SCAR
Standing Committee on Agriculture Research

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Sustainable agriculture, forestry and fisheries in the bioeconomy

Presentation and reflexions about the SCAR 4th foresight exercise- 2015

Michel Griffon- Euragri conference 2015- Luxembourg.

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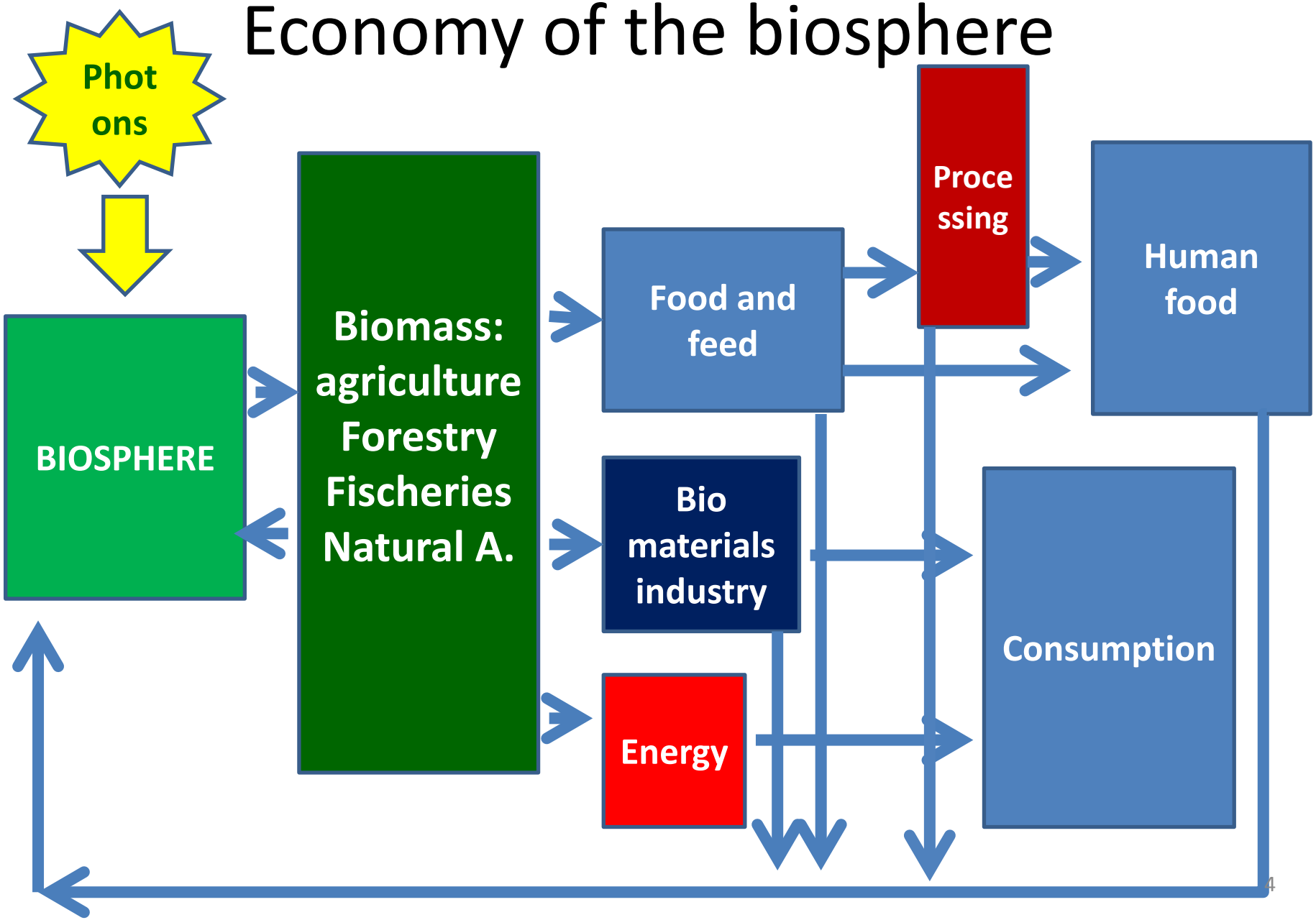
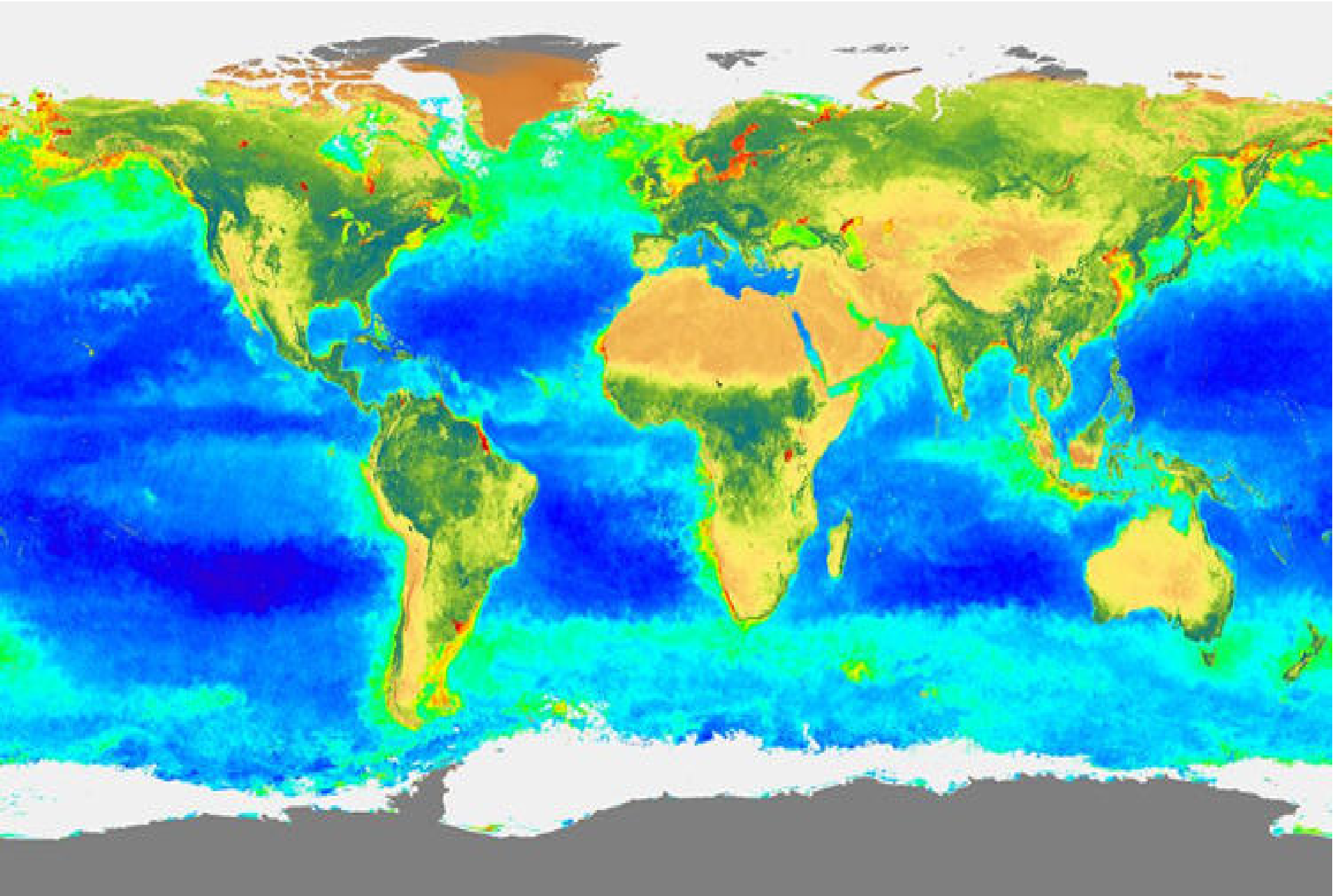
Purpose

