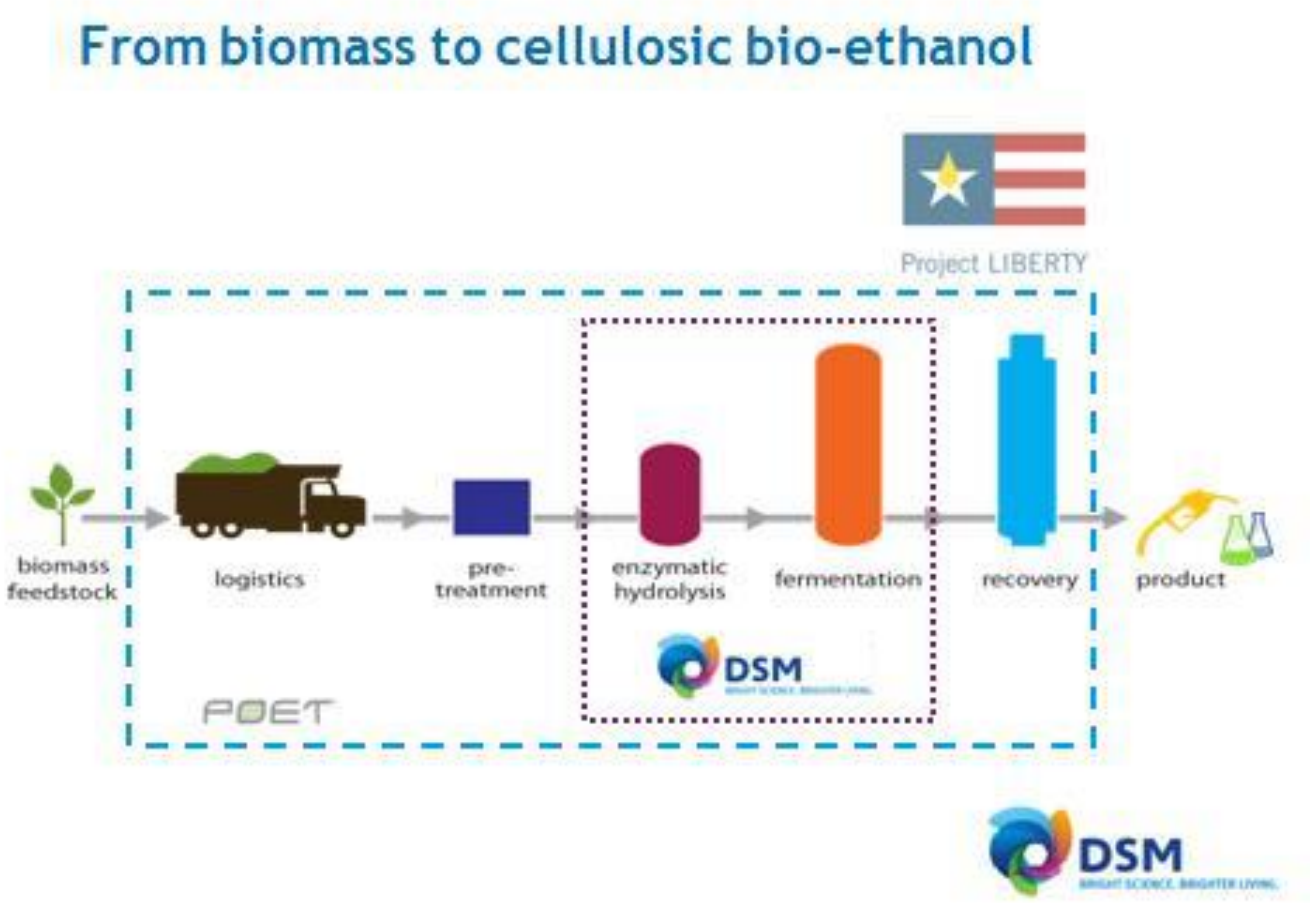
POET
Energy inspired

bp

DSM
BRIGHT SCIENCE. BRIGHTER LIVING.

