SOLVAY

asking more from chemistry®

Asking more from chemistry

"*More than a pledge, our signature is a vision and a challenge to which we are fully committed*"
Jean-Pierre Clamadieu, CEO

An industrial look about some achievements and challenges of Renewable Based Chemistry

UNAFIC, Paris , November 24, 2015

F Monnet
Renewable chemistry platform
Solvay R&I

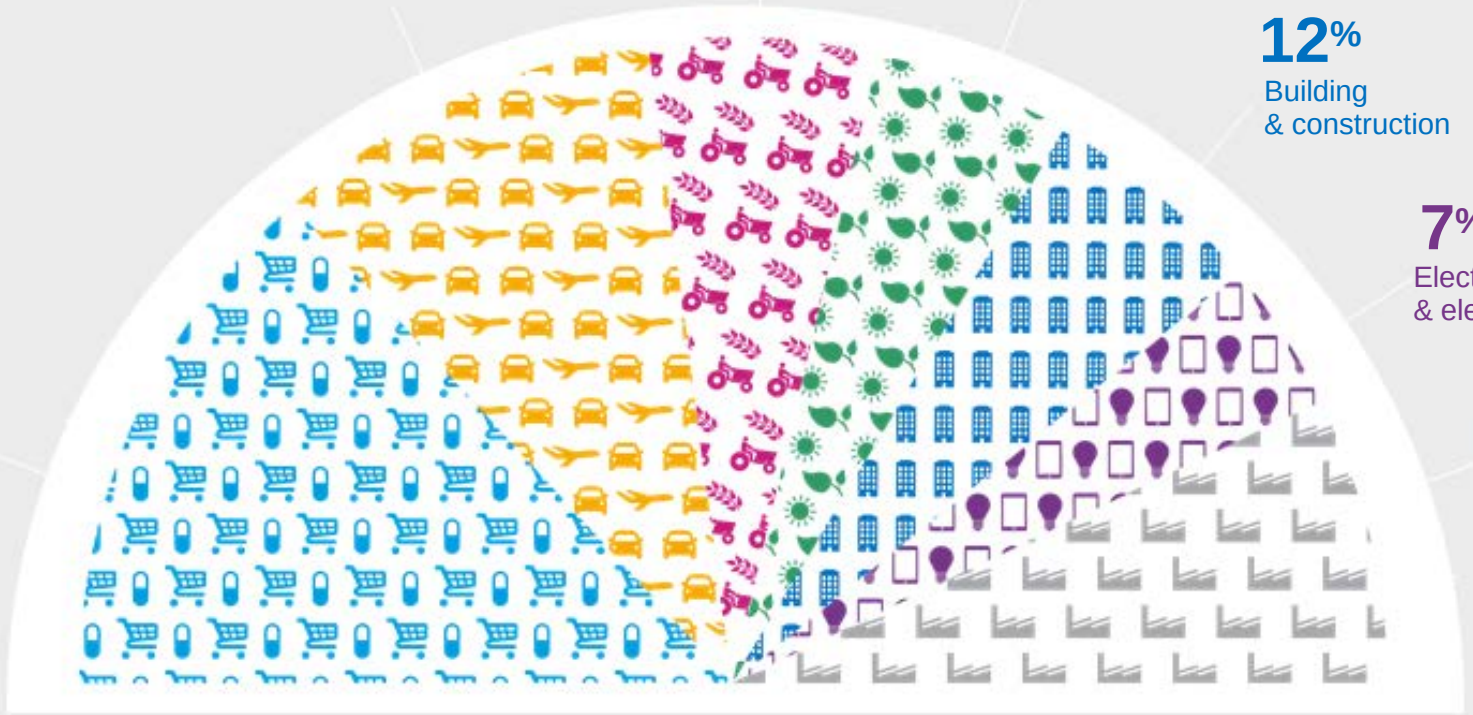
Building a model of sustainable chemistry

Building a strong leader, a player in the reshaping of the global chemical industry. **Asserting ourselves as a model** of sustainable chemistry, capable of attracting and developing talented people who conceive, design and produce solutions to meet the major challenges facing society today.

2014 figures

Solvay by market

A diversified **offering**



18% Automotive & aeronautics

11% Agro, feed & food

10% Energy & environment

12% Building & construction

7% Electrical & electronics

16% Industrial applications

26% Consumer goods & healthcare

Distribution of 2014 net sales

6 R&I areas to meet the challenges of the future

Advanced materials

Expertise in polymers and formulations

Eco-designed processes

New processes offering diminished raw materials and energy consumption, and reduced emissions

Renewable chemistry

Innovation in renewable or recycled raw materials

Advanced formulations

Creating responsible products that provide solutions to global issues

Organic electronics

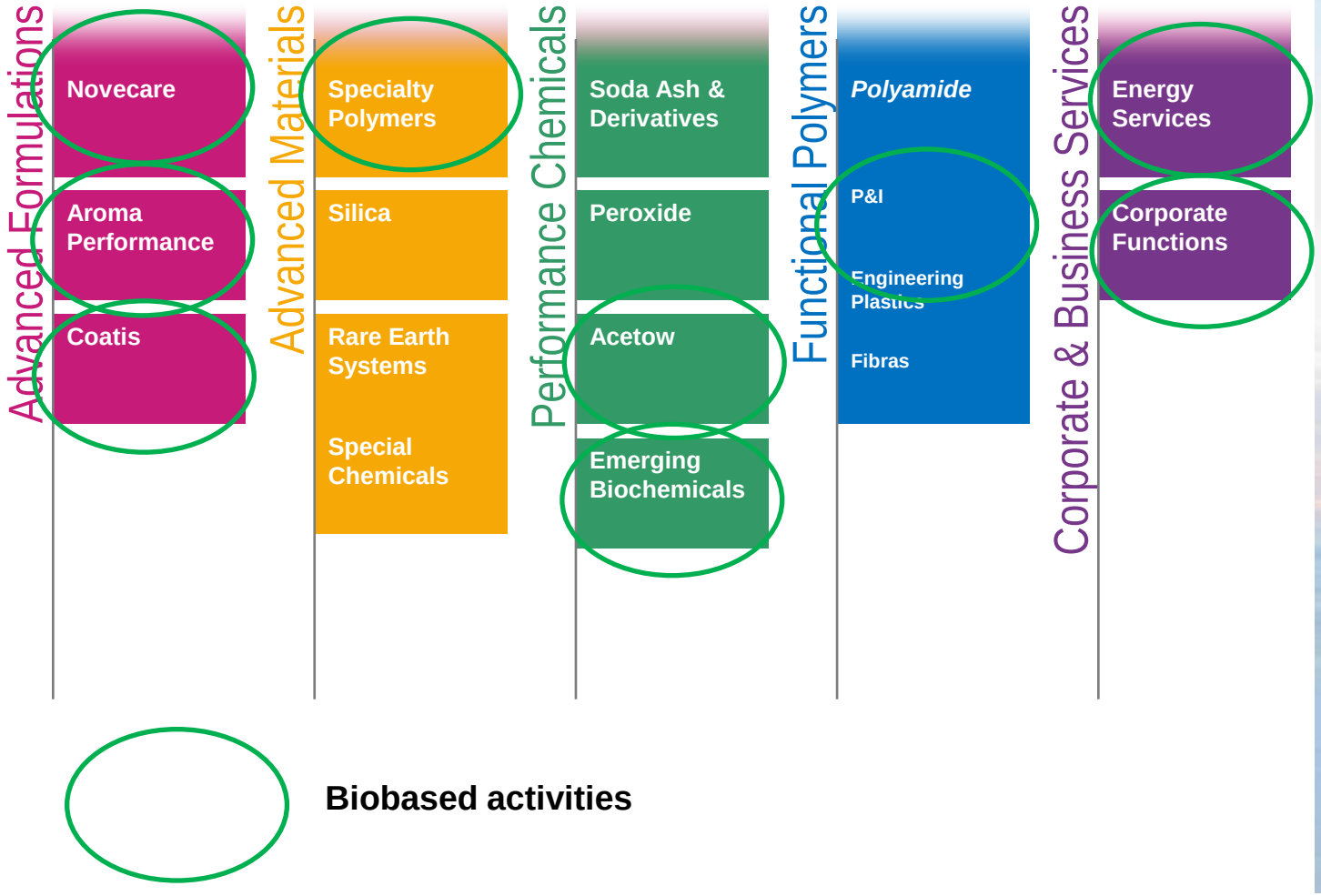
Materials to improve the sustainability of lighting devices and screens

Sustainable energy

Developing alternatives to fossil fuel consumption: new generation batteries, photovoltaics, bio-energy

Our business activities

Customer focused agile organization



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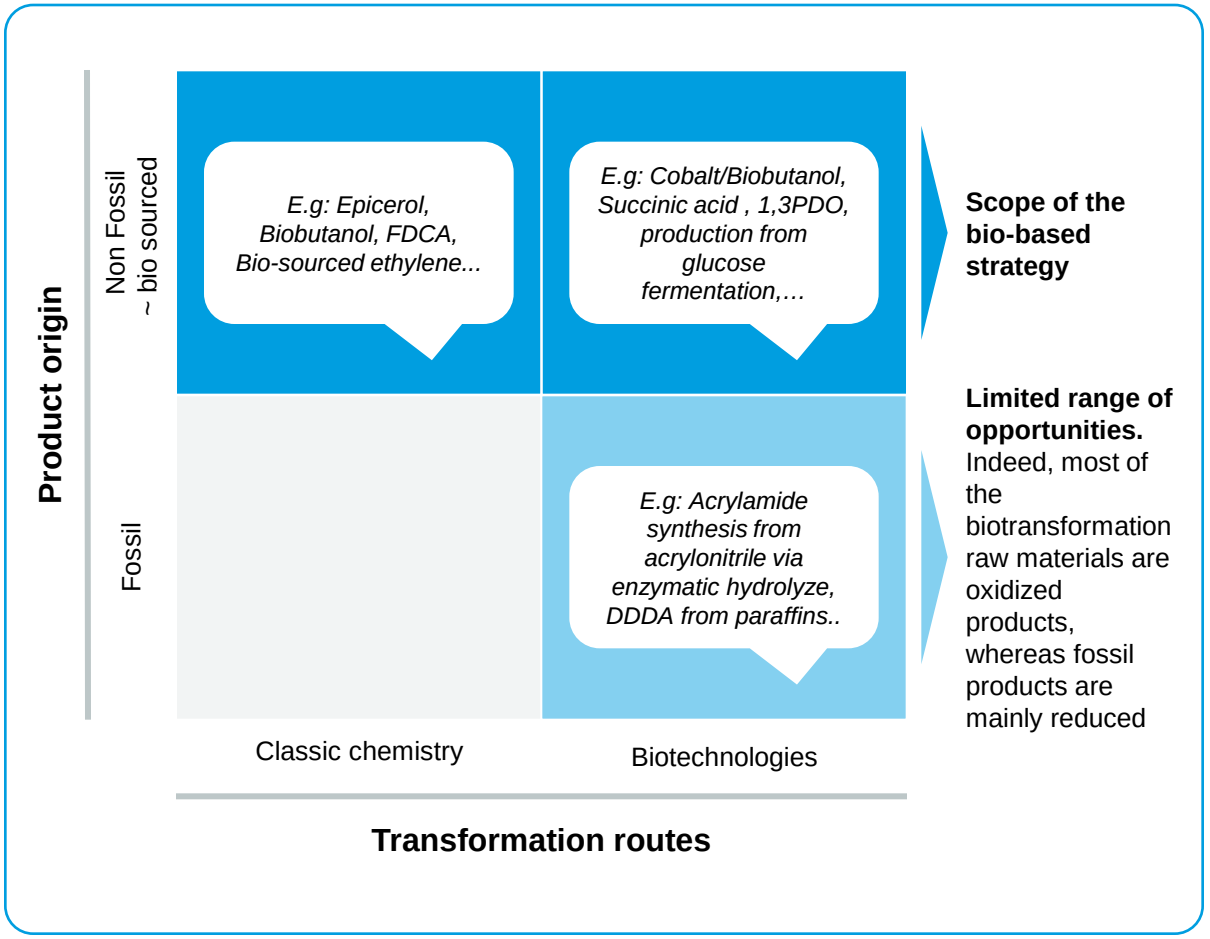
The bio-based chemistry is a new production paradigm driven by the latest developments in both classical chemistry and biotechnologies