- The 4th foresight exercise aims to
  - **identify emerging research questions**
  - **Anticipate** future innovation challenges
  - That can support the implementation of the European Bioeconomy strategy
  - And explores what might happen by **developping the paradigm within the fundamental constraint of sustainability.**

What is bioeconomy?
Economy of the biosphere



Primary production by the biosphere- Map : ENS Lyon



Employement in the Bioeconomy S.

18 M jobs in 2011 UE (28)	%
Agriculture	**58**
Forestry	2,5
Fisheries	0,9
Agro food and feed industry	**21**
Drinks industry	2,2
Tobacco	0,2
Textiles	4,4
Pulp and paper	3,4
Wood industry	**10,5**
Biofuels	**0,1**
Biomaterials	**1,5**

2 premises about biomass

1. Biomass **is underexploited**:
    1. too much waste not used optimally
    2. More material and energy can be extracted from current biomass streams
2. The biomass potential **can be upgraded** by
    1. Closing yield gaps
    2. Increasing productive land introducing new or improved species
    3. Introducing new and improved extraction and processing technologies

But: 6 Challenges for the coming decades for the bioeconomy

- **Increasing population** in Asia and Africa
- Increasing income → **increasing consumption**:
  - Food and feed
  - Fuels
  - Materials
- **But** :
  - Resources depletion (water, Phosphorus, fuel…)
  - Environmental pressure (chemicals)
  - Biodiversity 6th extinction
  - Climate change (yields reduction, catastrophes)

