

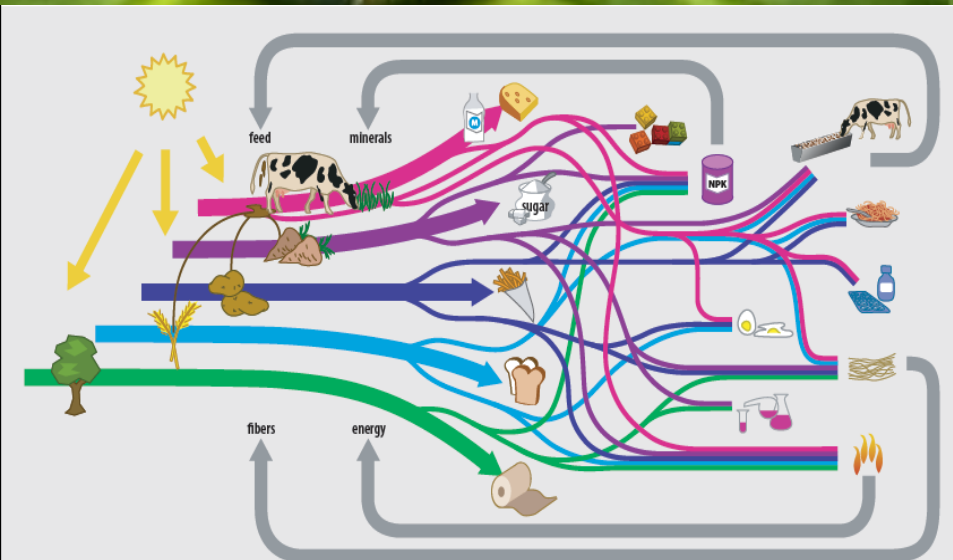


Netherlands Enterprise Agency



Biobased demonstrations to speed up market introduction

Ir. Kees W. Kwant





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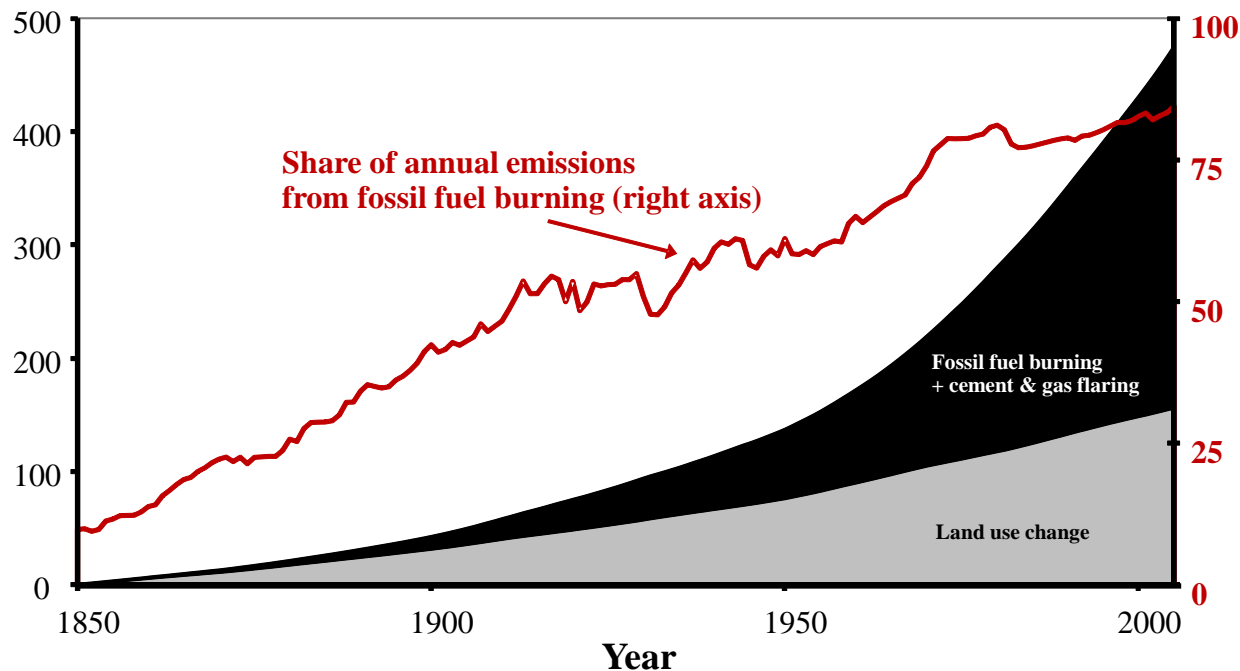
- Renewable Resources for a Low Carbon Economy
 - Biobased Economy
- Innovation system in the Netherlands
- Demonstrations of Biorefineries
- Results and Conclusion



CO₂ emissions from Land Use Change and fossil fuels

Accumulated emissions
to the atmosphere (Pg)

Share of emissions (%)