Page 1

DS


From biomass to cellulosic bio-ethanol
Project LIBERTY
biomass feedstock
logistics
pre-treatment
enzymatic hydrolysis
fermentation
recovery
product
POET
DSM
DSM

DSM's Current Global Perspective on cEtOH

Project LIBERTY

Corn Stover

- Construction in Emmetsburg, Iowa, USA
- Investment $250 million
- Capacity over 20 million gallons
- Replicate technology throughout POET's existing network of 27 corn ethanol plants

Wheat Straw

- Denmo in Kalundborg, Denmark
- Capacity over 5 million liters p.a.

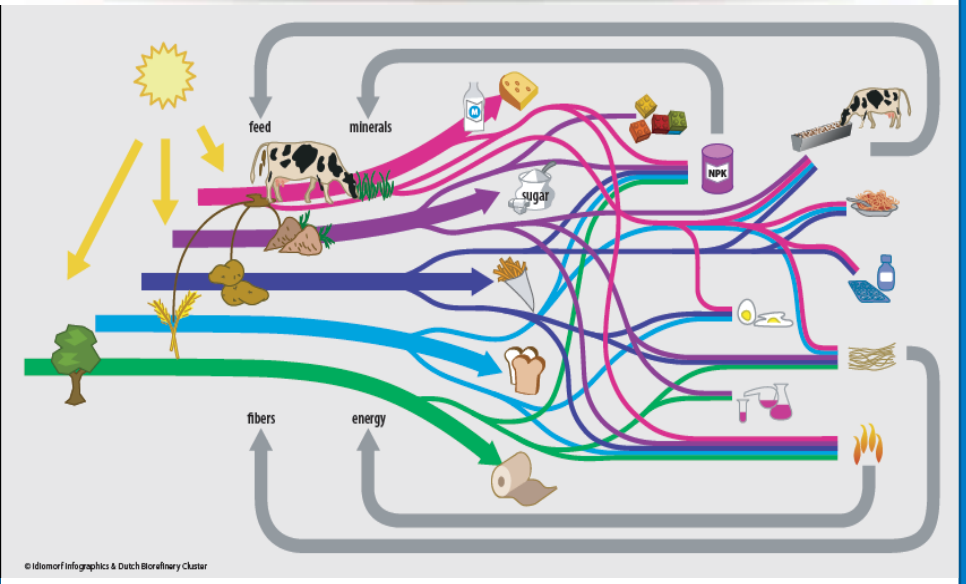
Cane Bagasse

- Construction in Alagoas, Brazil
- Capacity over 80 million liters per year

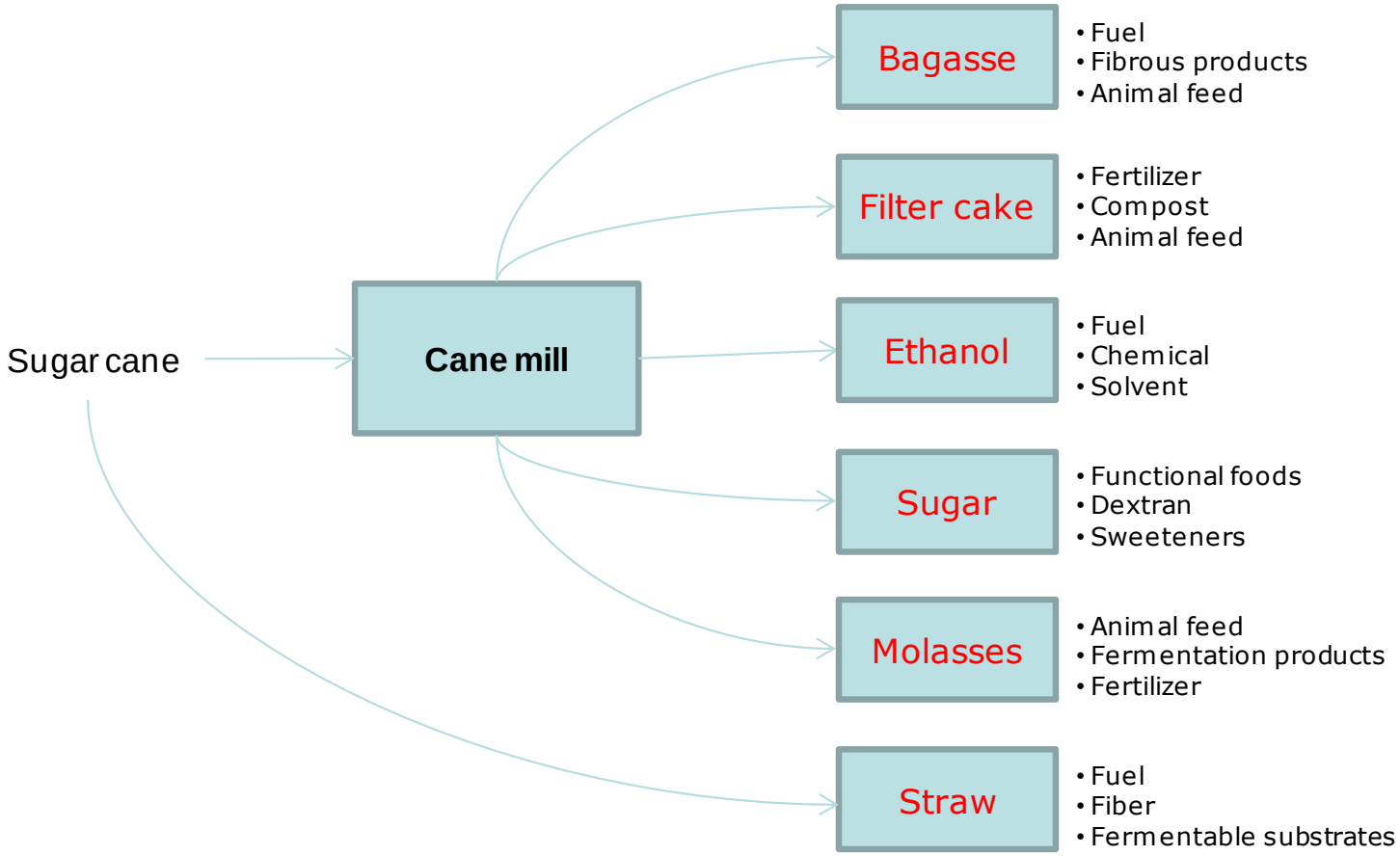
DSM

Rijksdienst voor Ondernemend Nederland

Biomass for Renewable Energy and Biobased Economy in Brasil



Study: Opportunities to increase sustainability and output in cane sector in Brasil



Present situation of sugarcane bioethanol in Brasil

- As far as we know…

- Still a large number of mills have a low efficiency of the power plant, due to limited access to grid

- Existing scheme to improve CHP in mills does not cover all plants

- Under utilisation of straw from the field

- -> Potential to increase harvest and outputs from the mills and improve GHG balance

Potential Availability of excess biomass: Straw

With increased mechanical harvesting, the tops and leaves can be collected

- Straw = 30% by mass of the produced sugarcane
- Sustainable harvesting allows for 50% straw to be removed from field (need for nutrient recycling)
- Based on harvest season 2008/2009 (648 Mtonne cane)
- Assuming 100% green harvesting (no burning)
- **potential yield 97 Mtonne straw (mc 50%) or 870 PJ**
- **and in 2020 about ¼ could be realised: 210 PJ**

Possibilities of additional output from existing plants

- By

1. improving efficiency of boiler/CHP
2. Process Optimisation (Pinch analysis)

Option	Biomass available	Mtonne Pellets	PJ
Efficiency improvements of boilers / CHP	107 Mtonnes bagasse	54	884
Efficiency improvements in process demand	75 Mtonnes bagasse	37	616

Or:

Second Generation bioethanol; 25 liter/ton cane ->

total additional 15 billion liter

Other applications of excess bagasse

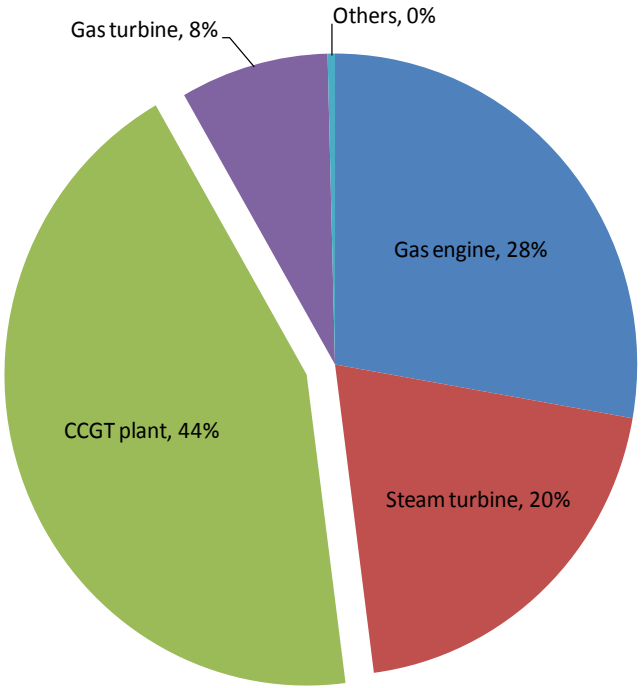
- Bagasse can be used as a component in animal feed. Such synergies between food and energy production offer real measures for reducing the risk of indirect land-use change (ILUC)[1]

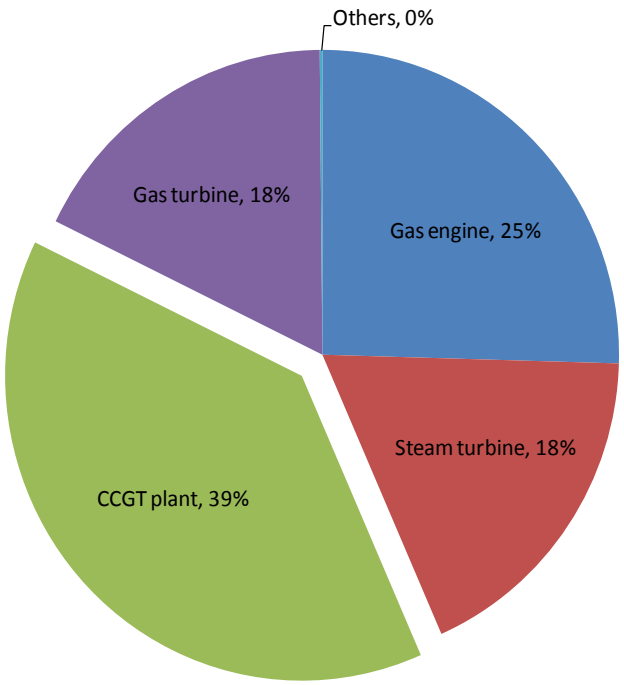
- Bagasse could be used as a heat source in other industrial sectors, such as the steel industry, which already uses charcoal for about a third of its energy needs (CGEE 2008).

- Sugargane biomass can also be used for high-value applications such as biochemistry, as is illustrated by the recent deal between European Solvay and the Brazilian National Bioethanol Science and Technology Laboratory (CTBE) to develop chemical routes for high-added value molecules => mills as bio-refineries