Business as usual scenarios are not sustainable

- High **competition** in
  - land use
  - Water use
  - Phosphorus use
- **Abuses** in biomass production (environment)
- Risks of **degradation of the biosphere** (biodiversity, deforestation, erosion…)
- In worst cases: inequality, conflicts, ecological collapse…

In the best cases

- Solar, wind… **abundant renewable energies**
  - allow abundance of water thus abundance of food
  - allow to let biomass for other uses (food, materials…)
- **Waste is entirely recycled**
- Policies are submitted to **sustainability**
- **Firms** processes and **consumers** patterns are sustainable…

So, the bioeconomy will have to deliver on its goals of:

- Food security
- Sustainable resource management
- Contributing reasonably to energy production
- Reducing dependency of Europe (energy and non-renewable resources)
- Tackling climate change
- Creating jobs
- Improve competitiveness.

Then, we set 6 principles

1- FOOD FIRST

- Food only comes from the biosphere, energy from sun, atmosphere and lithosphere. So the **first priority for biosphere is food**.
- **If not, we could have risks of food scarcity**. Food scarcity would mean high prices and **poverty**
- Policies related to agriculture (energy, environment, health, trade, investment) should be checked through **a food security test**

2 - SUSTAINABLE YIELDS

- Absolute necessity to **guarantee the renewable nature of biomass**
- Rule: the amount harvested should not be larger than regrowth
- Rule: **accumulate organic matter** in the soils
- Rule: **stock water** in the ecosystems

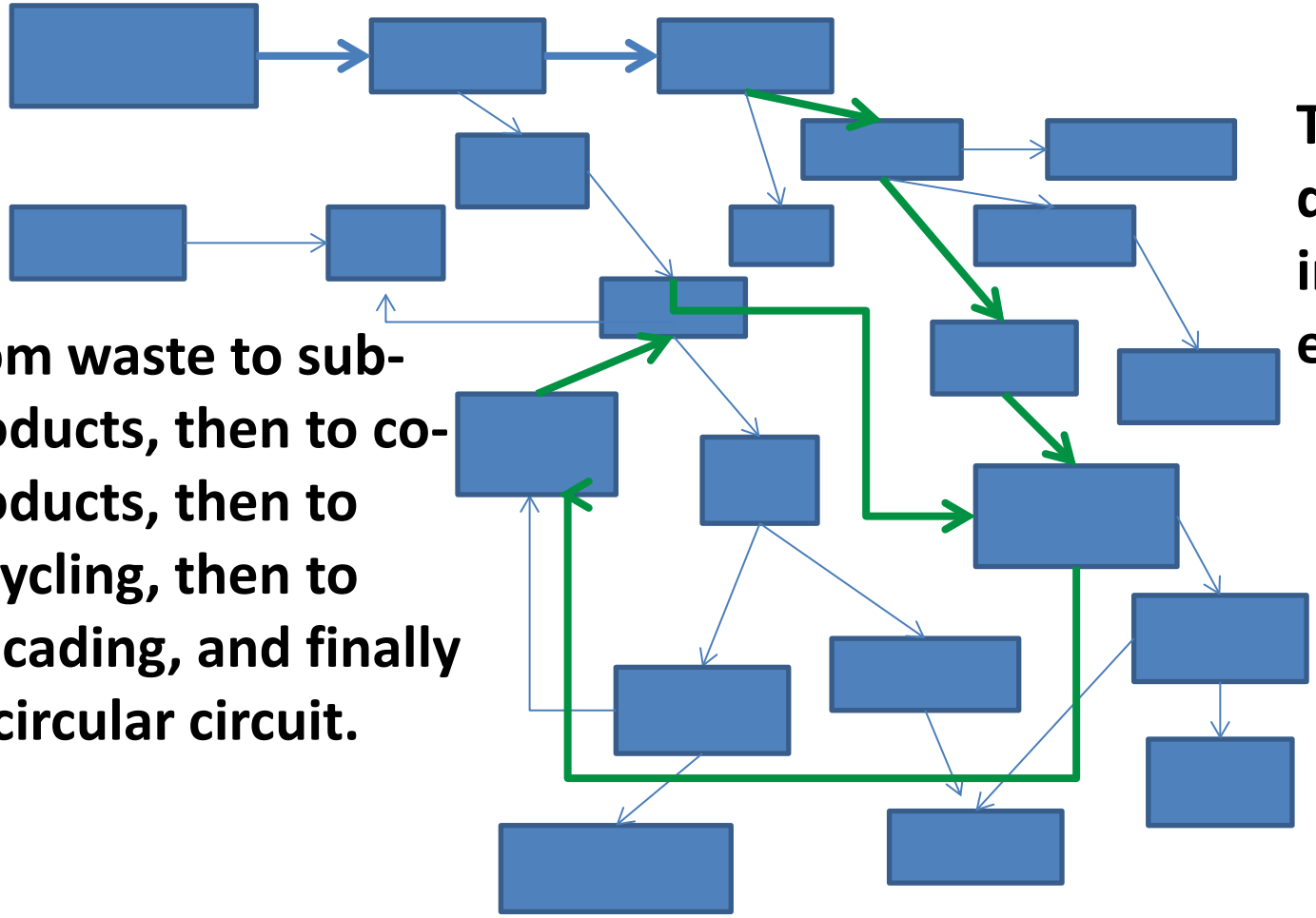
3 - CASCADING APPROACH

- Biomass have **to be used sequentially** as often as possible, as material and finally for energy
- Cascading **increases efficiency**
- **It is part of circular economy**
- Biomass can be used **several times**
- It could replace markets of “rights to pollute”