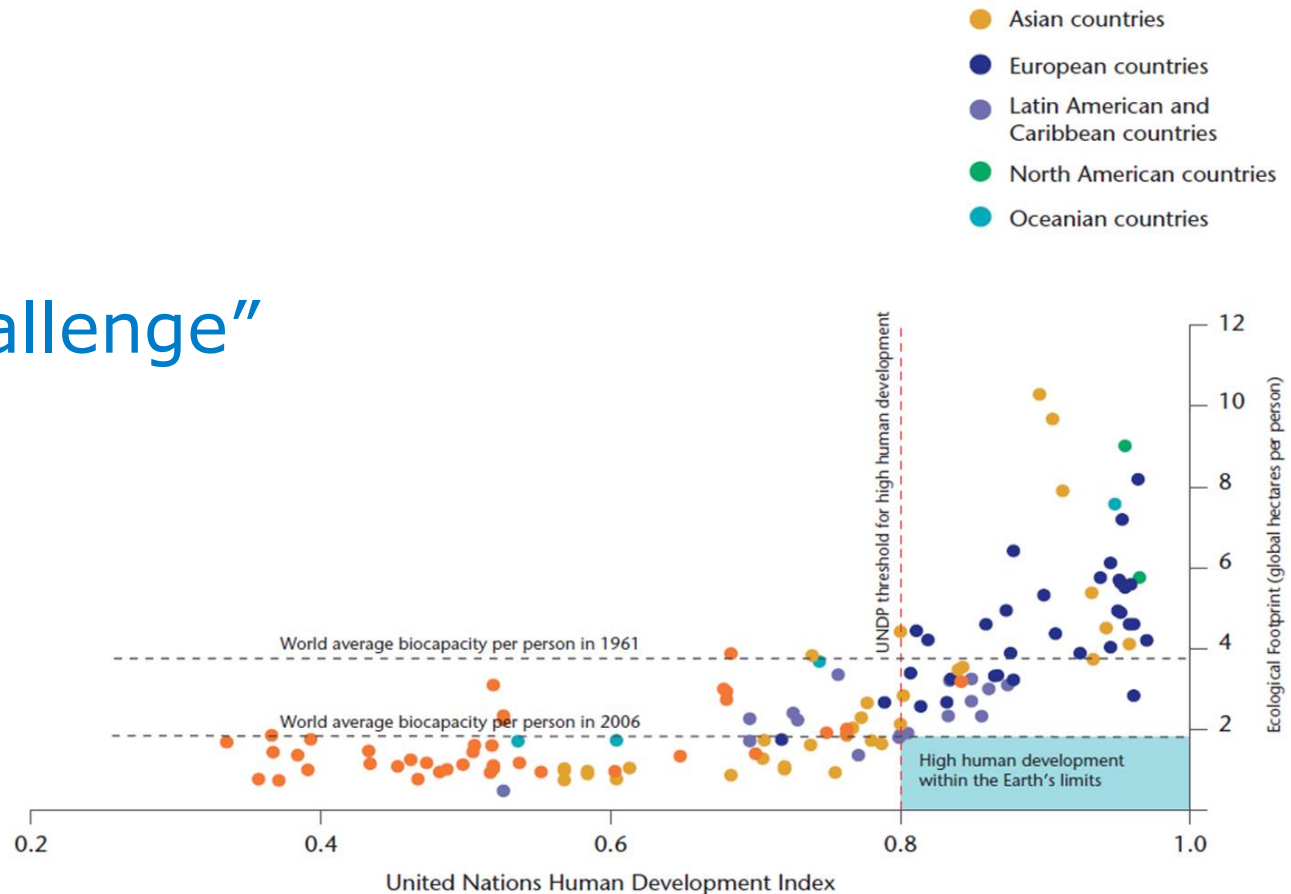
Fossil
CO₂

Land Use
Change



sustainable economy

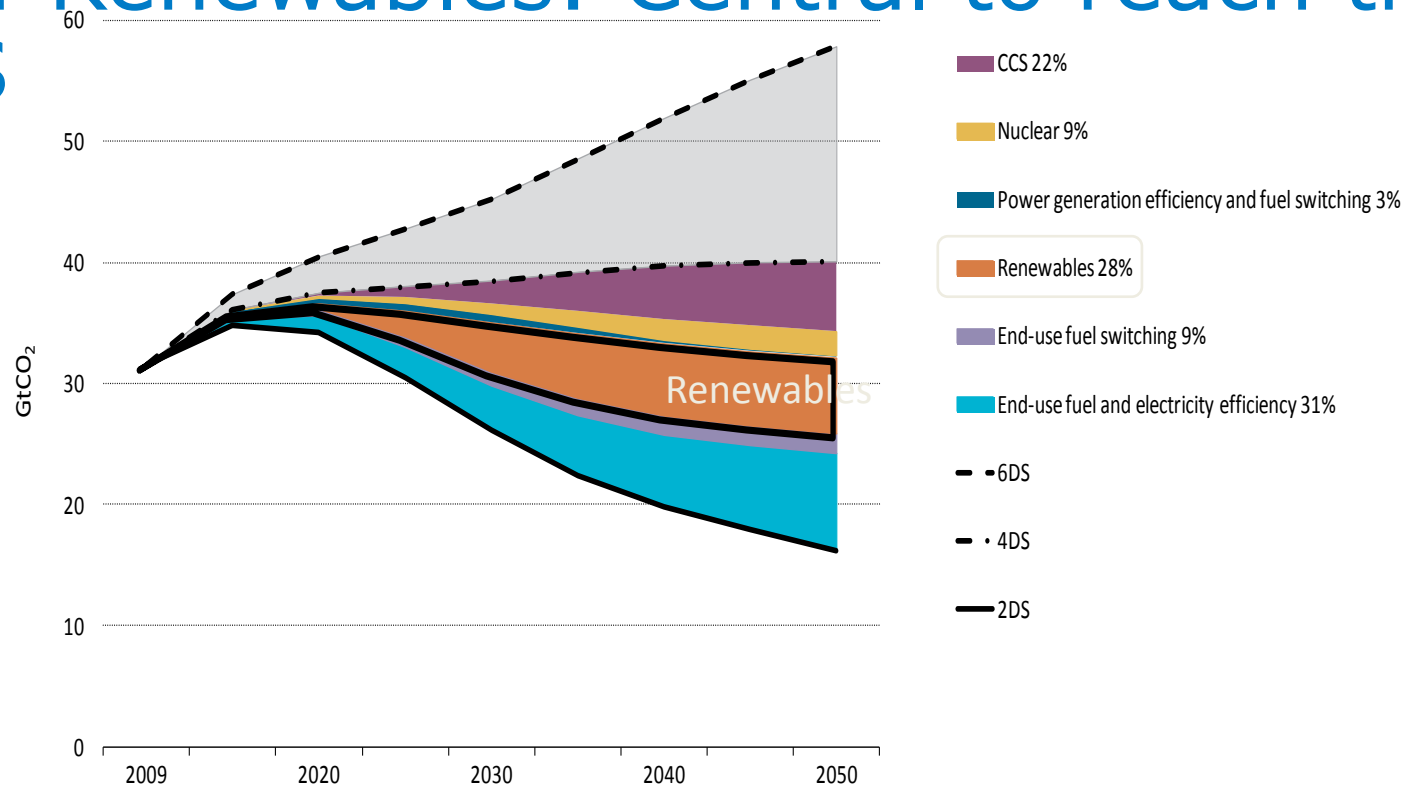
“The challenge”



© Global Footprint Network (2009). Data from Global Footprint Network National Footprint Accounts, 2009 Edition; UNDP Human Development Report, 2009



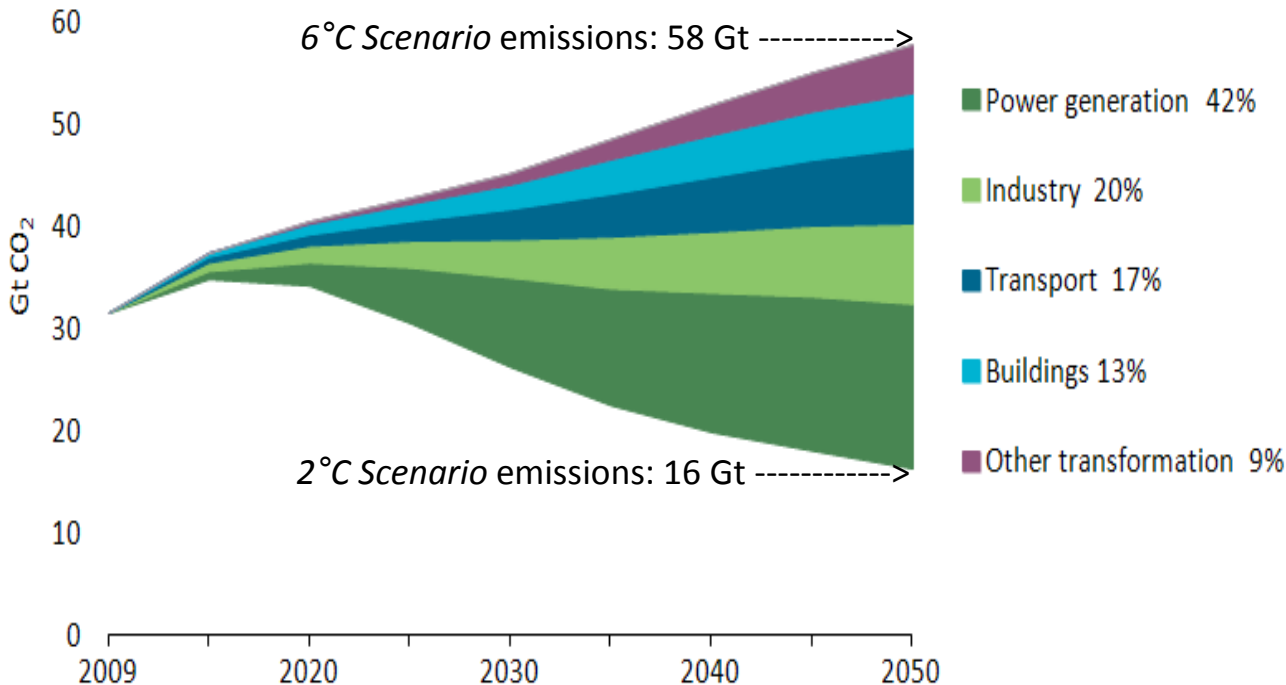
IEA: Renewables: Central to reach the 2DS



Renewables provide almost 30% of the cumulative reductions needed to reach the 2DS.



IEA: Key role of bioenergy in a low-carbon future



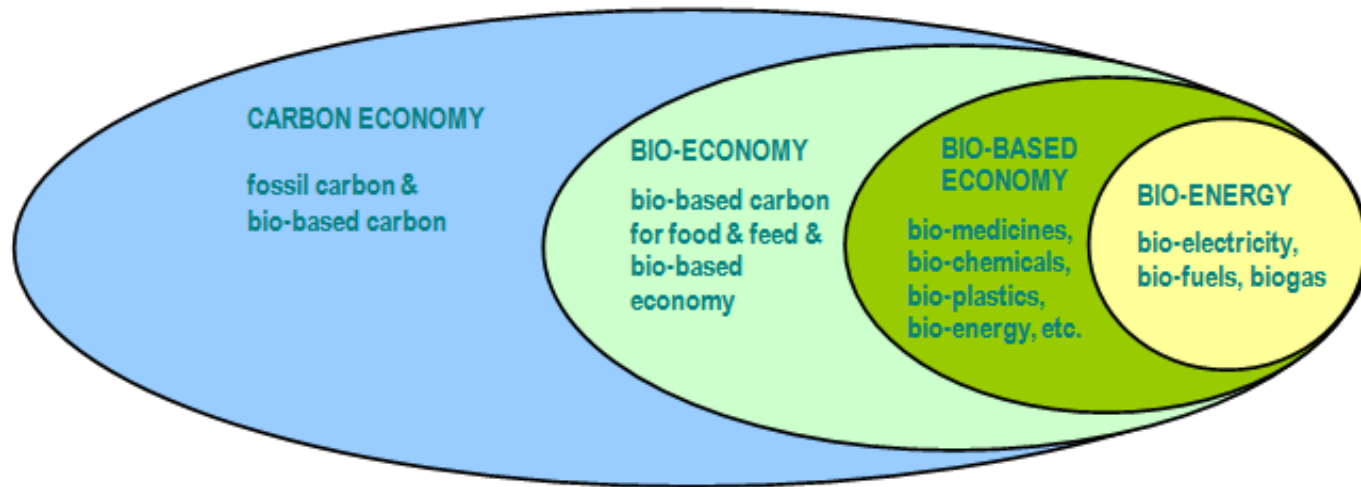
Bioenergy technologies	Emissions reduction in 2050
Bioenergy power	1.0 Gt CO ₂ -eq
Bio-power + CCS	0.3 Gt CO ₂ -eq
Bioenergy heat (industry)	0.5 Gt CO ₂ -eq
Bioenergy heat (buildings)	0.1 Gt CO ₂ -eq
Biofuels	2.1 Gt CO ₂ -eq
Total	4.1 Gt CO₂-eq

Source: Energy Technology Perspectives 2012

- Reaching the 2DS will require **42 Gt CO₂ annual emissions reduction** by 2050
- Biomass is the only renewable energy source that can make a contribution in all sectors, providing **around 10% of total CO₂ emissions reduction**



Integrated Approach for Bioenergy:– The bio-based economy in context



- The bio-energy arena is a subset of the bio-based arena (non-food use of biological resources), itself a subset of the bio economy, and ultimately of the 'carbon economy'.
- Our society is to a significant extent based on the 'carbon economy', fed both by fossil and renewable (or biological) carbon.