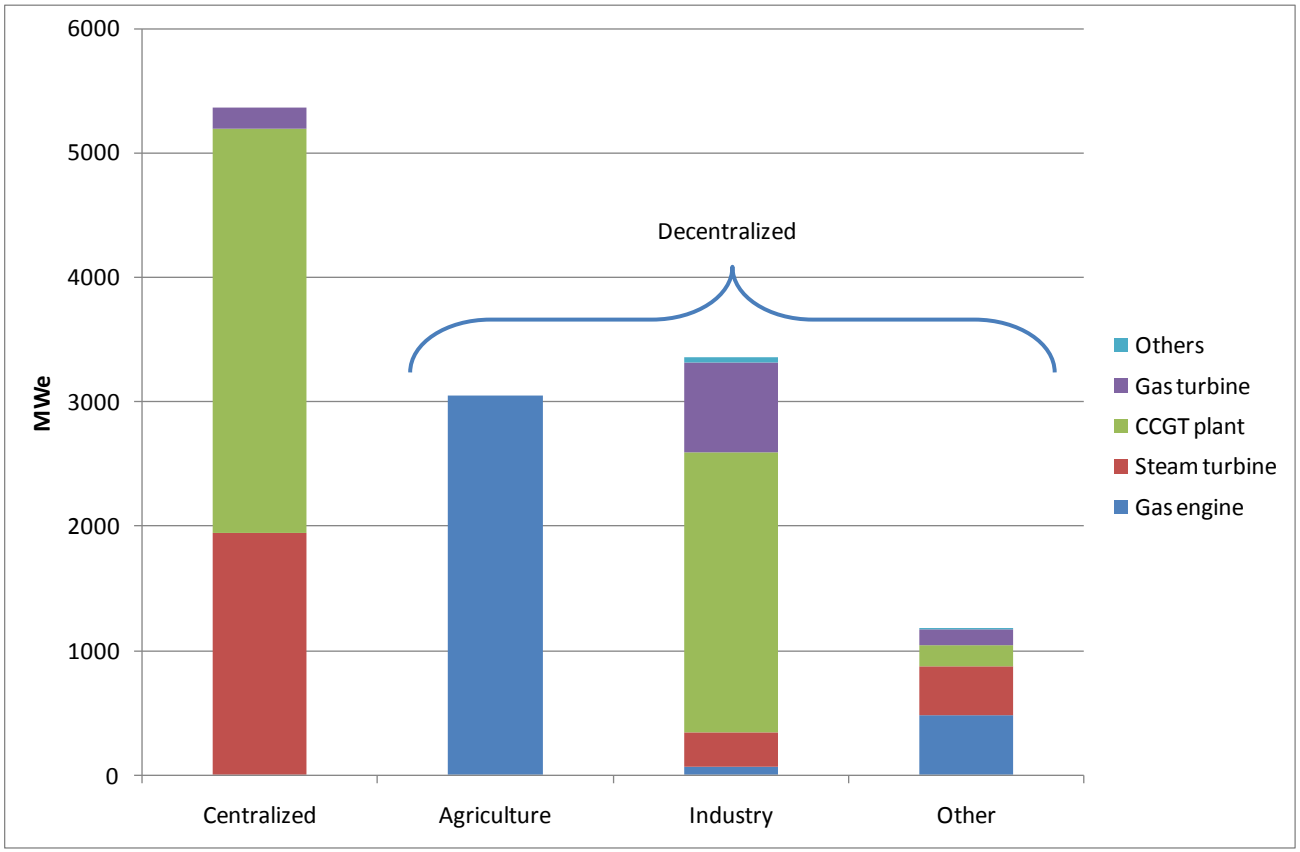
Netherlands: CHP experience: more than 50% of the power from CHP

- Total installed capacity in 2009: 13GW electrical and 19GW thermal.
- Centralised installations (mainly power plants): 5.4 MW (41%)
- Decentralized installations 7.6 MW (59%)





Netherlands: CHP plants in agriculture and industry



Possibilities for cooperation

- Agronomic improvements in the sugarcane, recycling of nutrients
- Densification of the biomass through pre-treatment technologies like torrefaction and pelletisation
- Logistics and infrastructure development
- Sustainability issues and regulations that could hamper access to (European) markets (ILUC mitigation)
- Research and development, especially in the field of second generation ethanol and biobased chemicals
- Energy system analysis and implementation of CHP by matching to heat demand in greenhouses and built environment.