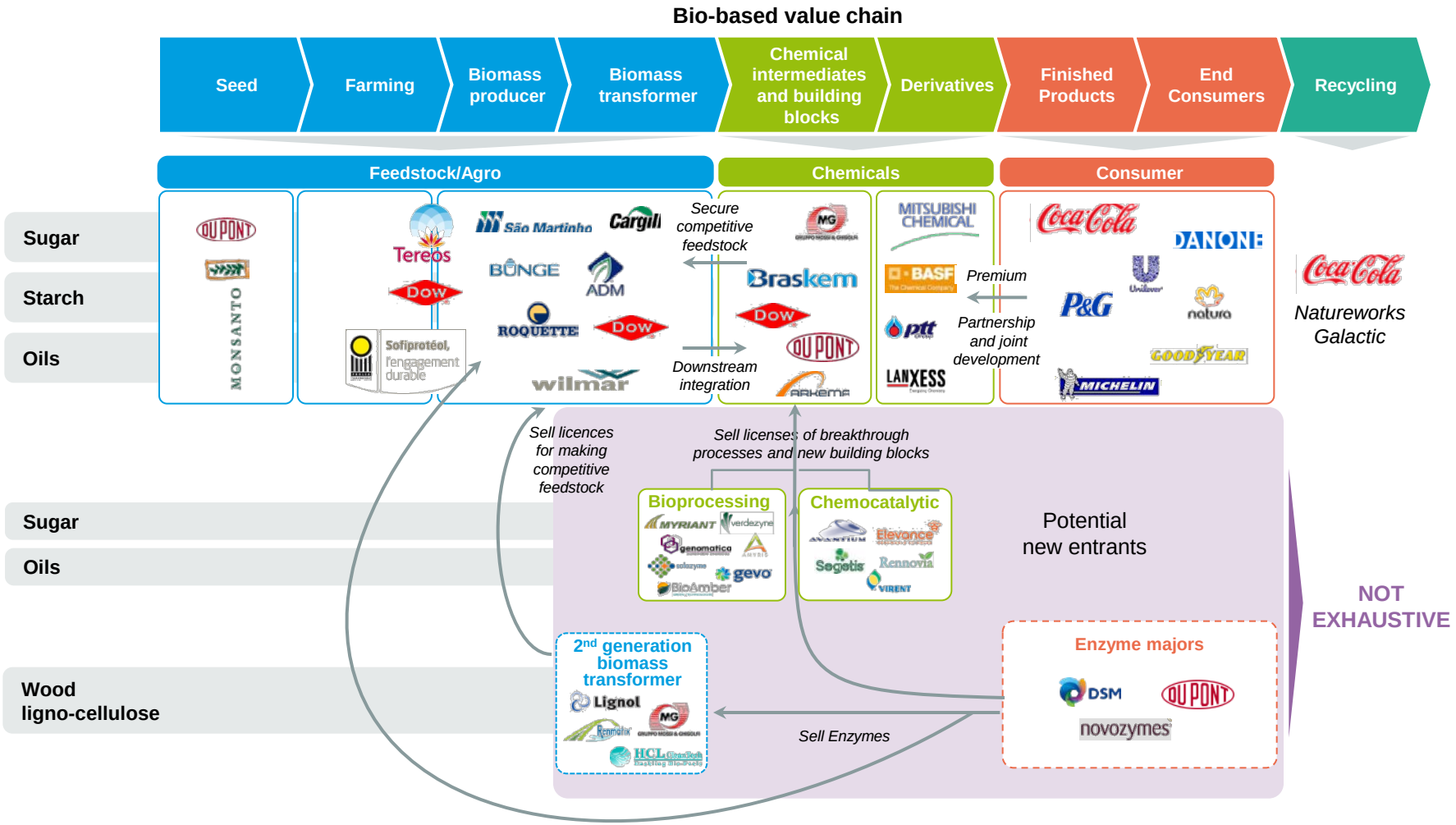


Our definitions

- **A bio-based chemical or polymer is defined as a material that contains carbon derived from renewable feedstocks**
  - Not to be confused with bio-degradable or bio-processed/biotechnology
  - It can be bio-sourced identical replacement (“drop in”), new types (polymers such as PLA, PHA) or functional replacement (esters for plasticizers or hydrocarbon solvents, isobutanol for gasoline, FDCA for TPA)
  - No global standard defining the bio-sourced products, but multiple certifications and labels with important variations (bio-sourced content limited to carbon or extended to other atoms, level of minimum bio-sourced content…)

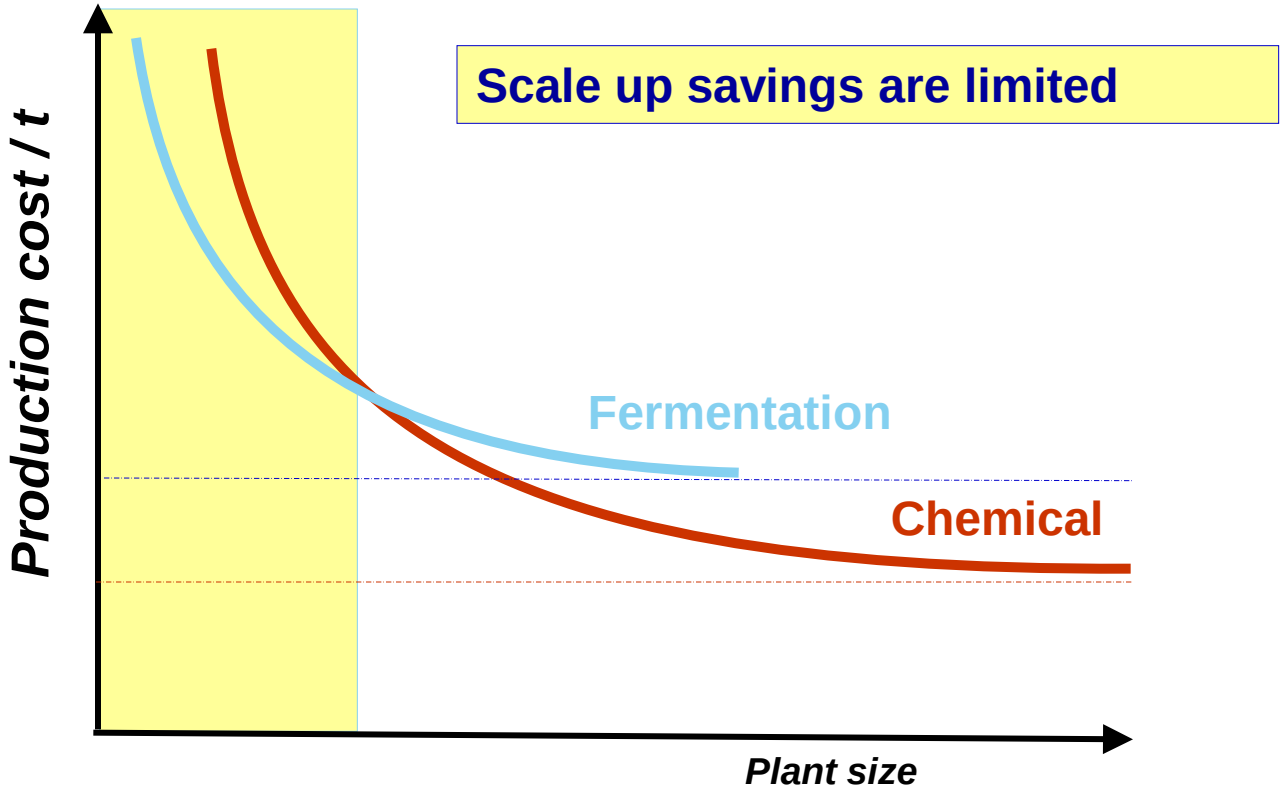
NB: the « bio » terms used in every day life corresponds to a defined specifications , without any systematic link with bio sourced or bio transformed

Many changes appearing in the value chain (2)

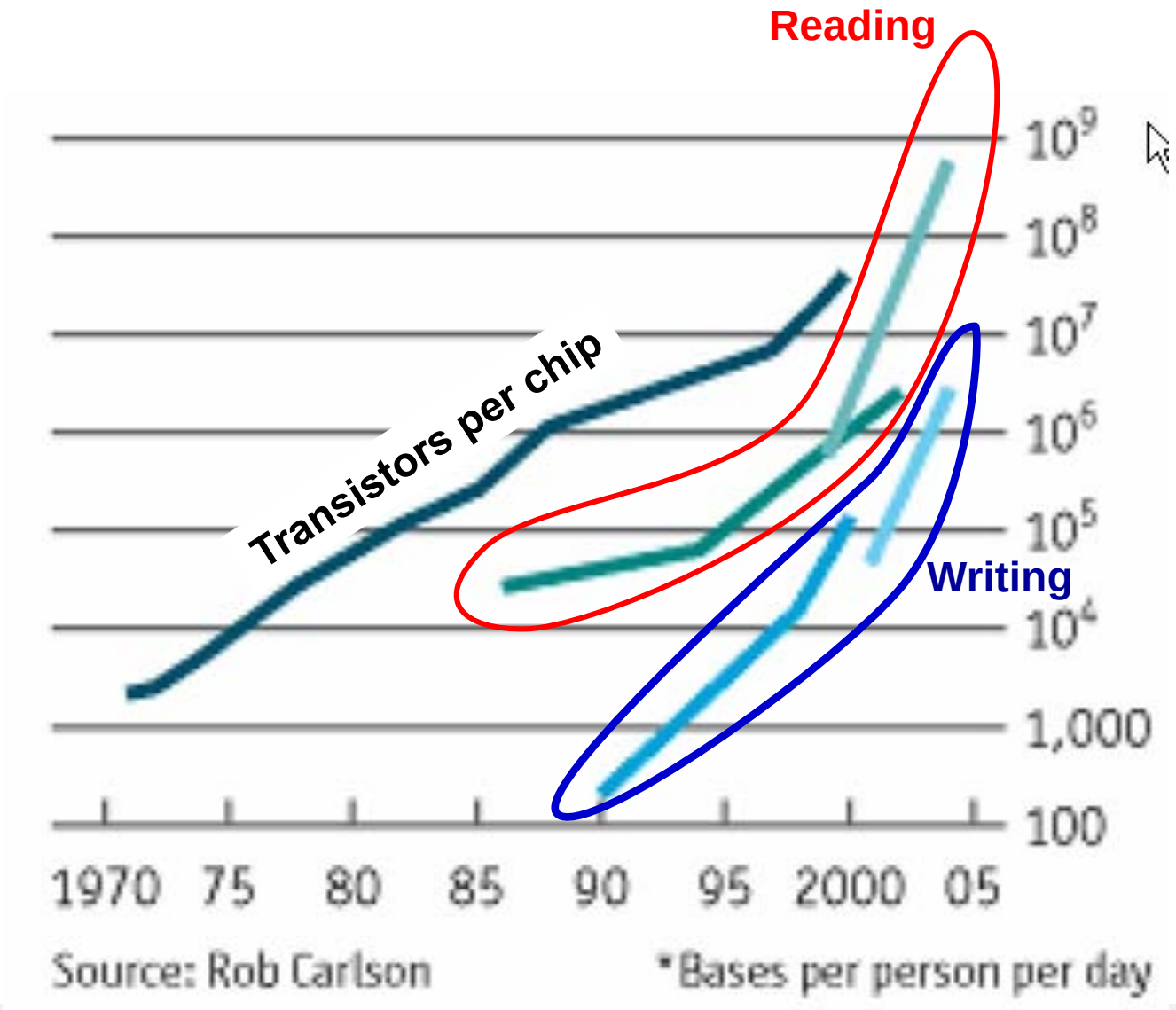


SOLVAY asking more from chemistry®

Bio-conversions have an intrinsic disadvantage for large scale bulk production



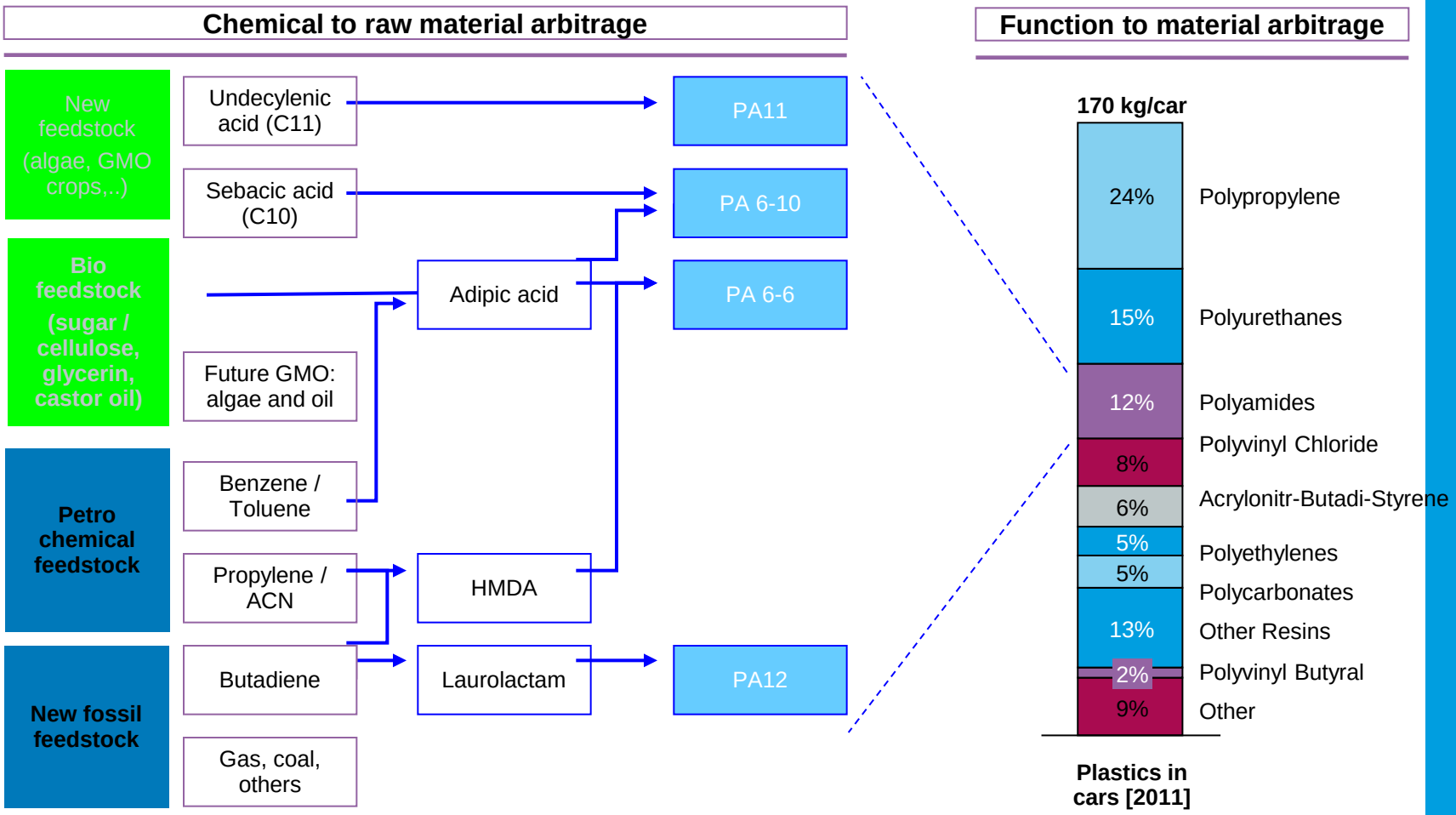
Technology – synthetic biology



An ever faster pace of innovation

An increasing number of alternative for the same market needs

Illustration: Polyamide production routes



.. leading to an ever increasing complexity !