4 - CIRCULARITY

- Waste does not exist, as products are designed for a cycle of disassembly and reuse
- Consumables should be returned to the biosphere without harm, after a cascading sequence of uses, contributing to its restauration, while durables are designed to maximize their reuse or upgrade
- Renewable energy should be used to fuel the process

Cascading → circular economy

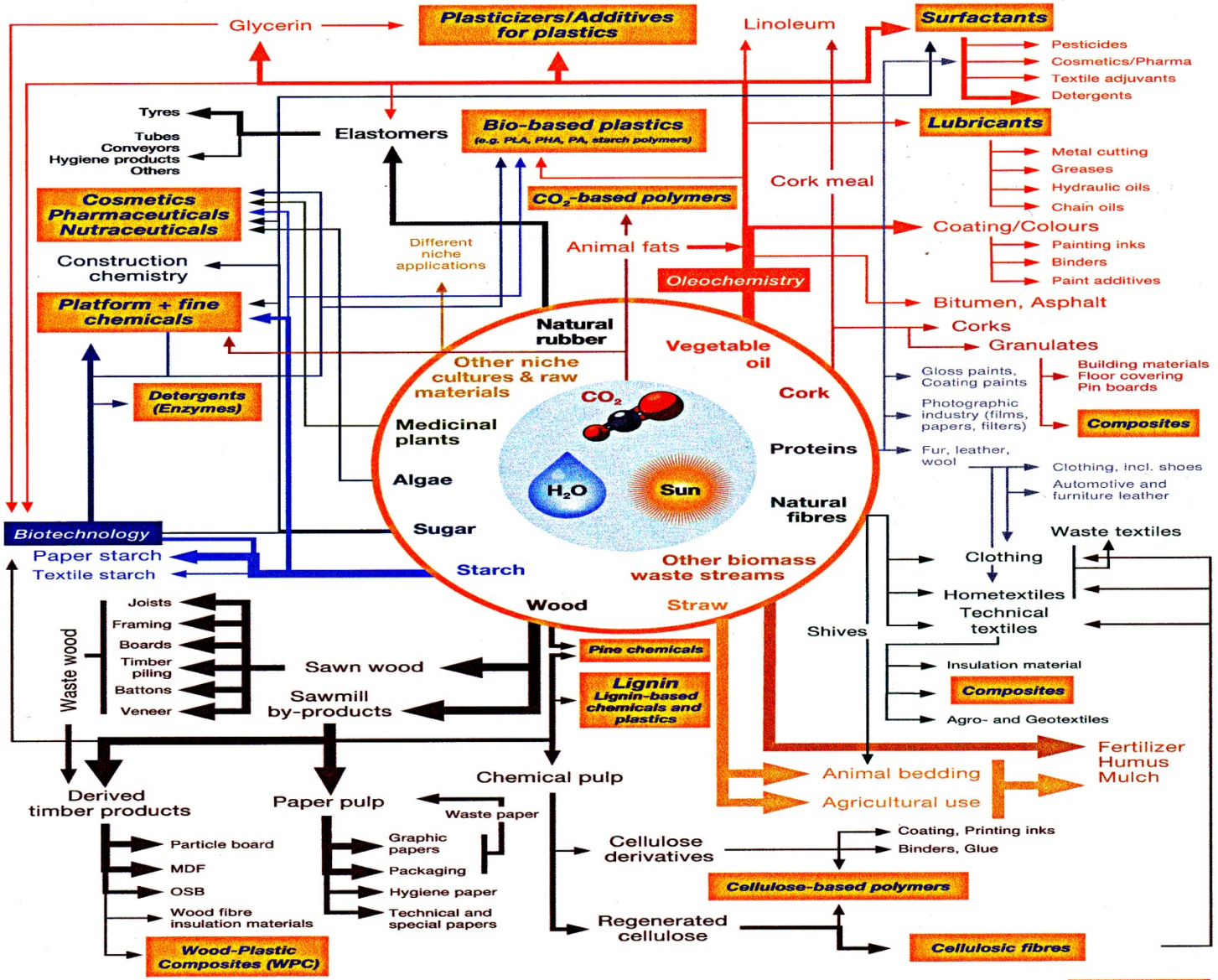


From waste to sub-products, then to co-products, then to recycling, then to cascading, and finally to circular circuit.