Principles of the sustainable bio-based economy

First: Sustainable biomass growth

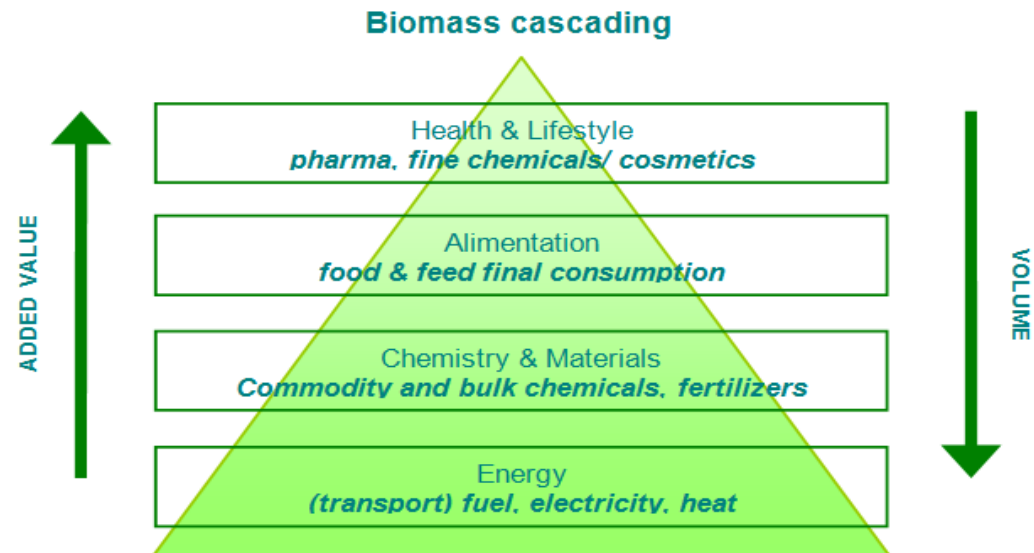
(GBEP) –sustainability indicators for bioenergy:

- Improving yields in agriculture (with better crops, cultures, nursing, care)
- Nutrient recycling
- Optimal use of water (e.g. drip irrigation)
- Minimal pesticide (organic pest control)
- Minimal energy use in production chains

These elements are in line with the Good Agricultural Practices (GAP) codes, standards and regulations promoted by the FAO (2013).



Second: Resource Efficiency

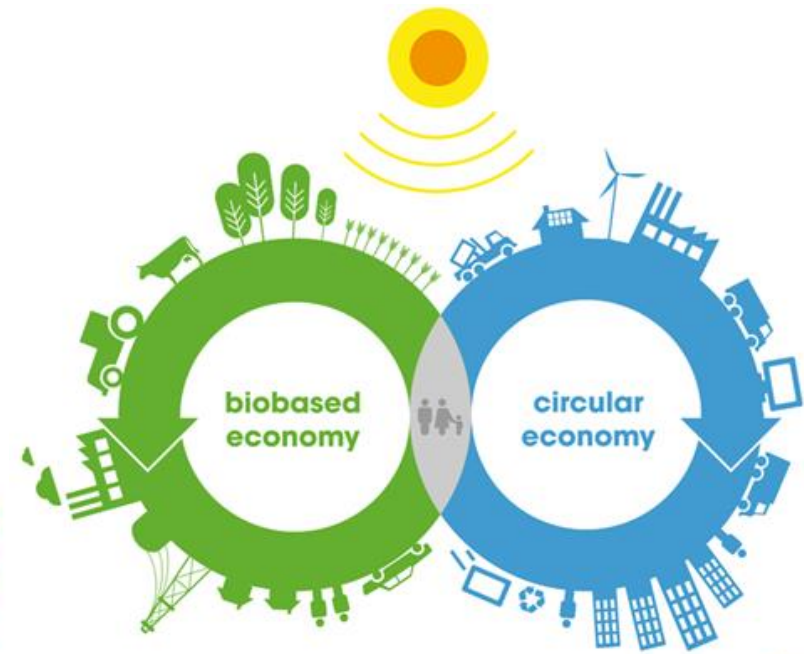
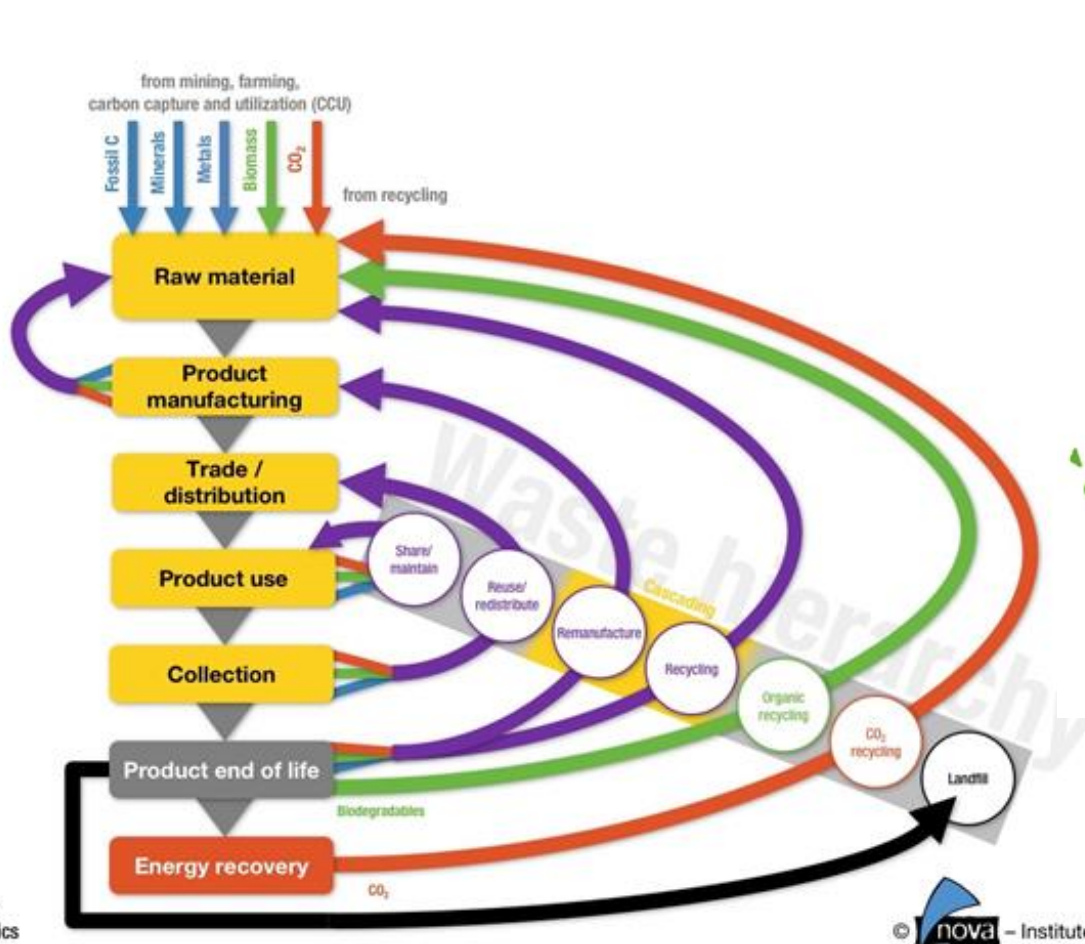


Optimum use of bio-resources implies 'cascading'

- Cascading in time: expanding the utilization of harvested biomass by re-using (or even upgrading) waste streams
- Cascading in value: maximizing and optimizing the economic benefit of the bio resource life cycle.
- Cascading in function: benefiting from all potential functions, e.g. through bio-refinery



Circular & Biobased Economy





Third: Principles: 'trias biologica'

The 'Trias Biologica' is a popularized expansion of the 'Trias Energetica' – (1) reduce energy demand, (2) meet the demand as far as possible with renewable resources, and (3) minimize emissions and ecological impact from the remaining (fossil) supply.