Addressing renewable chemistry means answering to questions like:

- The competitiveness of biobased raw materials versus present and new C-sources
- The ability to define new competitive chemical schemes more specific to biobased molecules
- The breakthrough economic potential of biorefineries, which would integrate several businesses
- The suitability of biobased raw materials for designing final products with differentiated properties and market traction
- The potential of biotechnologies to revolutionise or not the commodity/specialty chemical production, from raw materials to end products

The 3 levers of Renewable Based Chemistry

New functions and properties

- Polyamides using sebacic acid: **Stabamid® 6.10, Kalix® HPPA**
- **JAGUAR®**, a guar based rheological agent for cosmetic
- **Rhodoclean**, surfactant based on pine derivatives

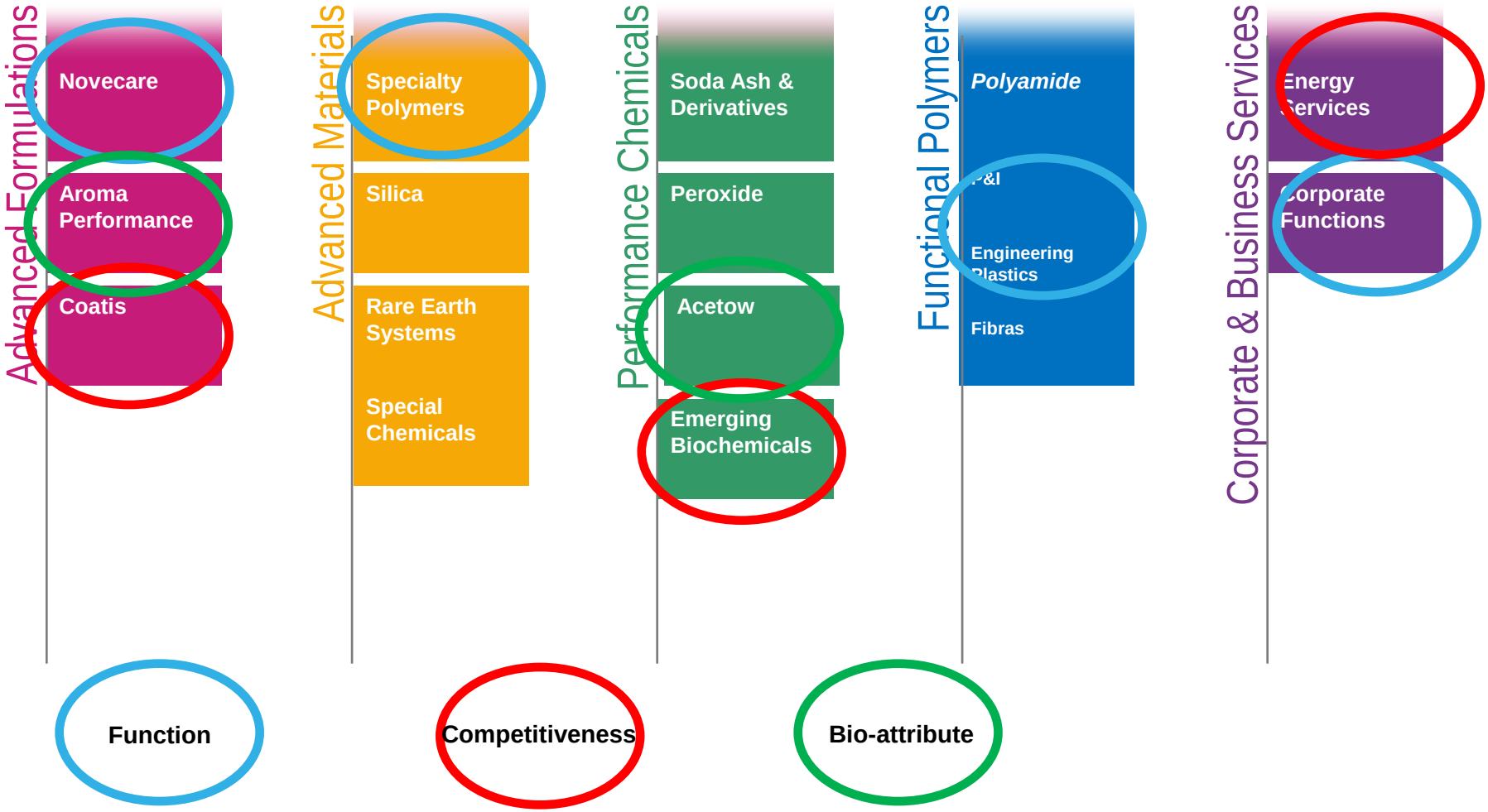
Improve competitiveness

- Use of glycerol instead of propylen: **Epicerol®**
- Development of **N-butanol** production on bagasse in Brazil

Valorisation of **Bio-Attribute(s)**

- Natural vanillin: **Rhovanil Natural®**
- **Augeo®** solvent, based on glycerol for paints

Our business activities…



… rely on diversified biosourced materials…


eucalyptus


spruce


pine


coconut


palm

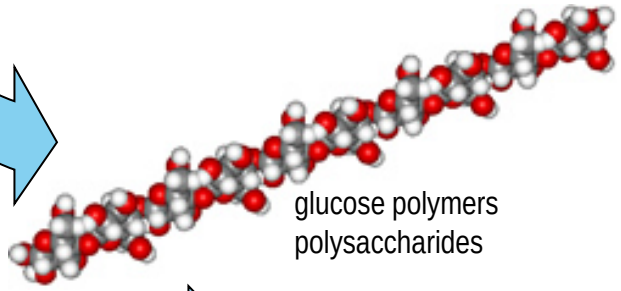

soybean

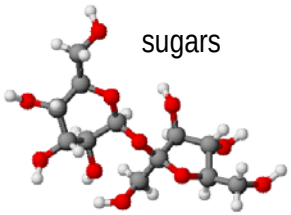

rapeseed

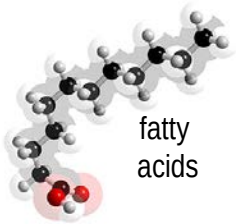

peanut


castor bean

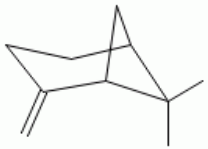
Plants: a source of natural molecules and polymers