Towards the design of industrial ecosystems

Industrial Material Use of Biomass in Europe 2015

www.bio-based.eu

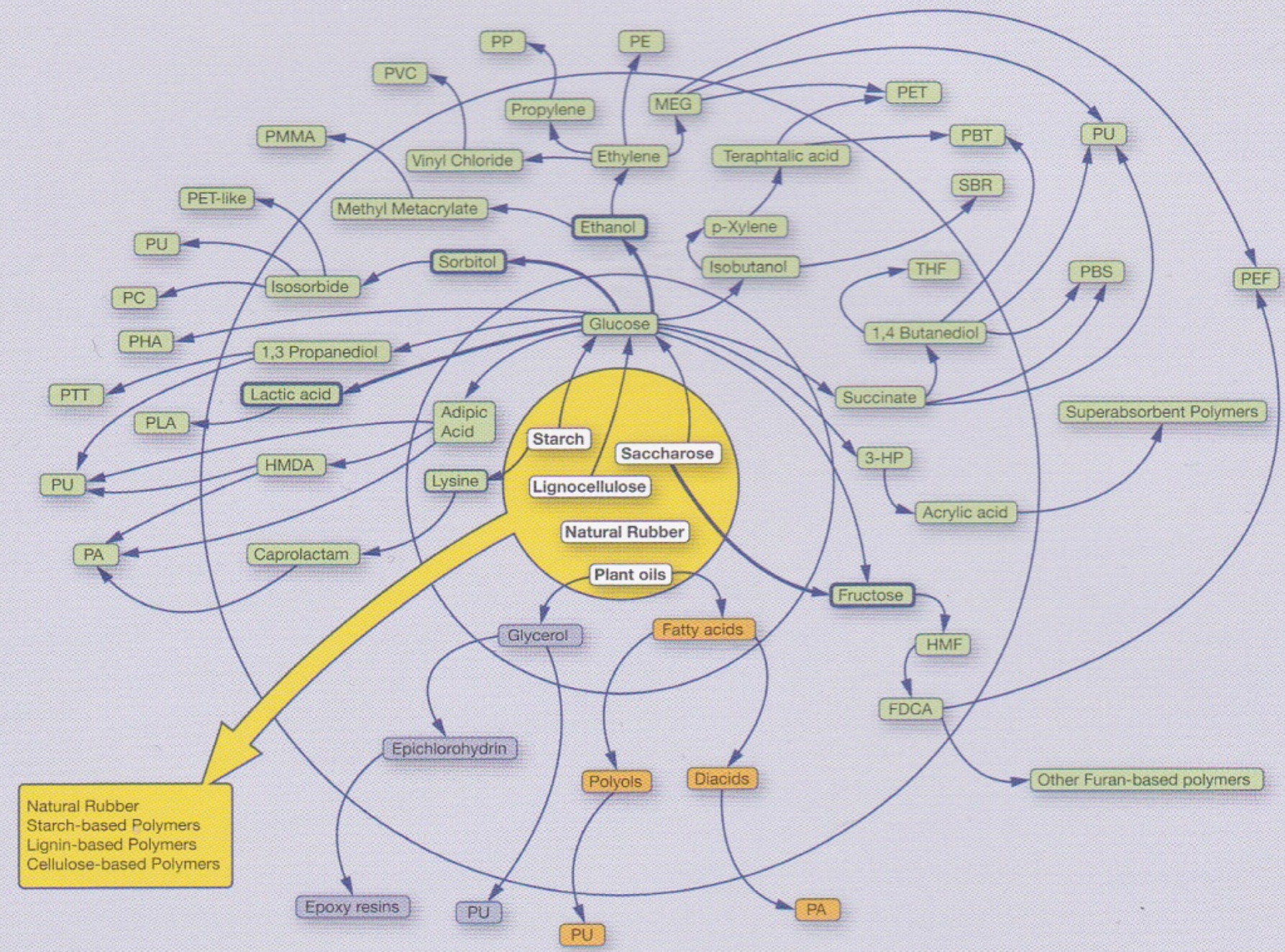


Use of biomass in the EU-27 2011 (domestic and imported)

	Industrial material use	Bioenergy, incl. electricity, heat, biogas and biofuels
Agricultural biomass	42 Million t	61 Million t
Wood	123 Million t	116 Million t

Source: PIOTROWSKI, S. et al. 2015: Sustainable Biomass Potential for Biofuels in Competition to Food, Feed, Bioenergy and Industrial Material – a Global Analysis of Biomass Supply and Demand. Download at www.bio-based.eu/markets

www.bio-based.eu/graphics



Pathways to bio-based polymers- NOVA institute

5- DIVERSITY

- Production system should be diverse
- To use context-specific substratum, climate , biomass oportunities, and practices
- At different scales
- Producing a diversity of outputs
- And contributing to resilience (diversity being a key for resilience)

6- GOVERNING THE TRANSITION

- Transition to a sustainable bioeconomy **cannot be governed by markets and technology**
- **Monitoring** is necessary as orientations are strong, and need
  - Clear identification of societal challenges
  - Holistic view
  - Reflexive governance
  - Empirical evidence
- **Integration of relevant policies** is necessary

All this is a new basis for a bioeconomic orientation and for a sustainable world.
It is not a scenario, but a necessary vision of the future of the biosphere.