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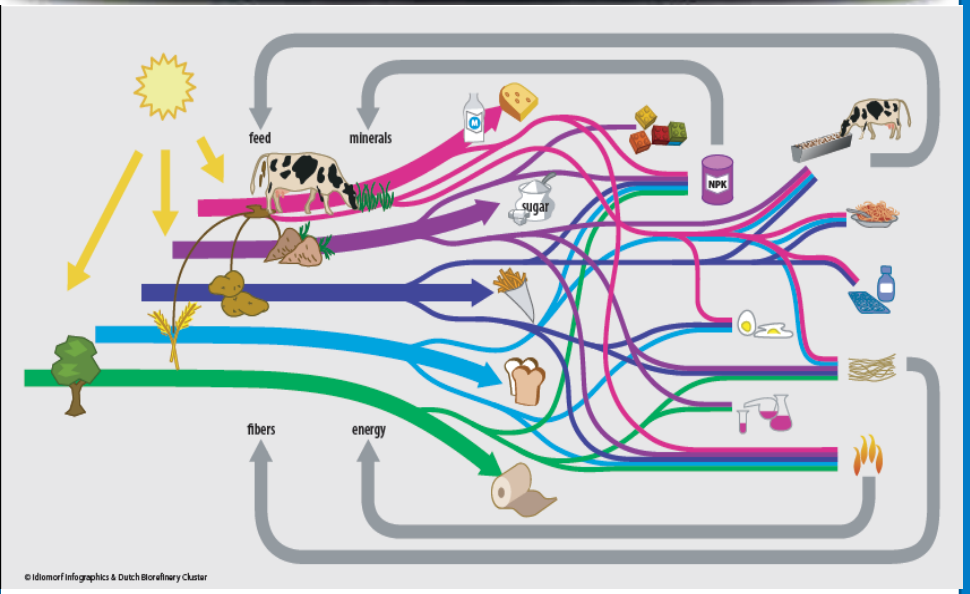
Conclusion



Conclusion

Large volumes of unused biomass residues are available

Technologies for valorisation of residues exist or are being developed

Unique opportunities for collaboration between Netherlands and Brasil

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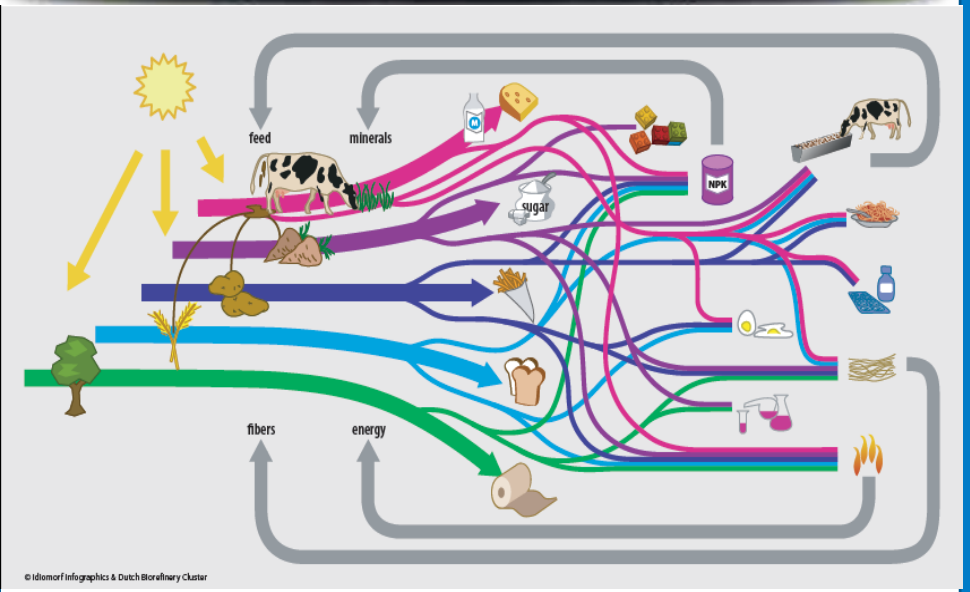

Questions?

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