glucose polymers
polysaccharides


sugars


fatty
acids


alcohols
glycerin


b-pinene

sugarcane

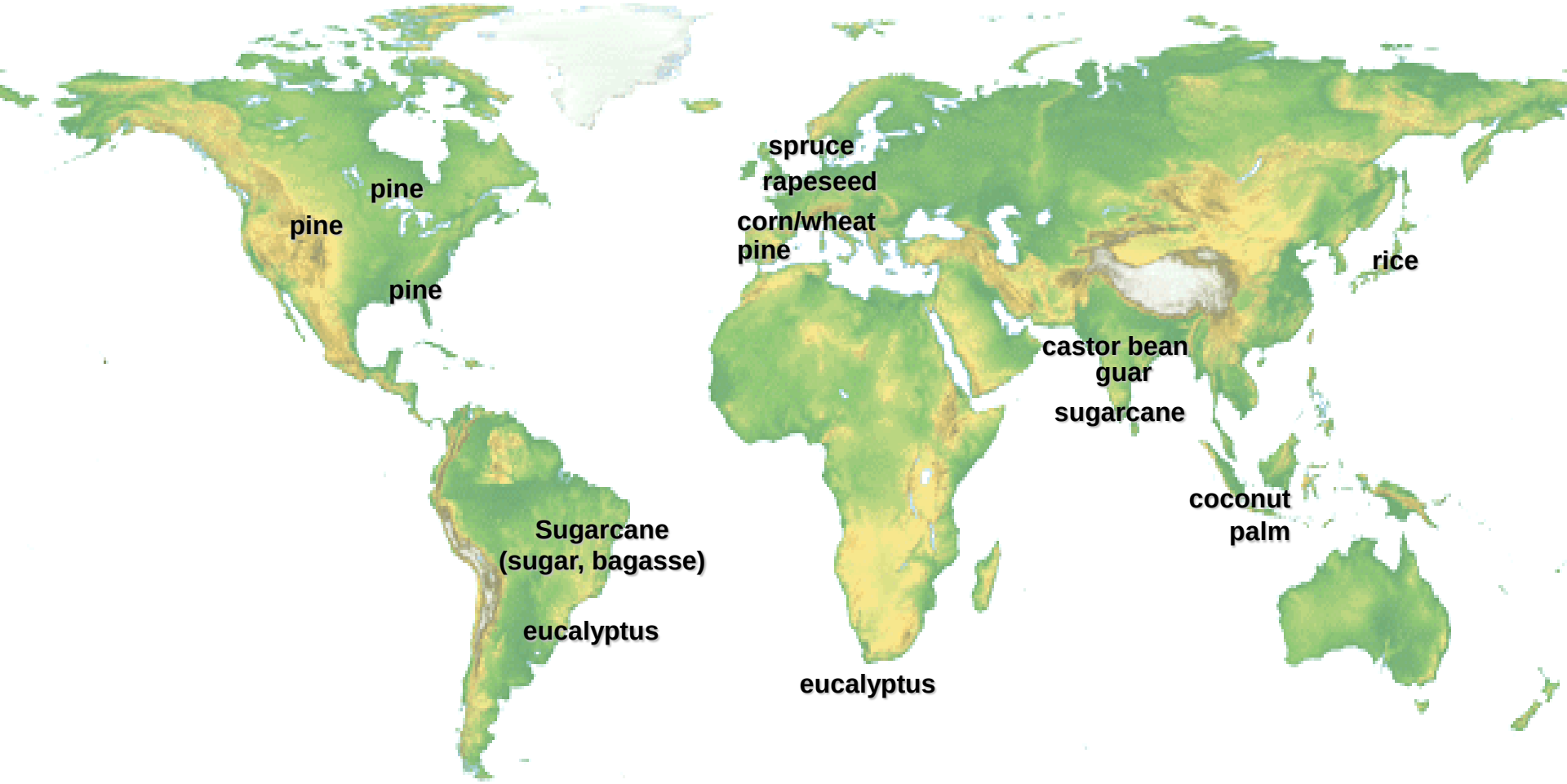
corn

wheat

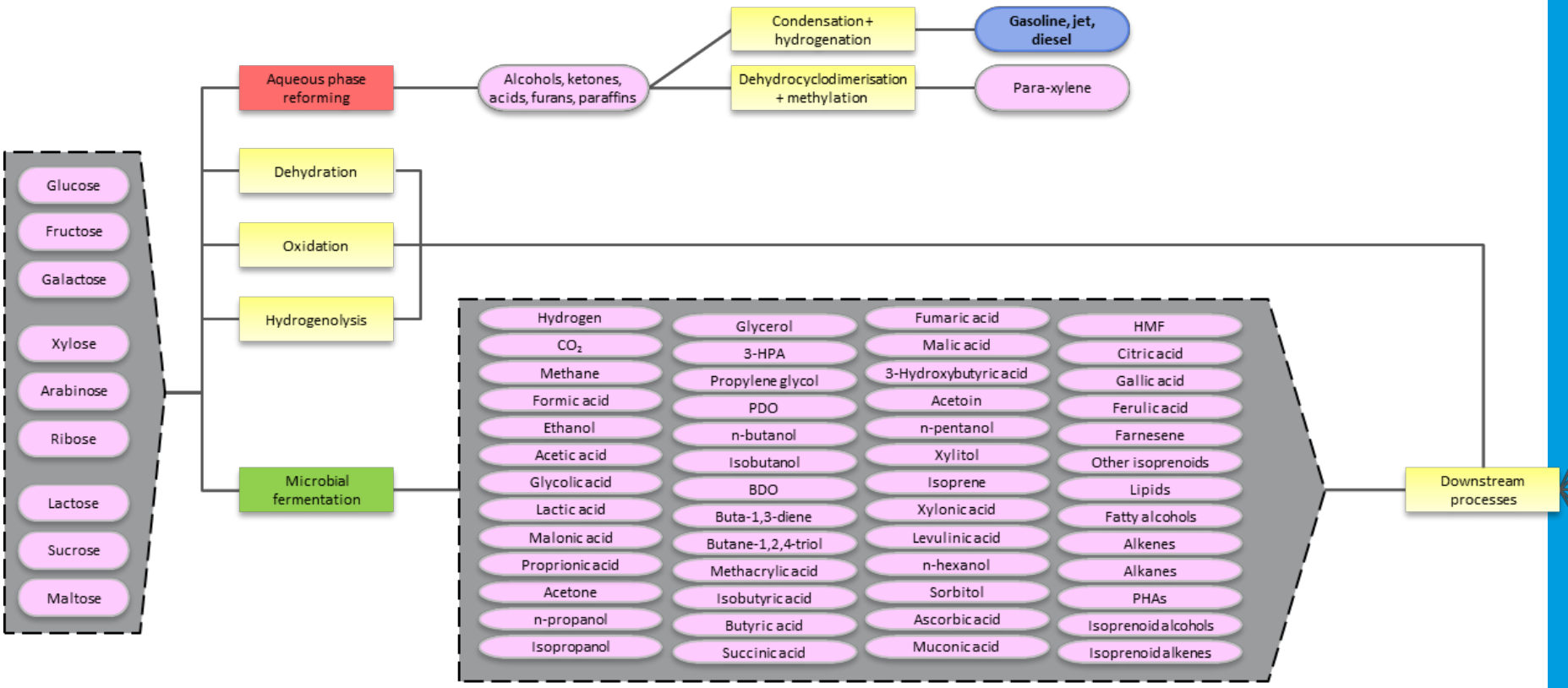
rice

guar

… from different geographical origins

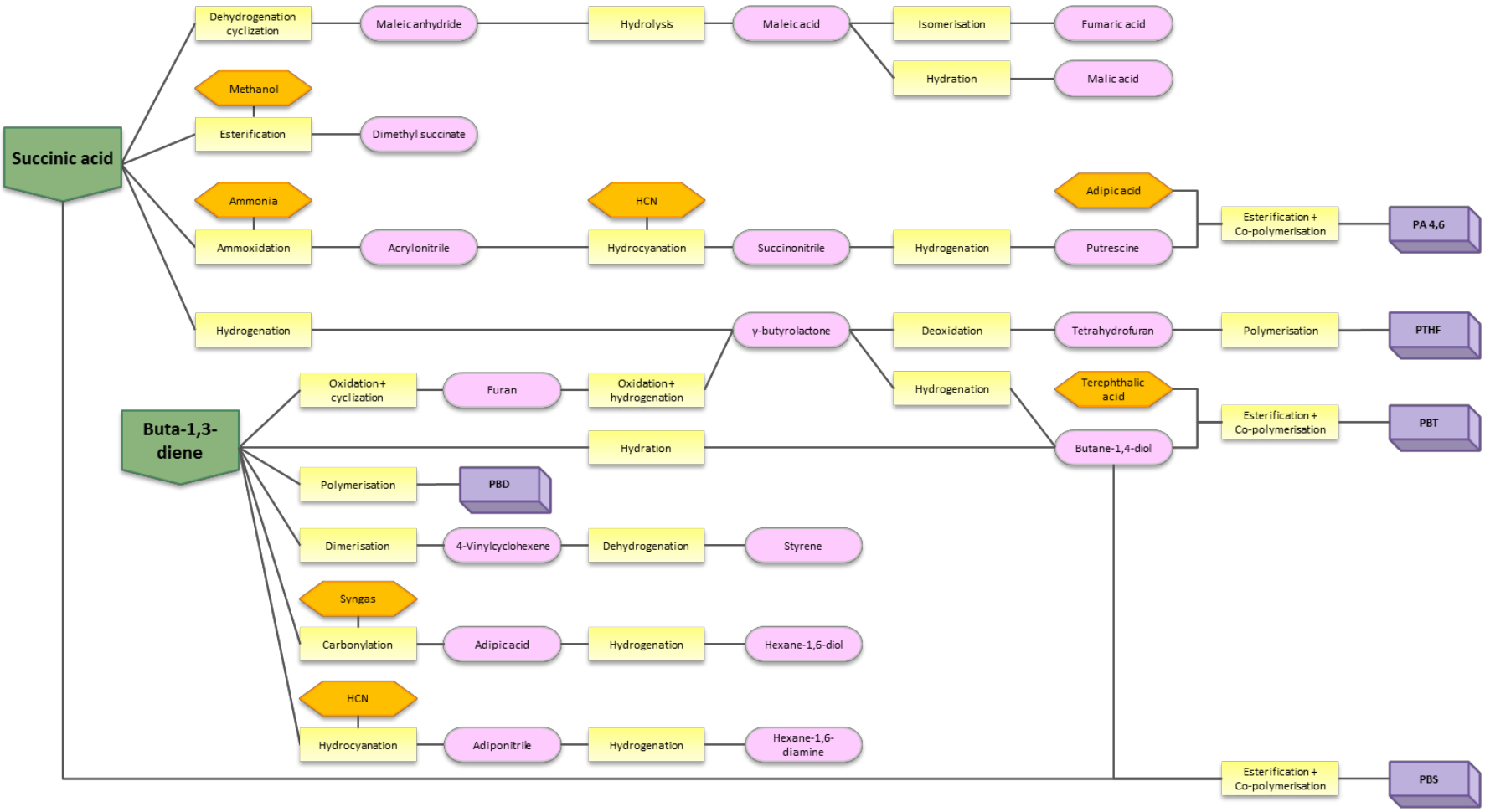


A promise of industrial biotechnologies



From the Sugar Platform to biofuels and biochemicals
Final report for the European Commission Directorate-General Energy
N° ENER/C2/423-2012/SI2.673791 **April 2015 V2.1**
https://ec.europa.eu/energy/sites/ener/files/documents/EC%20Sugar%20Platform%20final%20report.pdf

The ability to rebuild brand new production trees….



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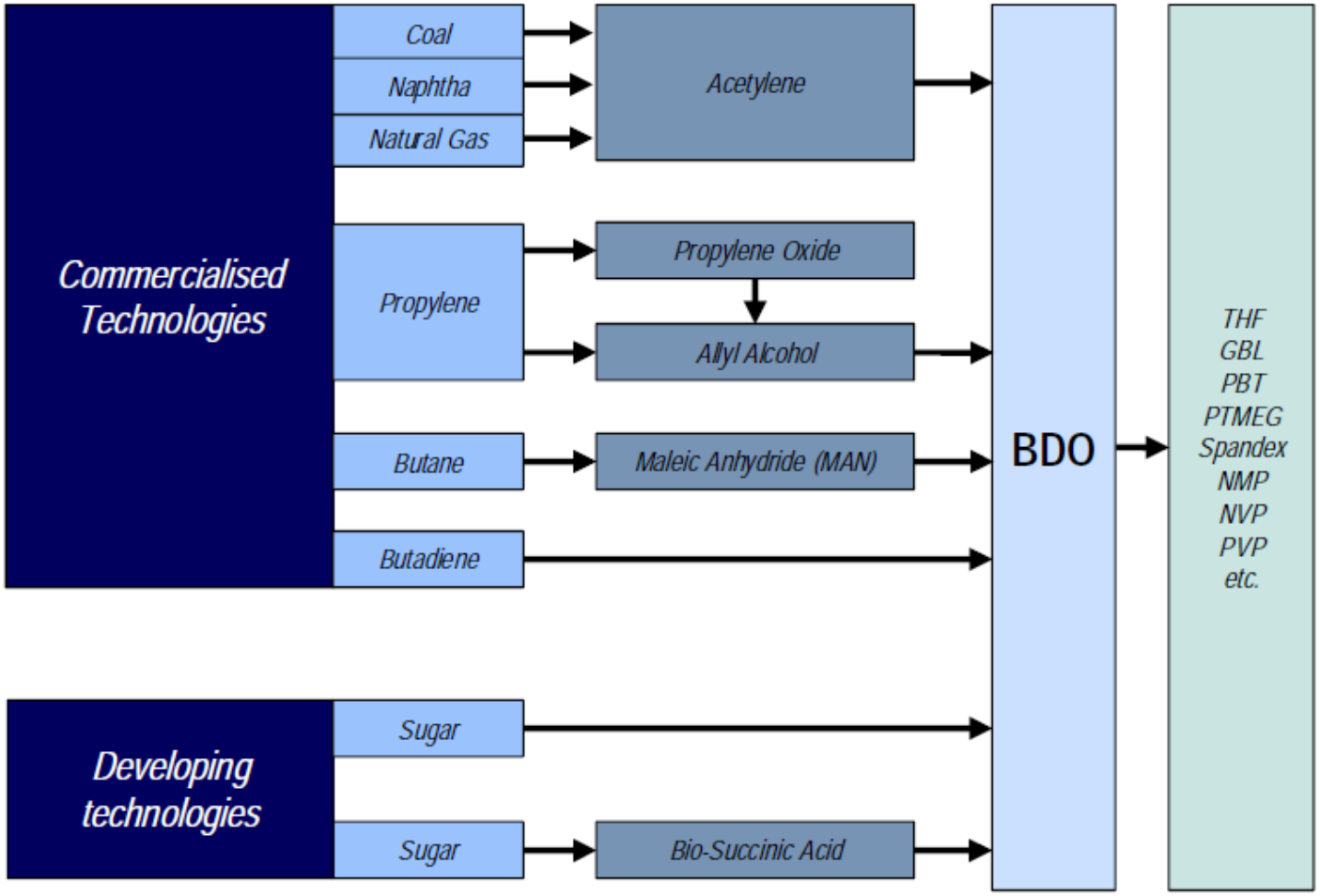
… is nevertheless facing existing competitors



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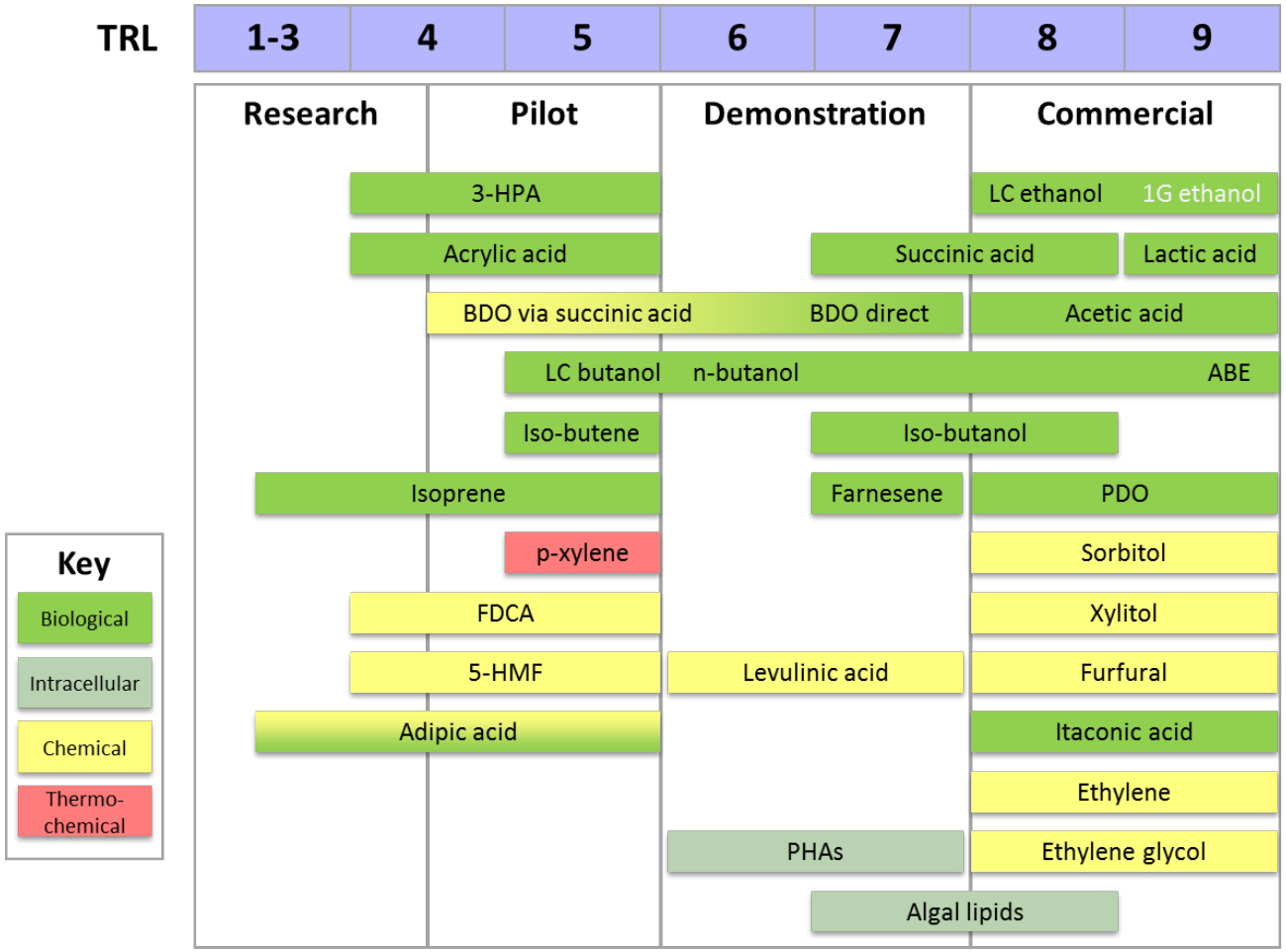
The status of biotechnology-based building block production