From where do we start?
The state of the play.

FOOD and FEED

- Food for humans, Feed for animals that are producing for humans: **feed is a land use multiplier**
- **Changes in the diet** in emerging economies: more meat and milk → more land. Not in Europe
- Market is globalizing and **price are more volatile**
- **There is more competition**
- Supply chains and retail are **concentrating**
- The digital revolution could change the game

Evolution of international prices

nova-indices

January 1980 = 100 %

All raw materials are equally weighted in all indices

nova-Index 18

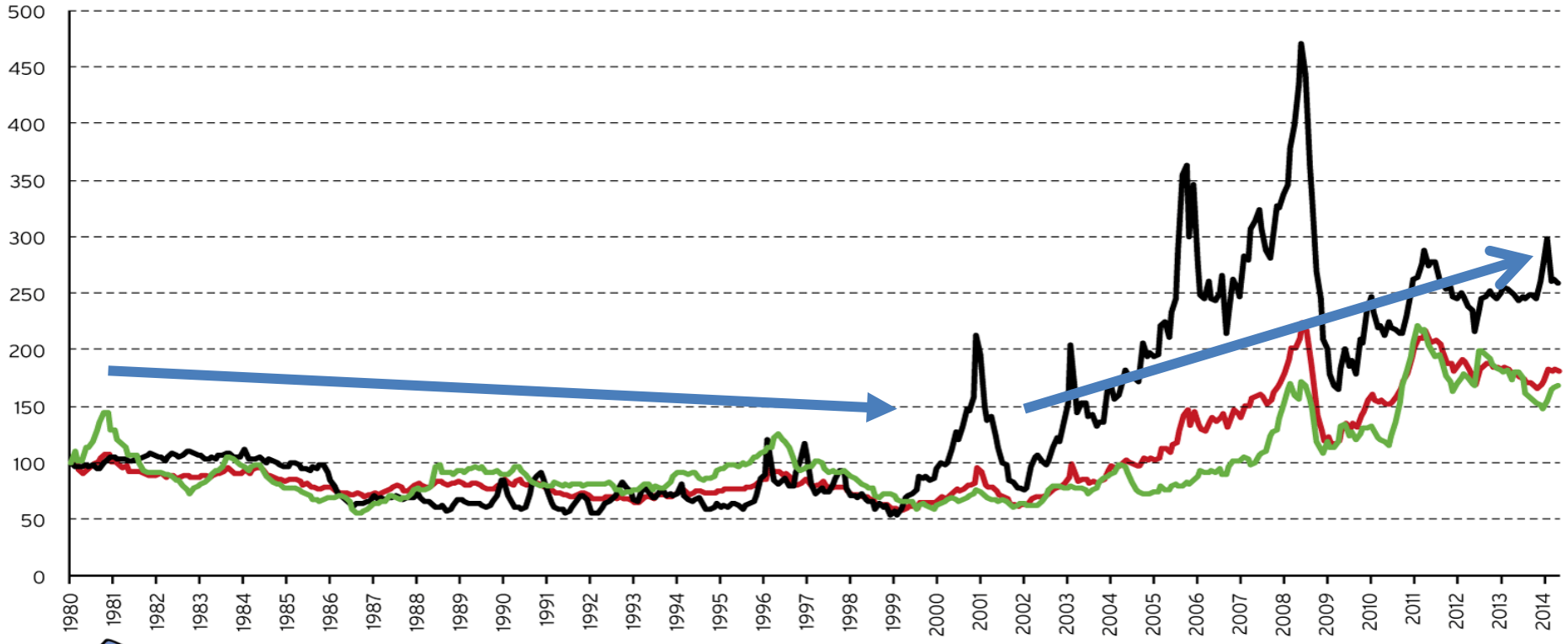
Beef
Cocoa
Coffee
Copper
Cotton
Crude Oil
Gold
Heating oil
Maize
Natural gas
Orange juice
Platinum
Pork
Silver
Soybeans
Sugar
Uranium
Wheat