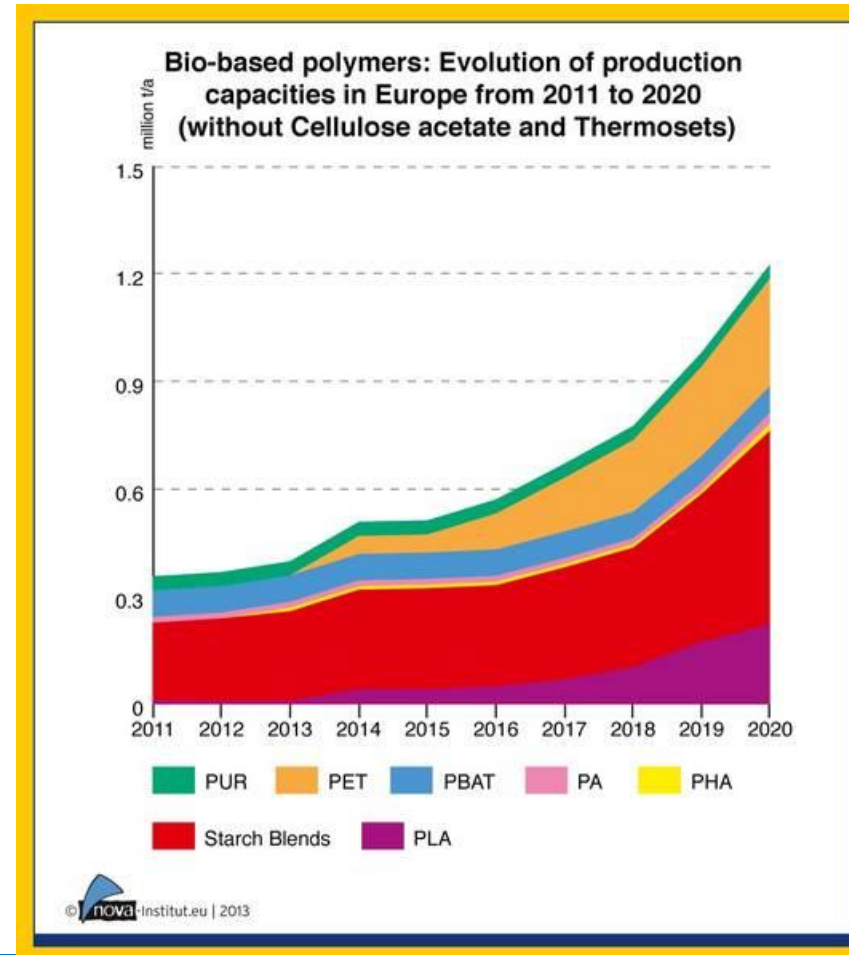
Trias Biologica:

1. De carbonize the economy – i.e. minimize the 'carbon need and footprint'
2. Supply the remaining carbon need from sustainably produced bio-resources
3. Minimize impact and maximize efficiency: use 'cascading' for all carbon resources and avoid all harmful emissions.



Economic opportunities

- Hardly any alternative renewable sources for
 - long distance shipping/aviation
 - chemicals and plastics
 - industrial heat
- Huge growth market for biochemicals and biomaterials



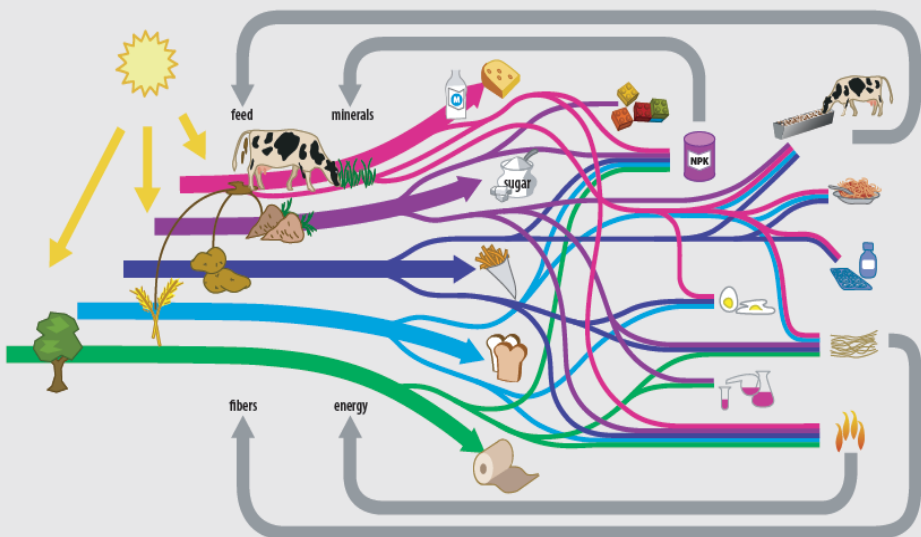


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Innovation System

A major transition towards the biobased resources required





Rules and Actors:

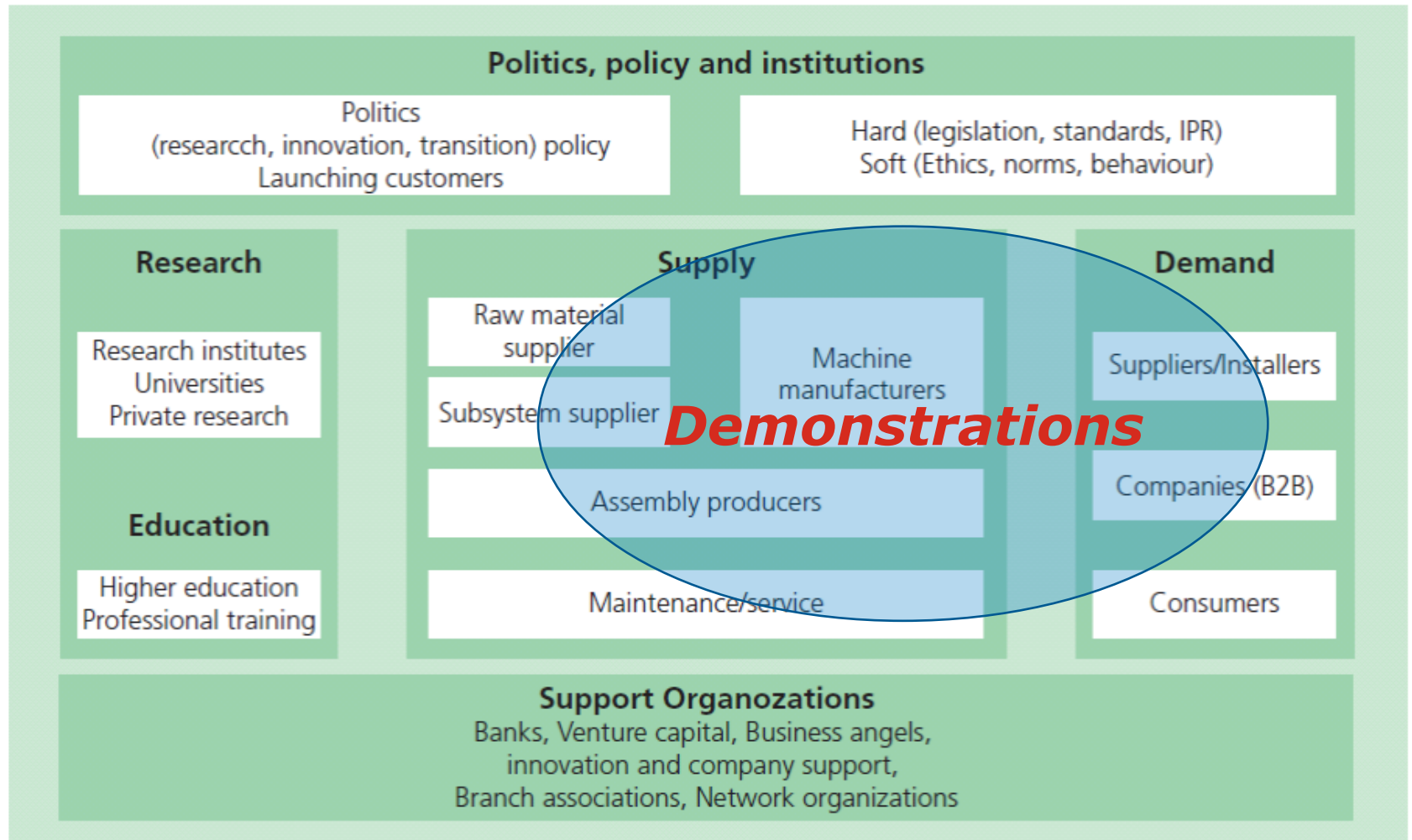


Figure 2 Structure of the innovation system (based on (Kuhlmann and Arnold, 2001))