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The central problem with the present times,

is that the future

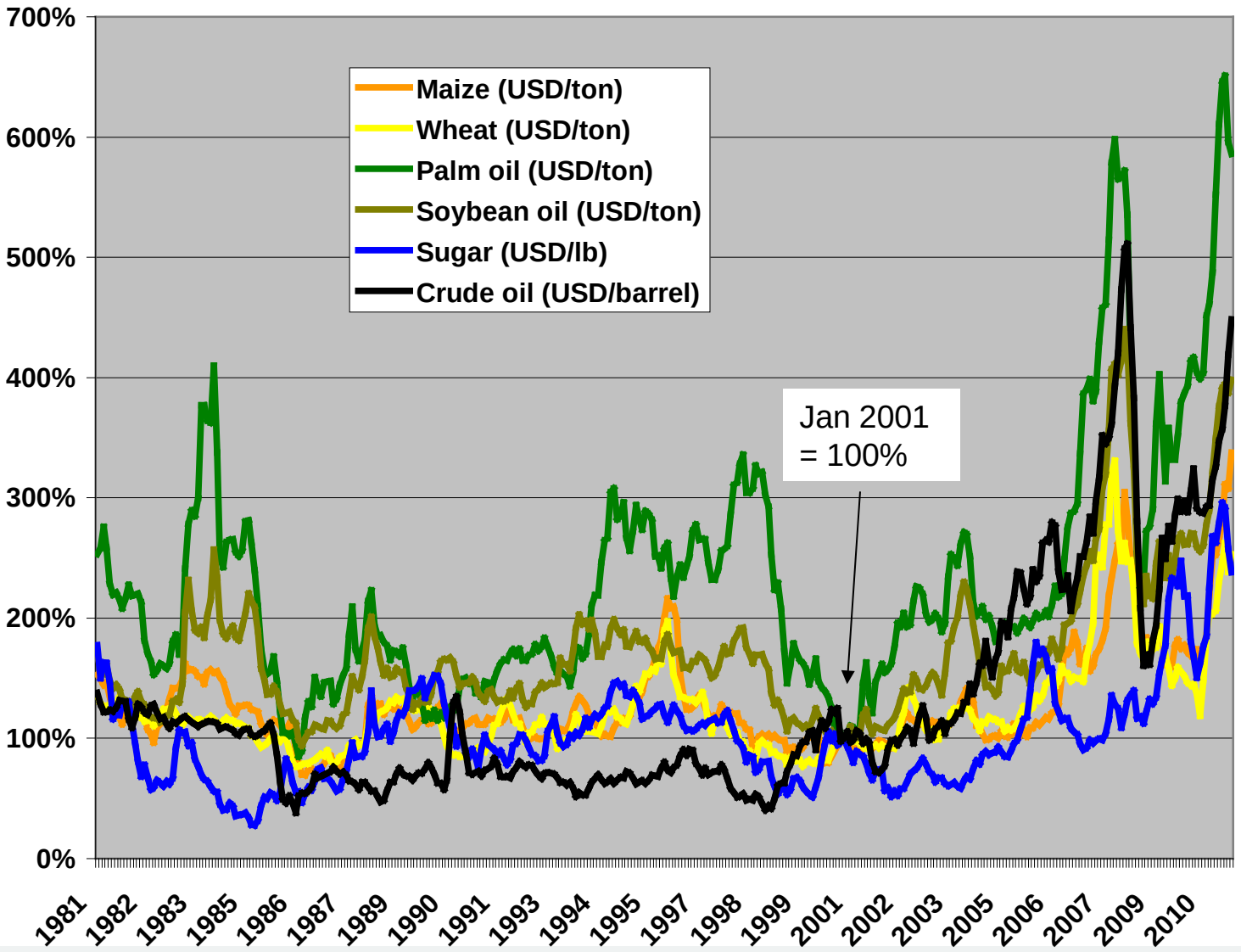
isn’t what it used to be….

Paul Valéry

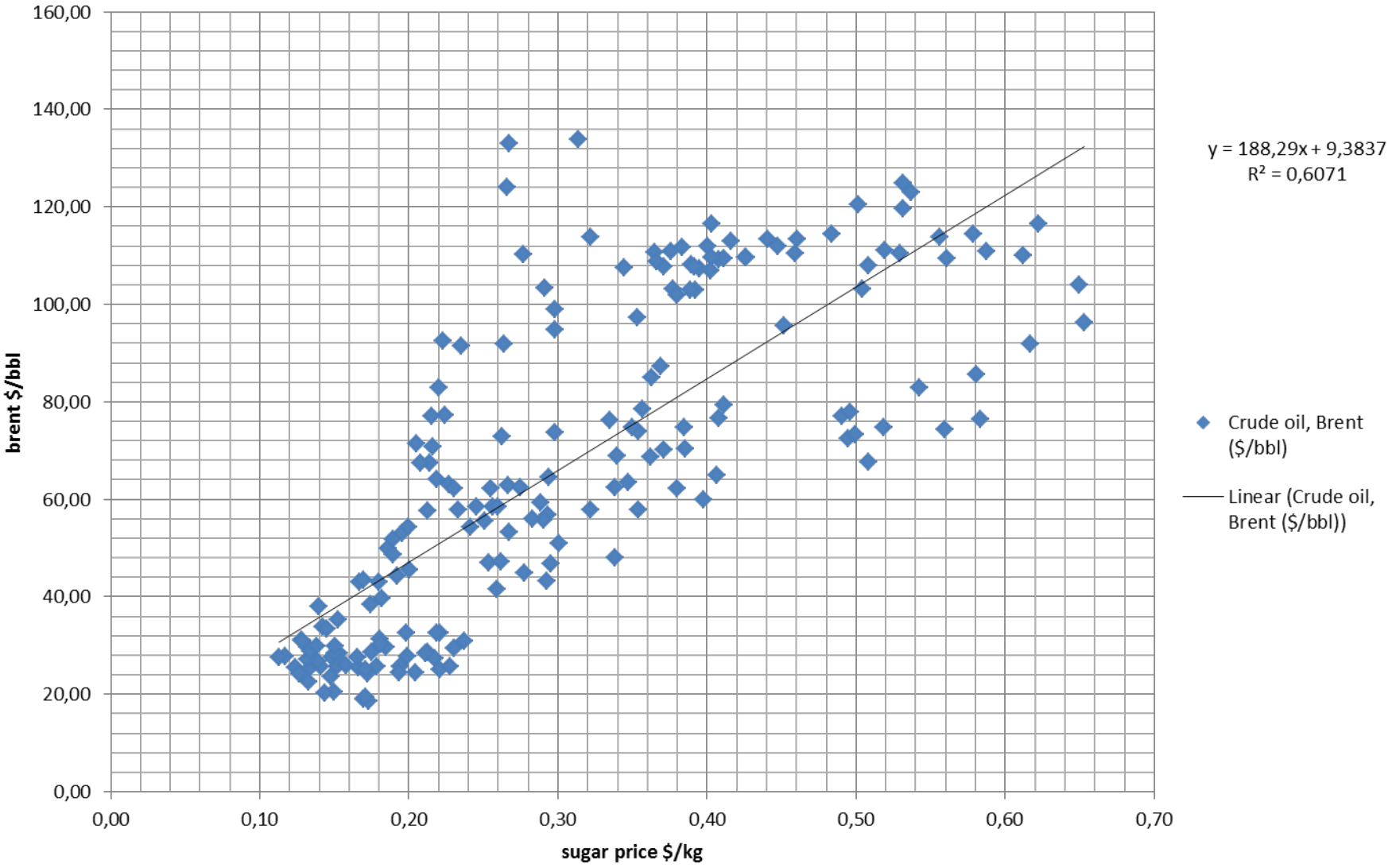
Technological

Cellulosic transport solved?

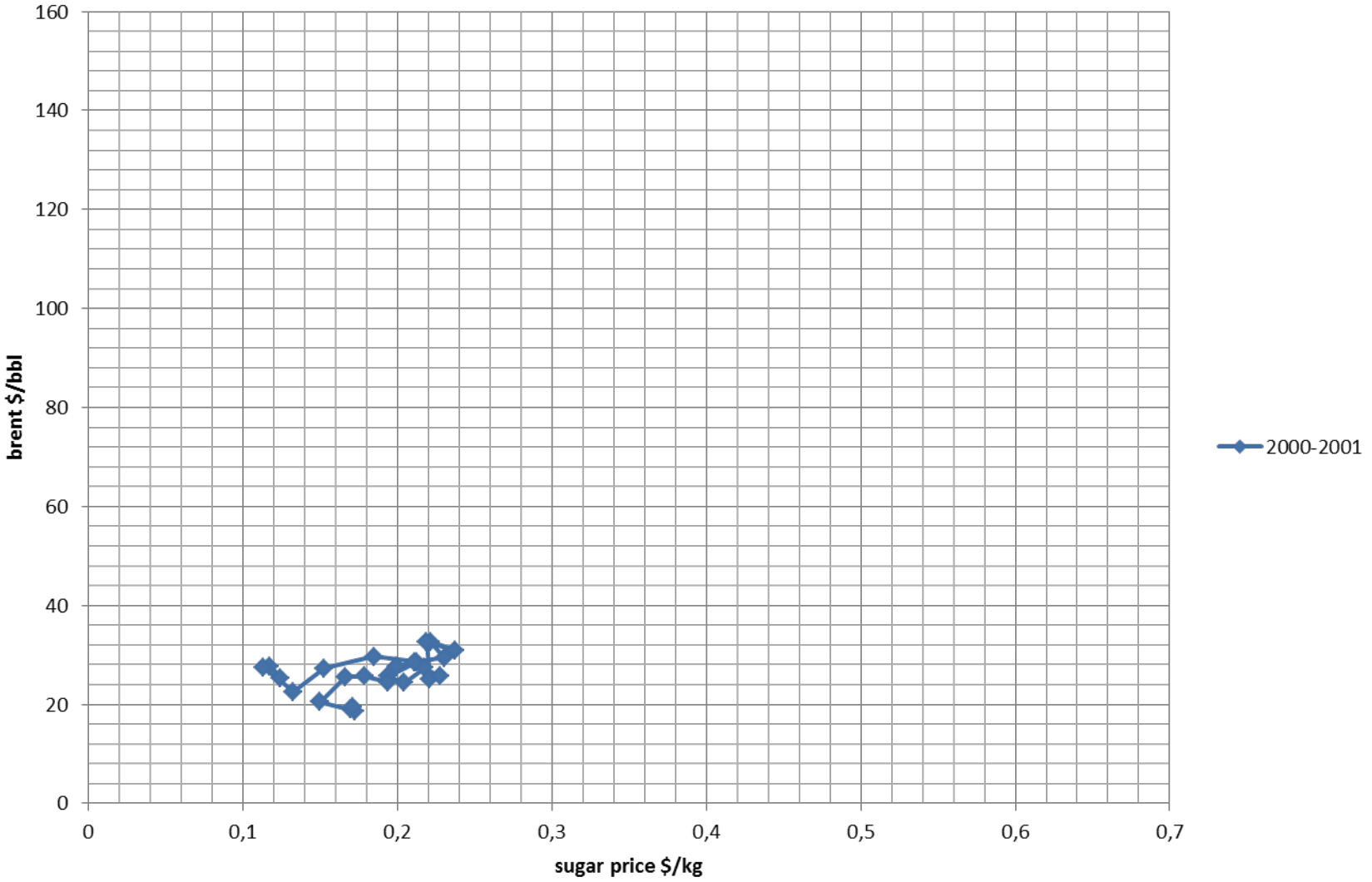
Feedstocks costs:volatility for all ?