nova-Index Energy

Crude oil
Heating oil
Natural gas
Uranium

nova-Index Agriculture

Cotton
Maize
Soybeans
Sugar
Wheat



available at www.bio-based.eu/graphics

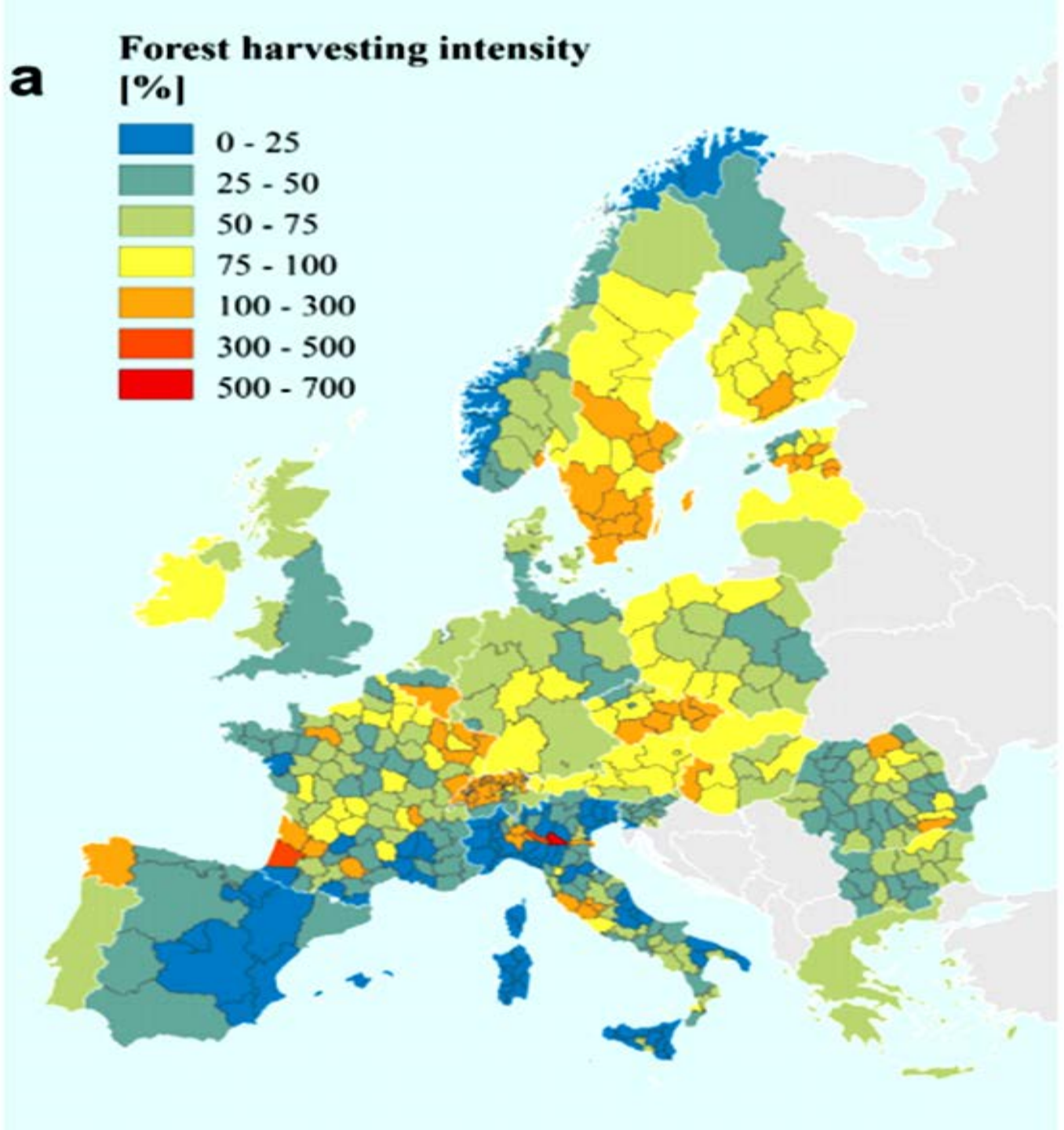
Source: IMF, World Bank, Silver Institute, EIA, FDOC, Johnson Matthey Plc

Bio-based chemicals & materials

- **Current uses of biomass**: animal bedding, construction, pulp & paper, textiles, chemical & plastic industry
- A lot of innovation in pulp & chemical industry: longstanding experience in biomass conversion
- Importance of cellulose and lignin
- **Future scarcity of oil**, then plastics → demand to biomass
- **Transition from oil refineries to biorefineries**:
  - Transport cost of the starting biomass relatively high
  - Mixed mode of operation needs research

Forestry

- Big differences in productivity
- Need to prepare forest to **multiple uses**: fuel, construction, materials, chemicals, furniture, landscape, recreation, ecosystem services…
- Need to prepare forests to **increased production : energy, biomaterials**
- Need to prepare to **climate change**
- Need for more nutrition management
- Need for a more ecologically approach of wood harvesting


a
Forest harvesting intensity
[%]
0 - 25
25 - 50
50 - 75
75 - 100
100 - 300
300 - 500
500 - 700