Innovation system, 7 determining functions, Hekkert, Univ. Utrecht

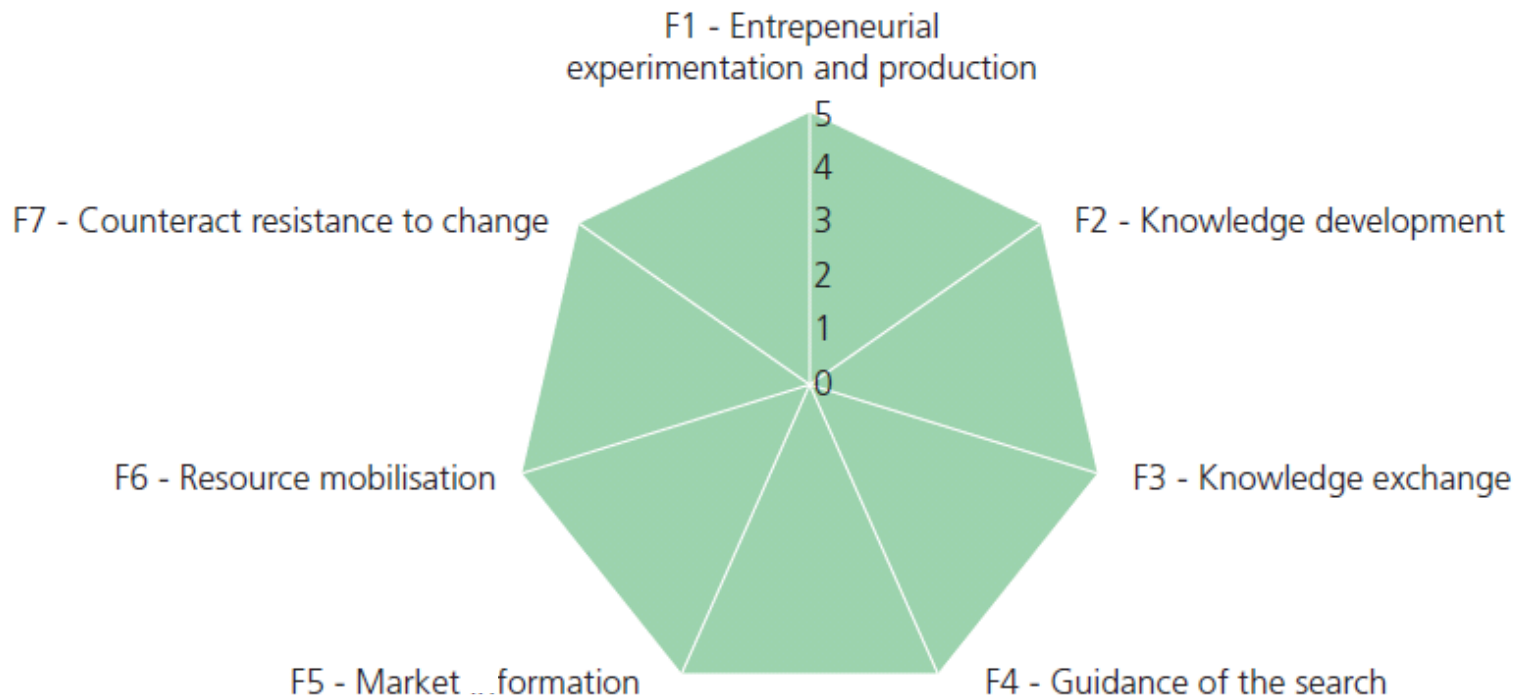


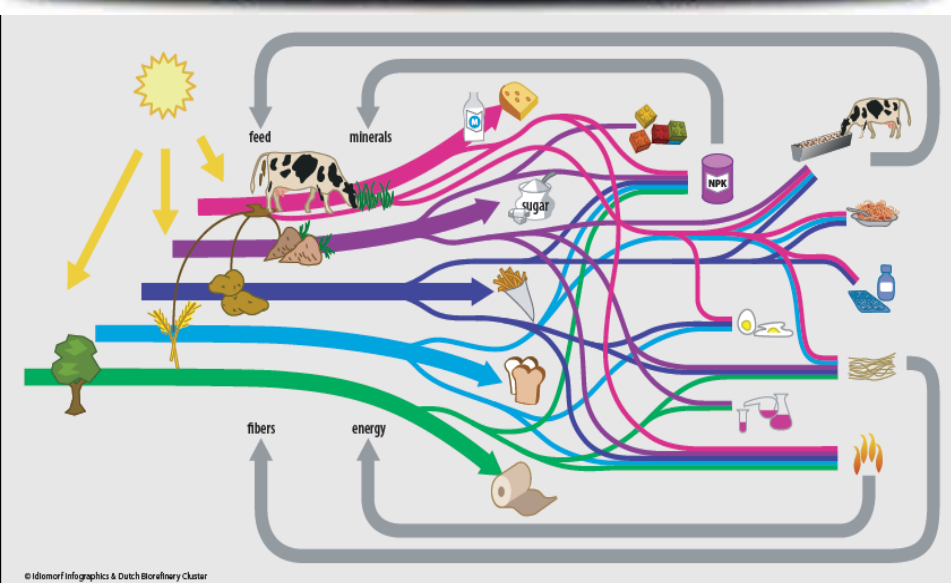
Figure 4 Overview of system function fulfillment



Rijksdienst voor Ondernemend
Nederland



Research and Development





Research & Development

- Support through topsector approach
- Market driven Research in topsectors
- Regional Support for specific strength
- Budget about 240 M€/year
- Support from government $\sim\sim$ 70 M€/year (subsidies, fiscal, loans etc.)



Development of Biobased Economy In the REGIONS

Flevoland

WUR/Accres, Prov. Flevoland en Eneco,
HarvestaGG, CAH Viltentum, Ringg, OMFL

Focus:

- * Bio-energie
- * Cascadering
- * BBE experimenteren/testen/
demonstraties

Biobased Connections

ICL, Cargill, Greenmills, AEB, Haven Amsterdam, Orgaworld, AIM, Schiphol, HvA, UvA, Amsterdam Economic Board Waterjet, Aalsmeer, Haarlemmermeer, Amstelveen, NPSP, Photonol, SADC, Ursapaint, Pharmafilter, Jagran, Hempflax etc.

Focus:

- * Inzet organische reststromen voor bio-energie, biofuels en biomaterialen

Biobased Delta

Green Chemistry Campus, DOW, Cosun, Purac, Sabic, Bio Base Europe, Avans Hogeschool, Prov. Zeeland, Brabant en Zuid-Holland, Haven Rotterdam (BioPort), TUD, Leiden Univ., Plant One, RCI, BE-BASIC, DSM, Pilotplant, Biotechpark Delft Kenniscentrum Plantenstoffen, Growport, Greenport, BOM, REWIN, Impuls, InnovationQuarter etc.

Focus:

- * biobuilding blocks
- * biobased aromatics
- * Performance materials & chemicals
- * Agro functionals/hoogwaardige plantinhoudsstoffen
- * Aquatische biomassa
- * Coatings
- * Witte bio-technologie voor fuels en chemicaliën
- * Bioport

Biobased Business Brainport

Focus:

- * Verwaarden van mineralen uit dierlijke en plantaardige nevenstromen richting food, feed en pharma

Biobased Economy Noord Nederland

Avebe, FrieslandCampina, Cosun, Agrifirm, BioMCN, Grassa, DOC, PKI, API, Cumapol, Eemshaven, Stenden PRE, Wetsus, biobRUG, Biocab, Hanze Hogeschool, CCC, HANNN, Prov. Groningen, Drenthe en Friesland, NOM etc.

Focus:

- * Verwaarding organische reststromen
- * Eiwitten & koolhydraten (food/feed/industrie)
- * Fybes en biopolymeren
- * Chemical buildingblocks
- * Biofuels

Biobased Economy Oost Nederland

Bio-energie Cluster Oost Nederland, BTG, Byosis, Ten Cate, AkzoNobel, Van Wijhe, Rolsma, ROVA, GTC, Utwente, WUR, BIC Oost-Nederland, Prov. Gelderland en Overijssel, OostNV etc.

Focus:

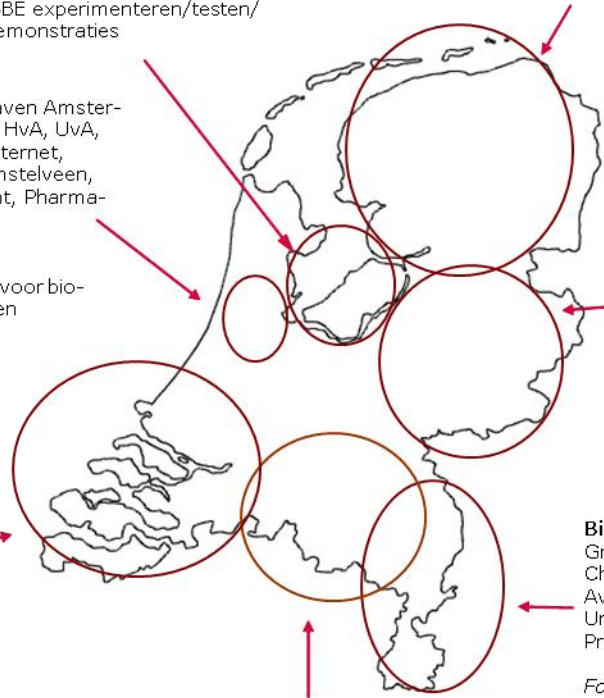
- * Bio energie (pyrolyse/fermentatie)
- * biobased coatings
- * Biobased garens, textiel en biopolymeren
- * Verwaarden van cellulose houdende materialen, gebruik van mest en slib als biomassagrondstofen toepassing van nieuwe biomassaströmen algen en kroos

Biobased Economy Limburg

Greenport & biotransitiehuis Venlo, Chemelot, DSM, Sabic, Lanxess, Avantium, Papier & Kartonindustrie, Univ. Maastricht, Zuyd Hogeschool, Prov. Limburg, Liof etc.