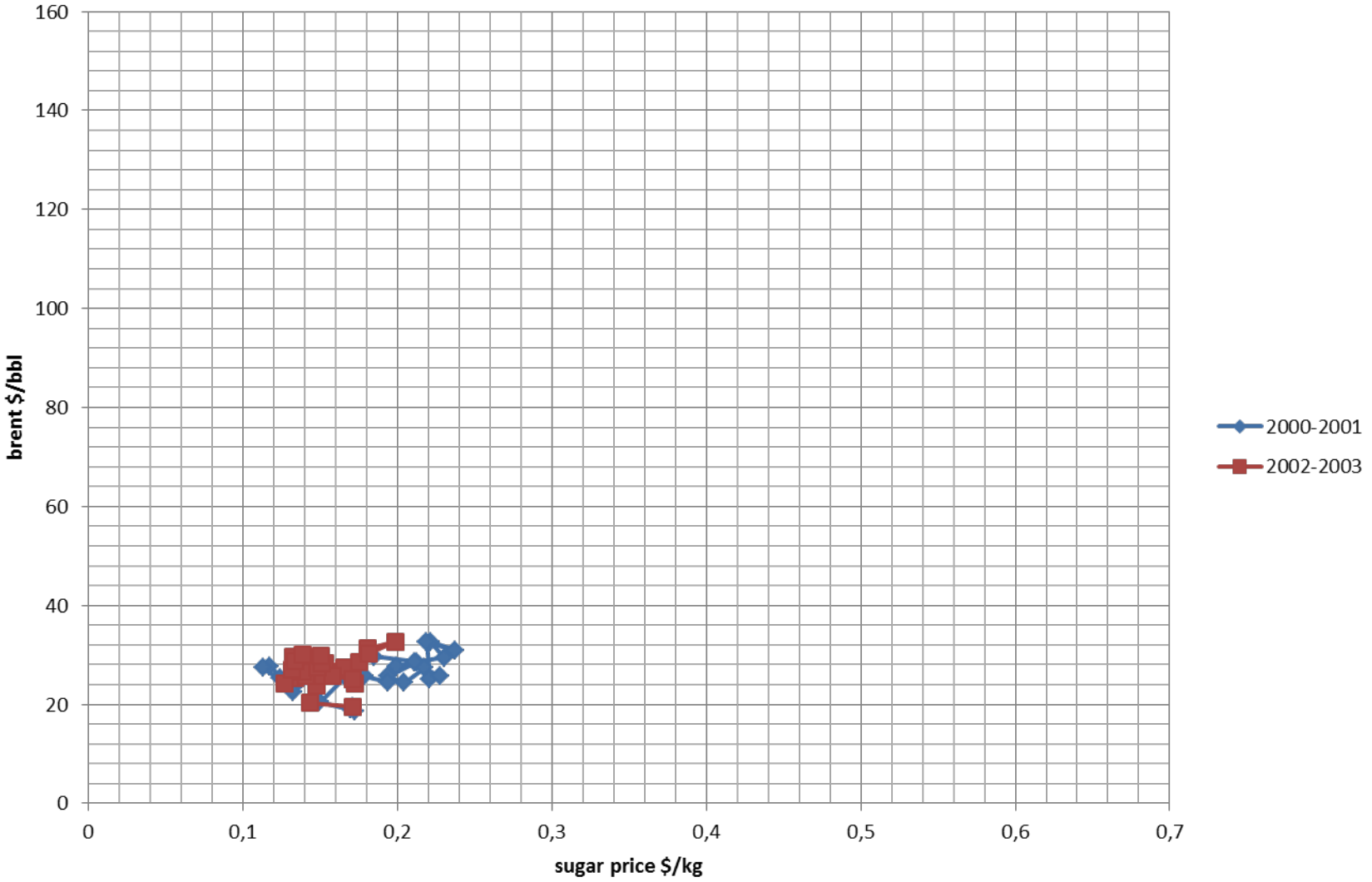
Feedstock: correlation ?



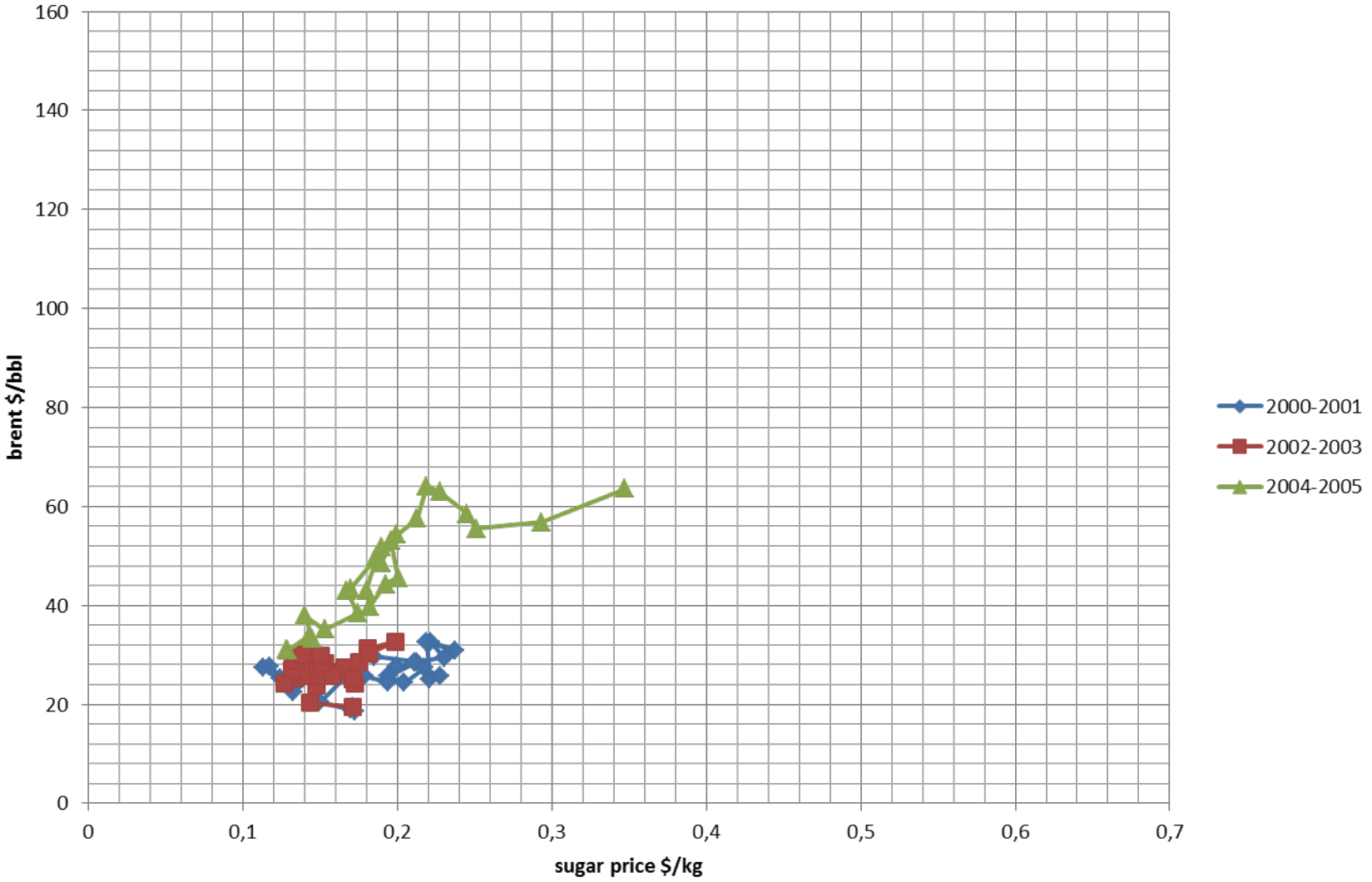
Feedstock: dispersion ?



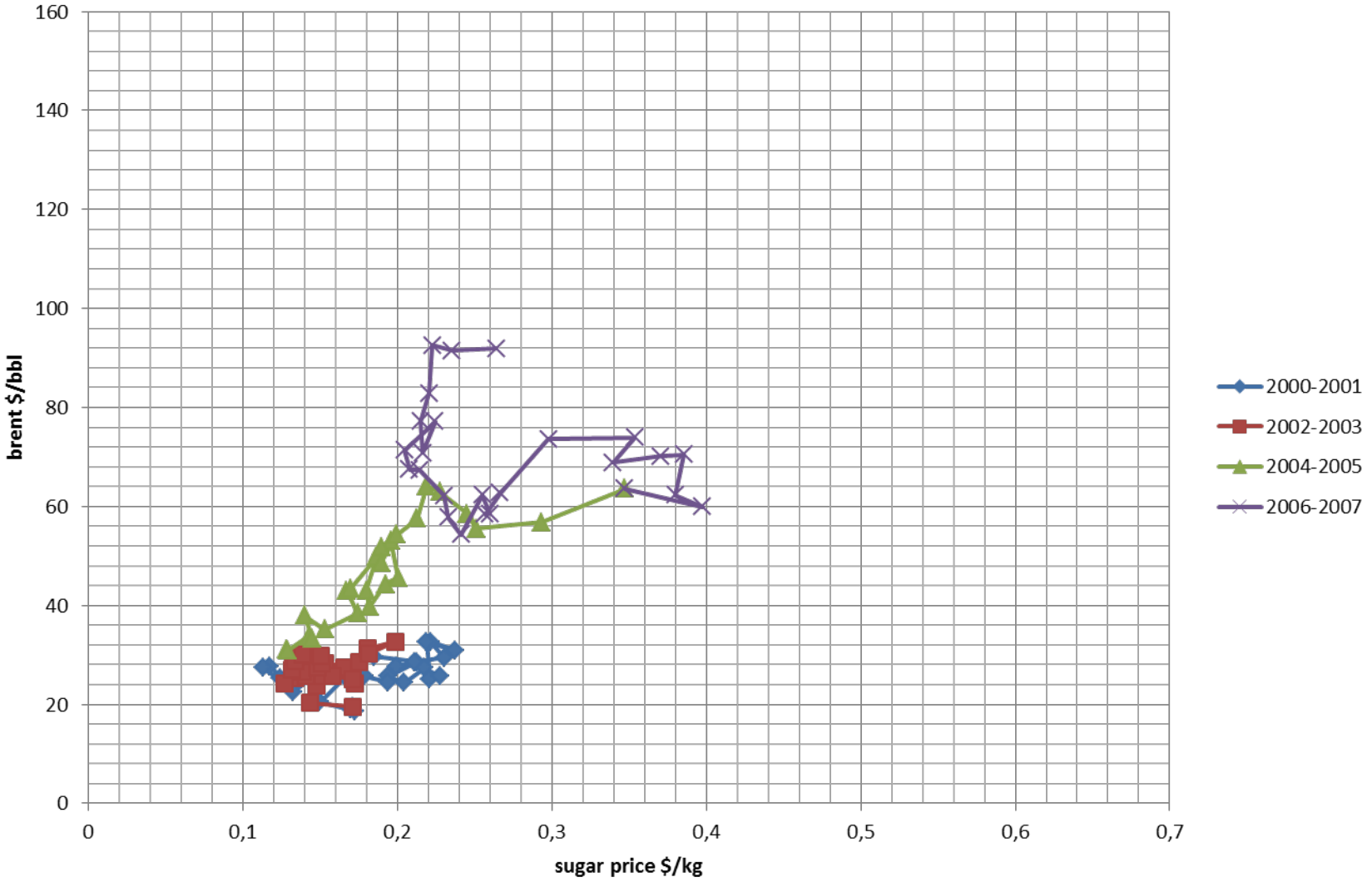
Feedstock: dispersion ?



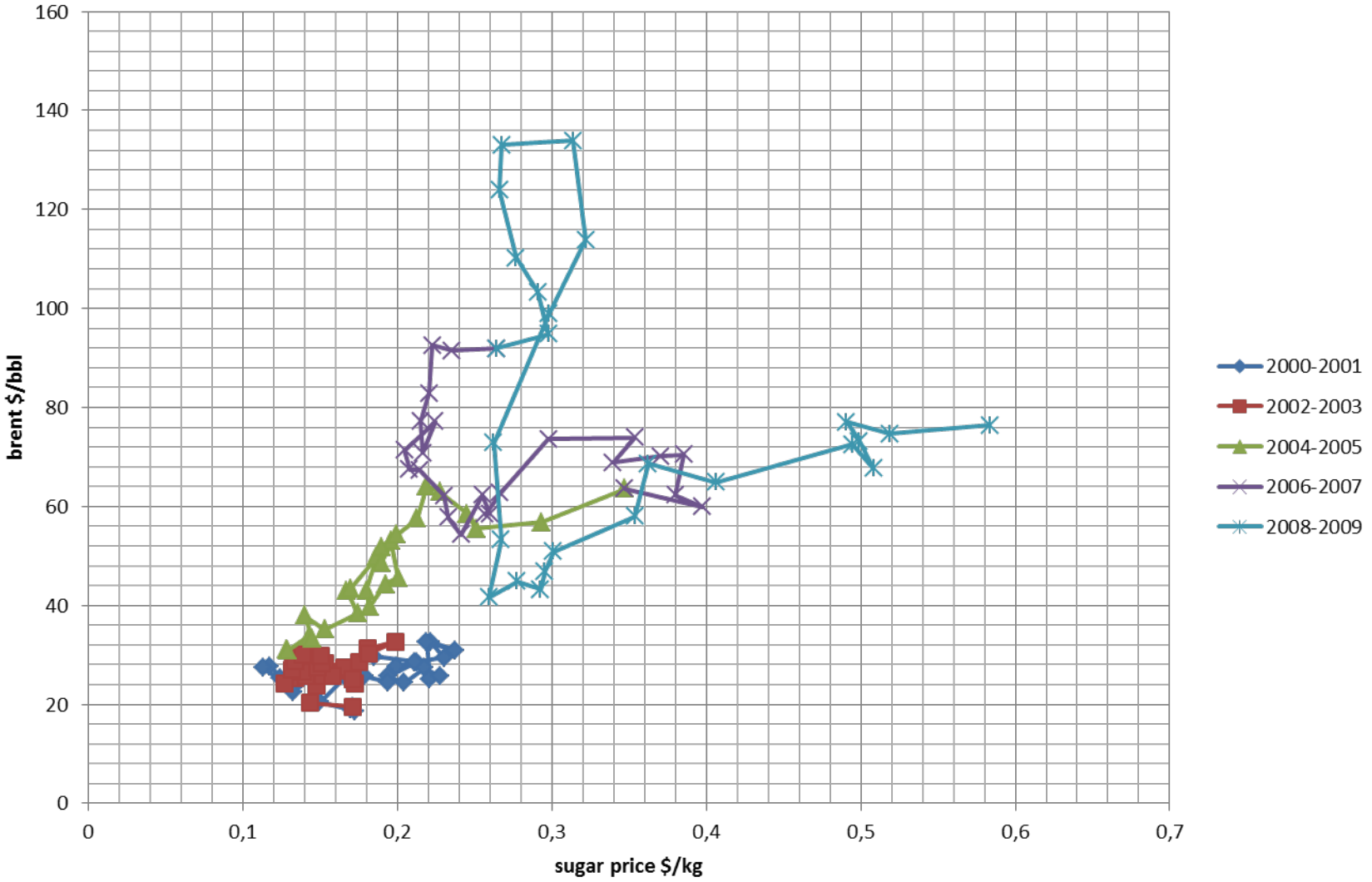
Feedstock: dispersion ?



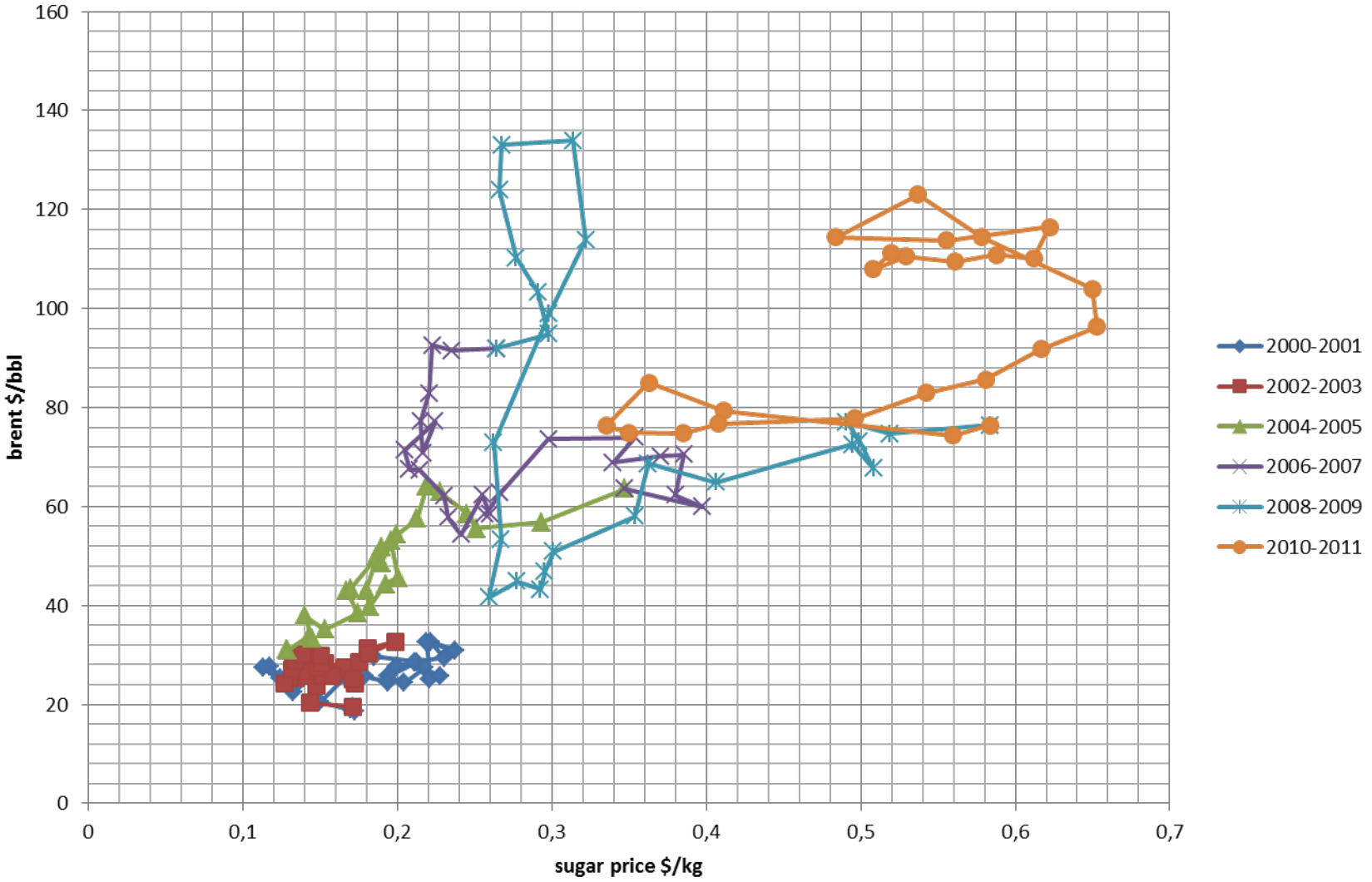
Feedstock: dispersion ?



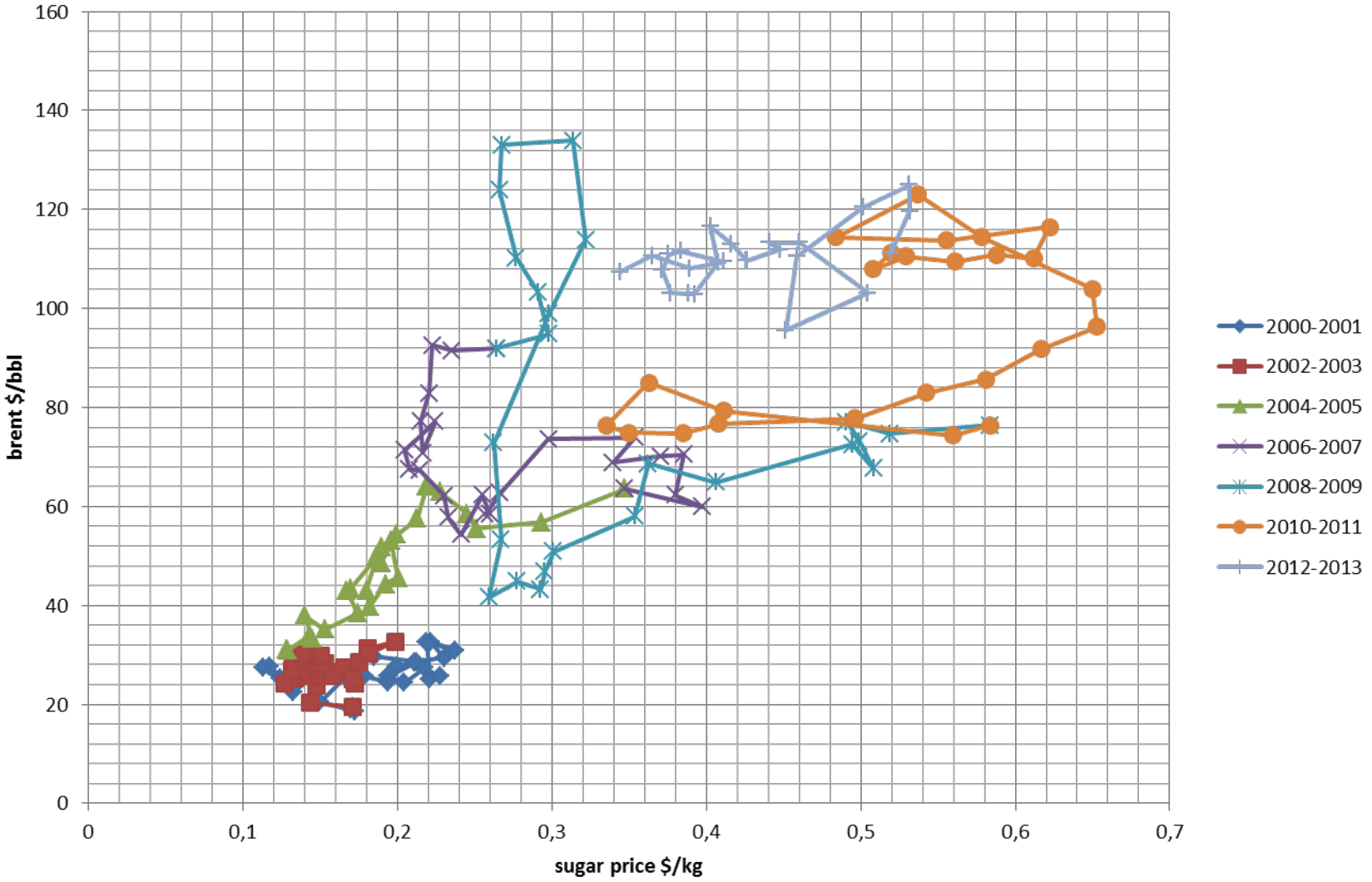
Feedstock: dispersion ?



Feedstock: dispersion ?



Feedstock: dispersion ?



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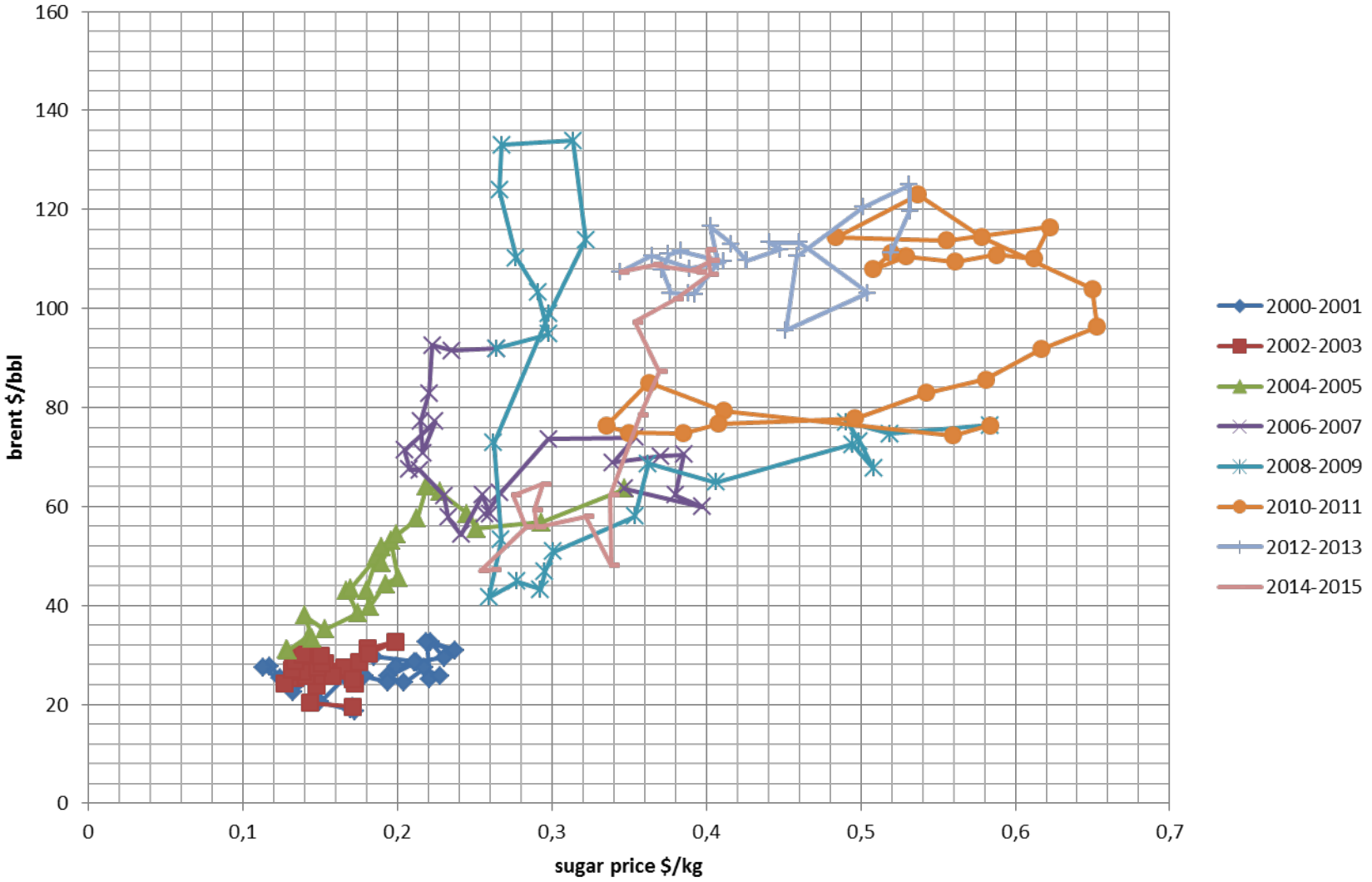