Focus:

- * Biobased performance materials & chemicals
- * Biomedical materials
- * Processtechnolgy & biobased buildingblocks
- * biobased tuinbouw toepassingen & Agrorafinage
- * Nutraceuticals en cosmetica





Research and Development

From lab to Market

- Biorefinery Program
 - 2010 - 2014
- Topsector Approach
 - www.tki-bbe.nl
- Upscaling:
 - www.bpf.eu
- Demonstration
- Flagships / Financing

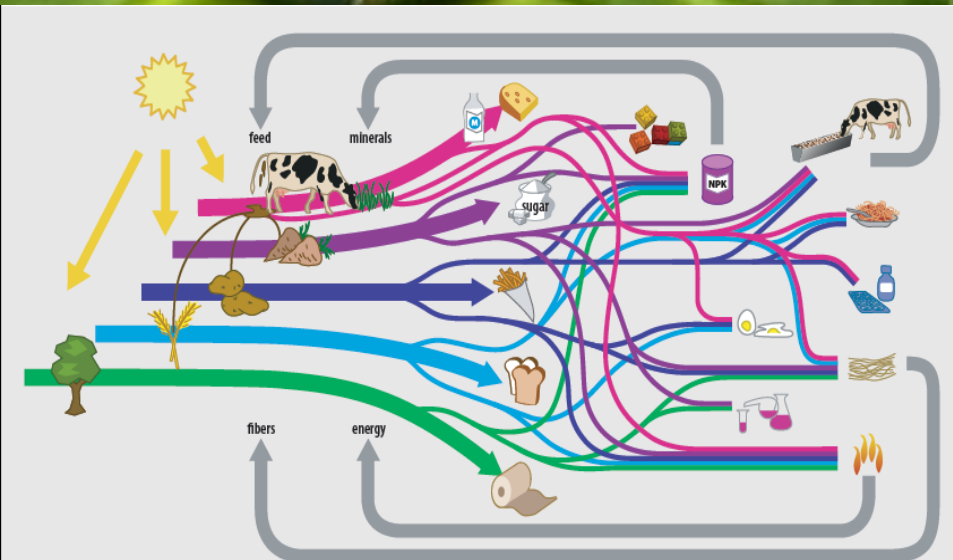
Bio Proces Facility Delft





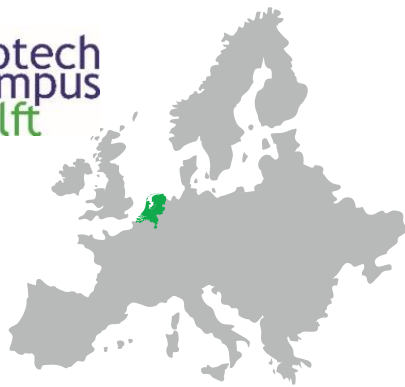
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Piloting with Biorefinery Processes and Products



Bioprocess Pilot Facility

Experienced industrial scale up facility
based in Delft, The Netherlands



Investing in your future.
The Bioprocess Pilot Facility is partly financed
by the European Regional Development Fund
of the European Union.



Ministerie van Economische Zaken,
Landbouw en Innovatie

Biotechnology & bio-based economy

Towards a sustainable world now!



Bulk-chemicals



Fine-chemicals



API's



Plastics



Food



Ingredients



Biofuel



Enzymes

***... (im)proving the
process
of the client***

Pilot Plant **BPF facilities**

Structure: 4 sections, modular operation

Pretreatment

Hydrolysis

Pilot Scale Pretreatment
Bench Scale Pretreatment

Fermentation

Separation

Stirred 10 L - 4 M³
Bubble column 8 M³



Scale up approach

- Scale down targeted commercial scale plant
- Run pilot scale to confirm / modify proof of concept
- Data generation for commercial scale engineering & safety

BENEFITS

- **Reduce risks** when scaling-up from lab-scale
- **Pre-marketing / application / tox trials** product quantities
- Test/validate **new technical designs**
- **Enhance** bio-processing **competence** of customer



Customer base

- Young company
- Longstanding industrial experience
- Growing customer base



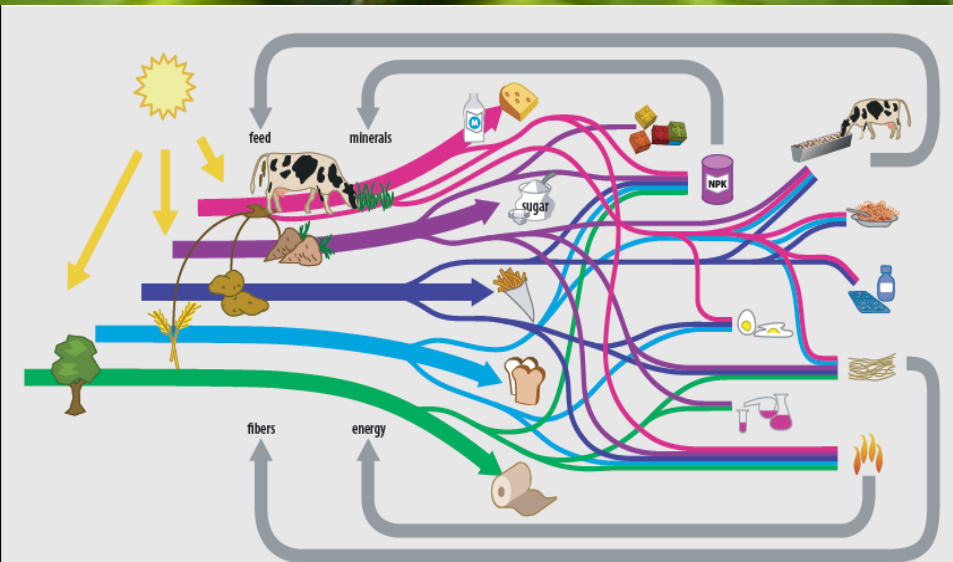
Result: New companies join and start demonstrating





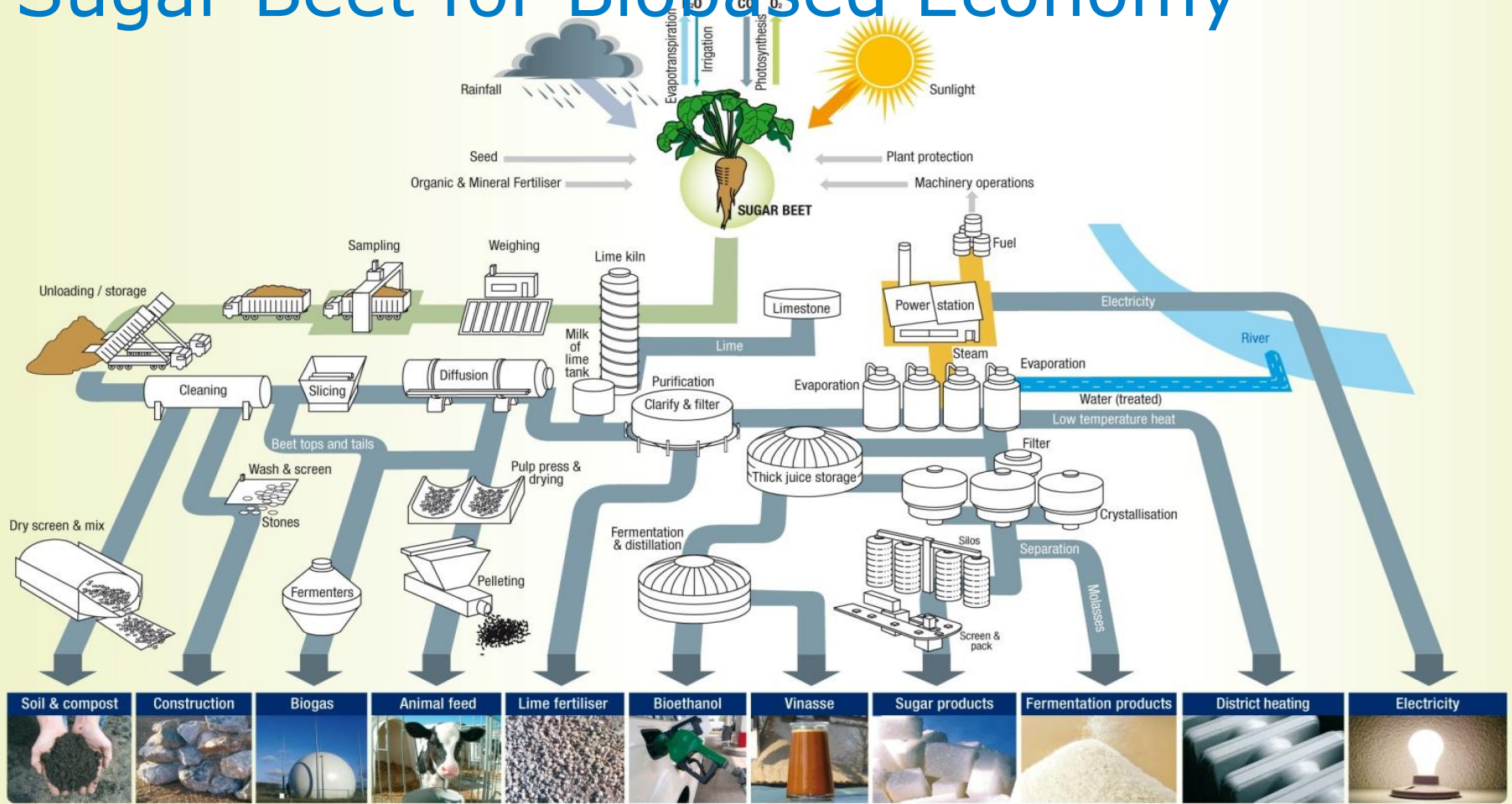
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Demonstrations of Biorefineries and lessons for innovation