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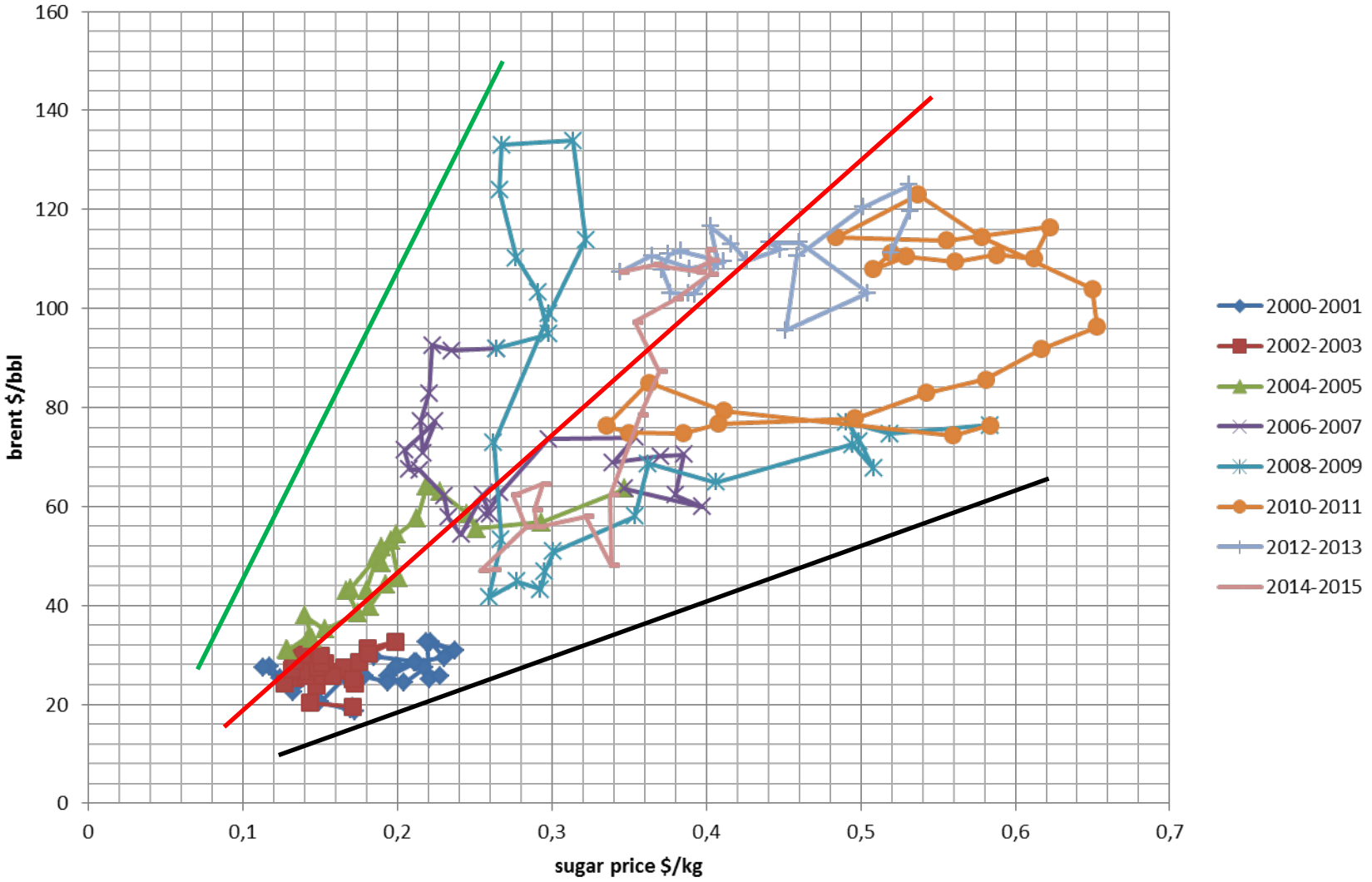
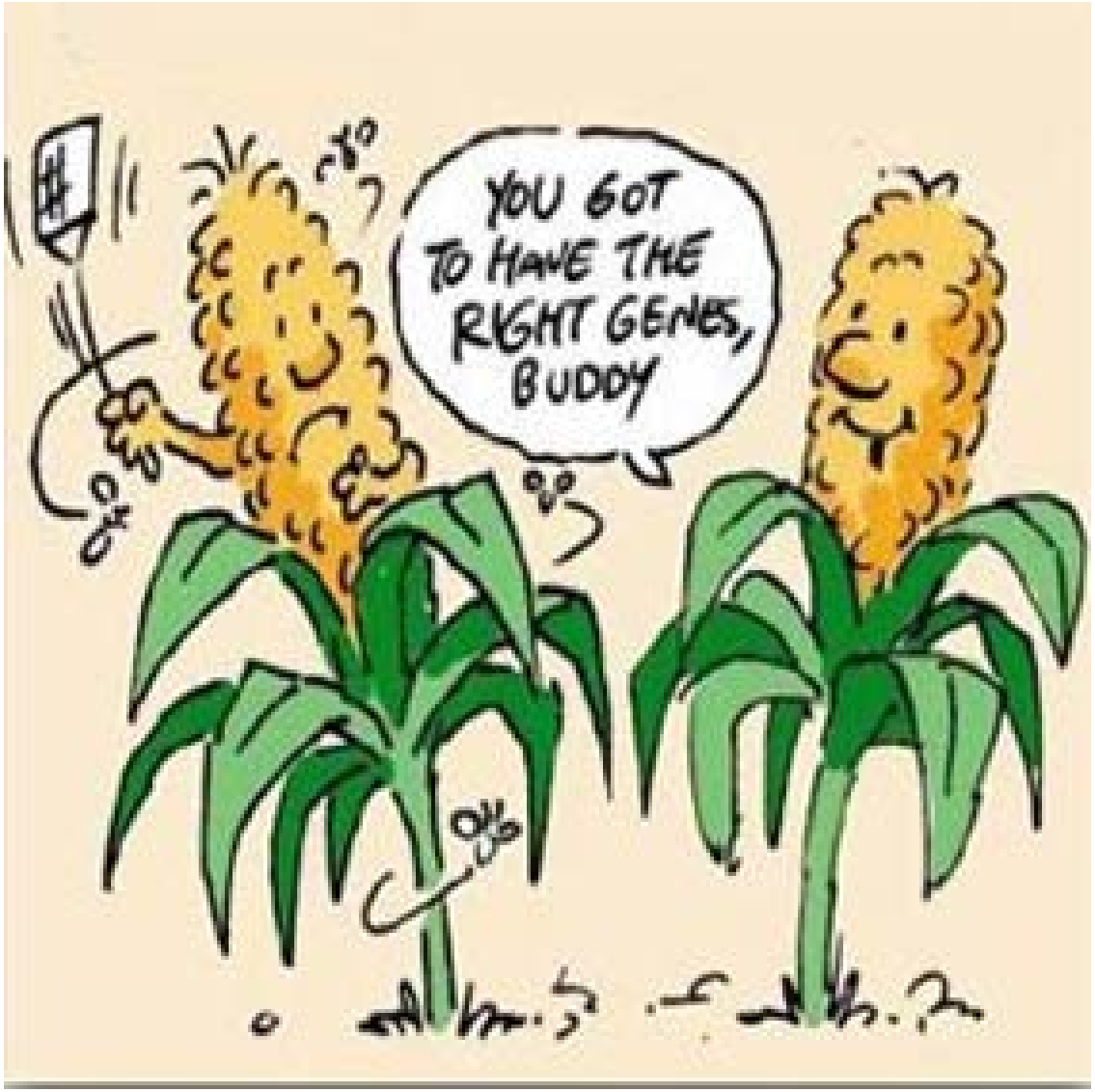


Challenges to reduce constraints

- Total cost should decrease – Don’t forget: Time is money too!
- Increase range of potential molecules

- **Development stage**
  - Faster and cheaper optimization
  - Eliminate demo stage
  - Novel enzymes/Micro-organisms

- **Operations**
  - Low-cost, available feedstock with low price volatility
  - Trinity - Titer, Yield and Productivity (Impact on building cost, operating cost and scaling)
  - Novel industrial downstream processes



Other challenges, questions, trends

- **Societal challenges**
  - Competition with food / feed chains
  - ILUC (indirect land use change)
  - Engineered crops and GMO
  - GMM and corresponding processes
  - Synthetic biology: understanding ? acceptability ?
  - Circular economy, waste valorisation
  - Management of emerging technologies

- **CO_2 challenge: helping or not ?**
  - LCA and footpint improvement of processes and products ?

- **Scientific and technological challenges**

Other challenges, questions, trends

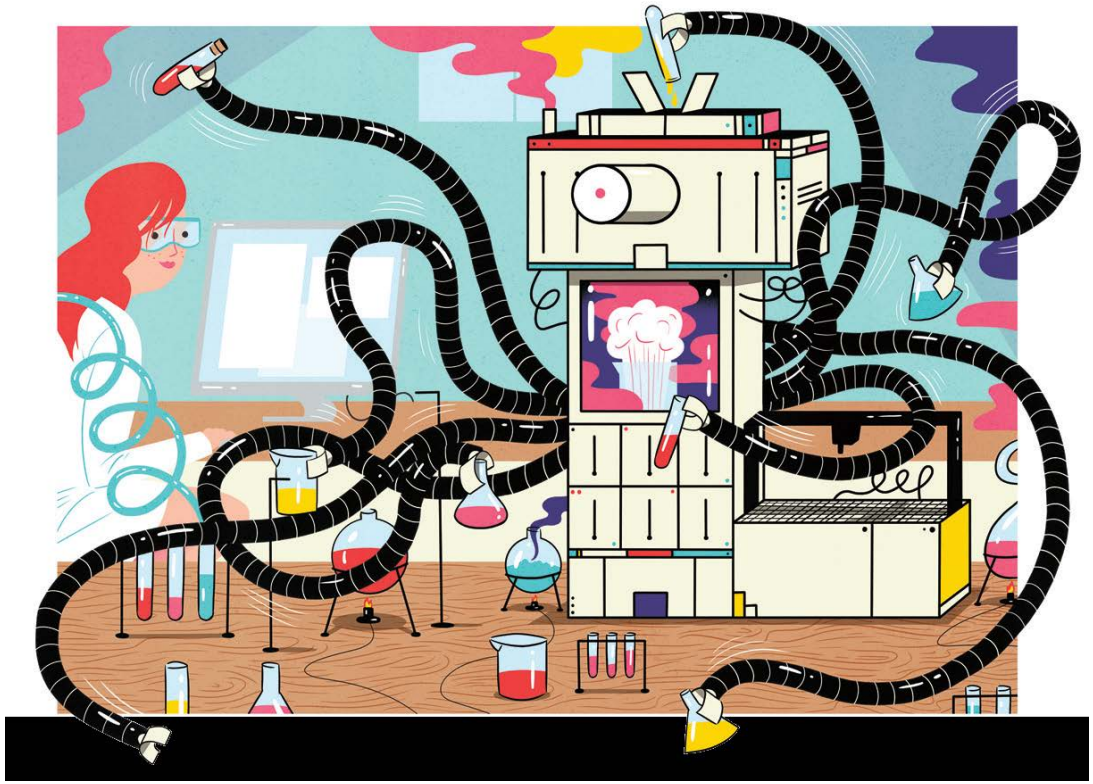
- **Economical challenges**
  - Regional ? Which advantages for each region ?
  - Switch to biomass: when ?
  - Raw materials: a new one per decade ?
  - Methane / shale gas/ methanol
  - Coal
  - Speed of evolution of fossil energies / raw materials ?
  - Price variability of biobased raw materials, especially if exposed to food/feed chains
  - Time and cost of process developments

Other challenges, questions, trends

- **Regulatory questions :**
  - Increasing number of labels, triggering even more debates: eg biosourced contents
  - Biology: one of identified KET
  - Support to R&D :
  - Subsidies and biaised competition :
    - *Subsidies to biofuels ?*
    - *Subsidies to biosourced products ?*
- **Some trends:**
  - Convergence nano/bio/info

The robo-chemist

Early retirement for our chemists?



The race is on to build a machine that can synthesize any organic compound. It could transform chemistry.

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