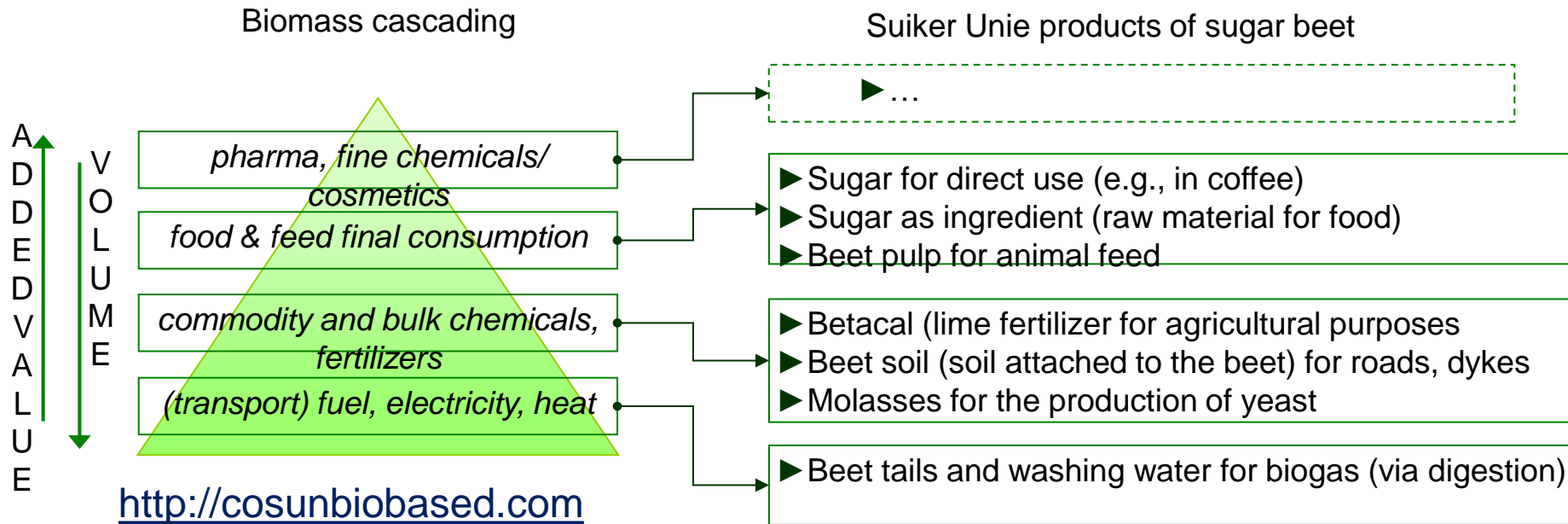
Sugar Beet for Biobased Economy



Source: CIBE and CEFS (after British Sugar)



Biomass Cascading and Valorisation



- Total concept, including a 50% increase in sugar beet yield per hectare, a 50% reduction in fertilizer use, and a 50% efficiency improvement in the sugar plant (all in about 20 years).
- Further optimization includes export of waste heat, and site utilization for renewable energy production (solar and wind).

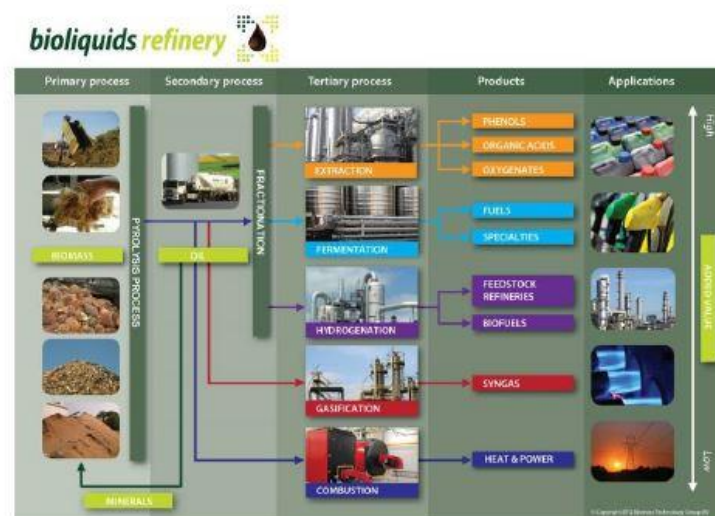
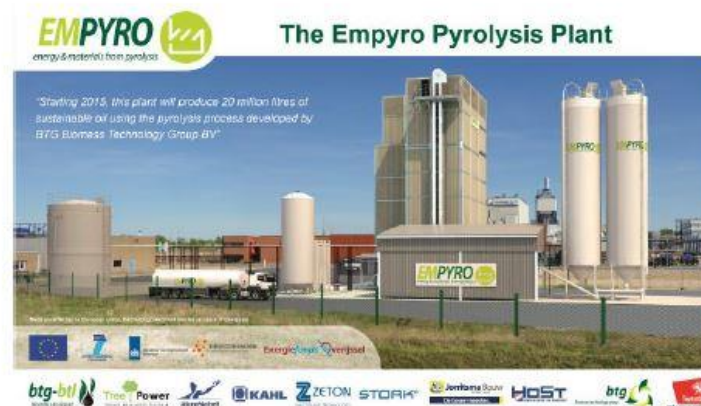


Lessons from Cosun, beet biorefinery

- Challenge -> Opportunity seen by cooperation of farmers
- Built on existing infrastructure
 - Sugar beet supply chain
- Start with simple demonstrations (Biogas) and move up in the chain



- Construction of pyrolysis plant started in February 2014
- Modules
- Feedstock e.g. wood chips
- Production of 20 million litres of pyrolysis oil per year
- Pyrolysis oil used for bioenergy (ST) and chemicals (LT)





Lessons Empyro (www.btg-btl.com)

- Persistence: result of 25 years research and pilots
- Phasing of applications
 - 1: burning -> 2: transport fuels -> 3: chemicals
- Take some years to Operationalise the Demonstration
 - Opening: May 2015, now at 50% capacity
- Find a take off client:
 - 20 mln. liter/jaar, used by Friesland Campina Borculo for steam





Biorefinery of grasses

- Grass Refinery:
 - > Green fibres and juice for digester
- Product: Green Egg box
 - www.huthamaki.com
- Result: 60% less water,
10 % less CO2
- Future: Juice for proteins
- Lesson:
 - Use Market opportunity
 - Work in the chain



- Chemical catalysis biorefinery
- Pilot plant in Geleen
- Feedstocks: cellulose, hemi-cellulose, starch, sucrose
- Outputs: furan based biofuels, monomers for polymers, fine and specialty chemicals, solid fuels



Plant based
Feedstock

PEF
making 100%
plant based
bottles possible



**Lower Footprint
Better Quality**



Lessons:

- Integrate Technology development with Market offtaker : (Avantium/CocaCola/Basf)
- Demonstration samples allow for market testing, touch, airtightness
- Market awareness about improved bottles
- Developing the Circular Chain (new recycling options)





Green chemicals from solar (www.photanol.com)

- CO₂+light -> chemicals
 - Blue algae -> lactic acid
- Spinn-off Univ. AMS
- Collaboration AKZO
- Labscale -> pilot -> demo in greenhouse

Lessons:

- Partnering for market entry
- Use existing infrastructure





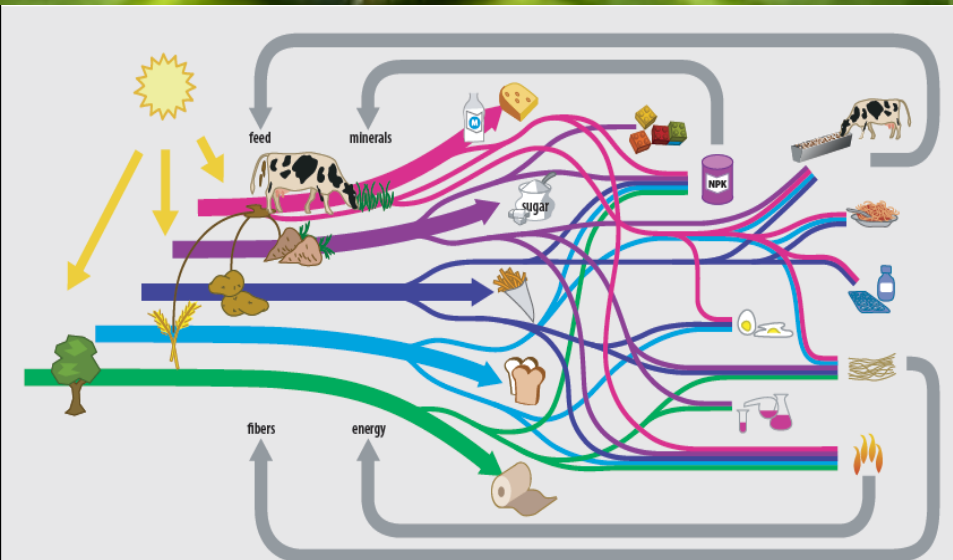
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Results

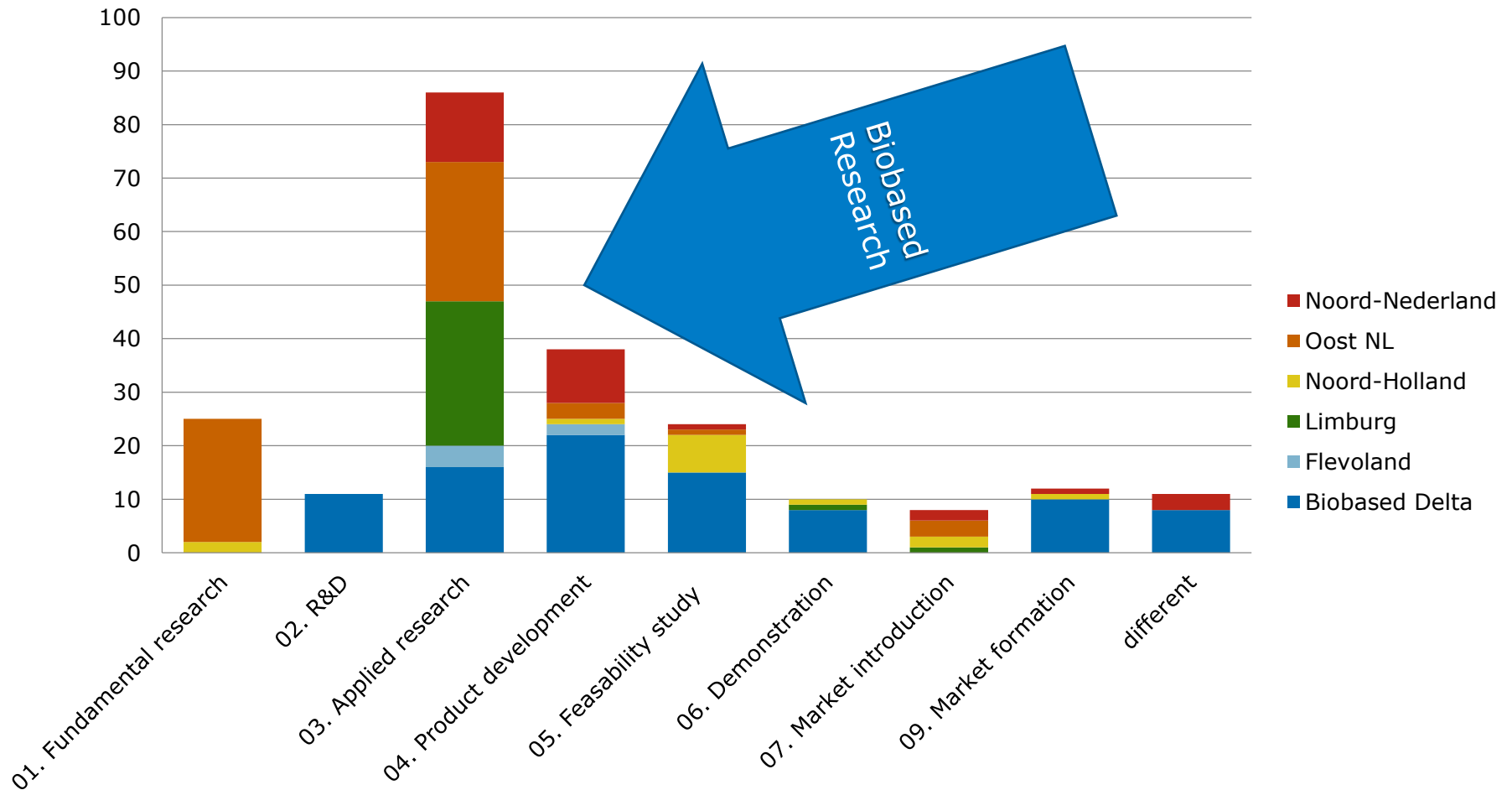
Recommendations

and Conclusion















































Projects from regions on the S-curve



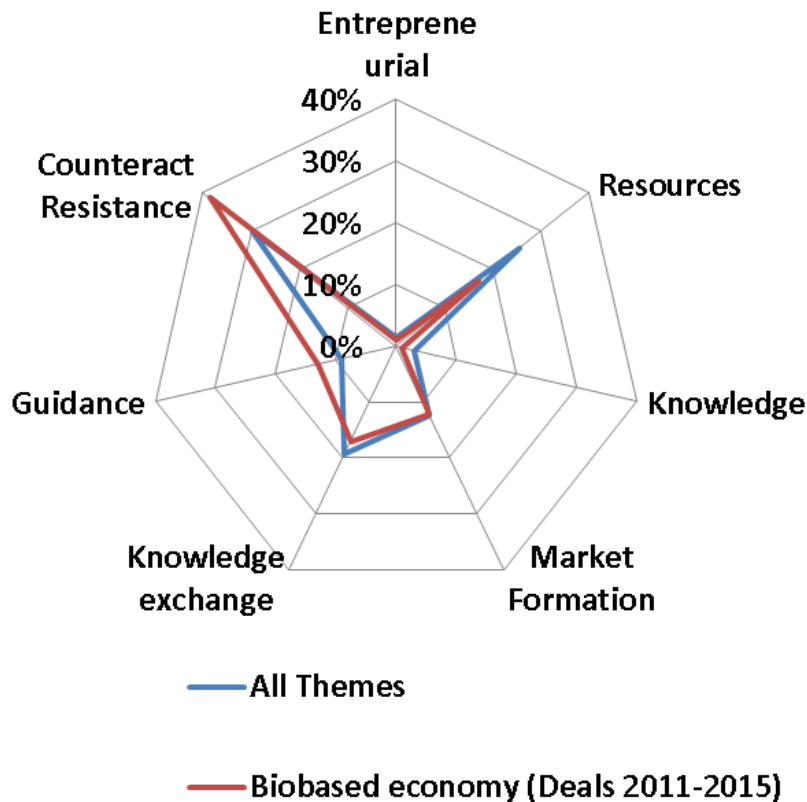


Demo: Score on Innovation functions

Functions	Bio Process Facility	Sugar Beet	Em Pyro	New Foss / Grassa	Avan tium	Photanol
Entrepreneurial						
Knowledge Development						
Knowledge Exchange						
Guidance						
Market formation						
Resource Mobilisation						
Counteract Resistance						



Role of Government in innovation system



- Gvt. Netherlands:
 - Green Deals:
 - > to take away hurdles for companies
 - Strong:
 - > Counteract Resistance
 - (legislation)
 - > Resources



Markets Slow: Biobased Procurement

- **Sustainable Procurement**
- Biobased <-> Biodegradable
- Biobased <-> Sustainable
- Complete Chain Evaluation





Conclusion

- Biorefineries can create value out of biomass for both materials and energy
- Level playing field between energy and biomass is required
- Demonstrations in Biorefineries create experience in market introduction with all market actors
- Collaboration between all actors in the innovation system crucial for succes



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***Thank you for
your attention***

Questions?

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