BIOENERGY & BIOFUELS

- **Role in the transition from fossil to renewable but with uncertain perspectives**
- Particularly for **transport** (liquid energy or power)
- **Multiple uses of biomass for energy**: methane CH4, thermal gasification, pelletisation, pyrolysis
- **Competition for carbon use**: fuel vs crop residues for soils (dilemma)
- **The sooner solar energy will be available and low cost** (photovoltaic → H2 → power), the better for alleviating competition for biomass. Note: energy efficiency of PhV, from 7% (2000), to 25% (2020) and 50% expected

POLICY FRAMEWORKS

- Many regulations and strategies in Europe: CAP, EU forest strategy, Common fisheries policy, Blue growth agenda, New EU framework for aquaculture, quality schemes, Renewable energy directive, 2030 framework for climate and energy, standards for bio-based products and circular economy
- **Conflicting interests but need for coherence: an integrated policy framework**

So, we have a main track for the future of the bioeconomy: **1**) **biomaterials will replace plastic, 2) a transition from fossil to renewable energies** with a **"biomass period"** during which high pressure on the biosphere is possible.

But uncertainties are important.

Some scenarios can help in exploring the possible futures.

Major uncertainties

1. **Demand growth for biomass** for energy and materials, and also for feed, depending on population, economic growth, technology evolutions for the biomass and all kinds of energies
2. **Supply growth of biomass** depending on the evolution of the technologies and the rate of intensification of the primary sector

3 scénarios for the european bioeconomy: 3 main possible situations

		Supply growth of biomass		
		Low	medium	high
Demand growth for biomass for materials & energy	low		A **Biomodesty**	
	medium			
	high	B **Bioscarcity**		C **Bioboom**

A **Biomodesty**

- Growth in demand for biomass low because of
  - Quick take off of non renewable energies
  - → Biobased solutions less competitive
- Supply: medium
- → No important changes in price formation of biomass- a scenario of continuity?

B **Bio-BOOM**

- Demand growth for energy and materials using biomass is high because…
  - Oil scarcity sooner than expected or geopolitical problems
  - New energies not available
  - No awareness about state of biosphere
- Supply meet demand (following)
- → Prices in favor of biomass

C **BIOSCARCITY**

- High growth in demand (like B)
- But Low supply (not meeting demand) because of
  - Societal resistance to energies from biomass and to biomaterials
  - Technology not enough available or expansive
- → Leading to high prices

B and C could be alternate sequences of a same story?

1. Growth of demand in the energy sector + oil scarcity geopolitical trouble + societal opposition against nuclear power → high demand for biomass for energy but slow supply→ Bio-scarcity → high prices
2. Reaction to high prices → supply "boom" but with a mix of classical and new technologies for biomass: Bio-BOOM.
3. Eventually: Reaction against "abuse" of biomass expoitation leading to reduction of supply growth
4. Back towards a situation of "scarcity"?…

The décor (context) will play an important role

Example of décor for the A,B&C scenarios

		Climate change	
		Fast	**Low**
World growth	**Low**	**Danger** High costs of Climate change and of transitions Risks of funding shortage Risks of conflicts and rising of poverty	**Business as usual** Incentive to low change
	High	**Difficulty** High costs of Climate change and transitions Acceleration of investments for mitigation, adaptation of climate change, and for energy transition **Organization or collapse?**	**Opportunity** Opportunity for anticipation Big investment in energy transition and climate mitigation and adaptation. **Virtue or not virtue?**

But the geopolitical situation and energy policies also will play a role

- Oil production of Iran and Saudi Arabia?
- Come back of Iraqi production or not?
- Emergence of Egyptian gas?
- Shale oil and shale gas from North America depending on energy prices and climate evolution?
- Chinese energy policy?
- European decision about energy dependency?

Then, the **transitions could be highly unstable** :

-Situation of **oil supply** depending of geopolitics

-Development of **renewable energy** fast or low

-And particularly the **availability of solar – H2 solutions** is still uncertain (when?)

-**Dilemma** : Carbon from biomass for soil or for energy production?

-**Dilemma** : share of feed / food → share of land use feed+food/ energy+materials?

-…

In that context, R&D and innovation will play a critical role:

The interest of Europe is likely to invest in R&D-I
-To be more independent for energy
-To be leader in solar –H2 – electricity energy
-To use biomass potential in the transition
-To develop biomaterials
-To invent a sound and competitive bioeconomy
-To invent new solutions to control climate

ECOLOGICAL INTENSIFICATION

- New **priority** for agriculture research
- Use of the regulation functions of nature
- **Amplification of functionalities** of ecosystems (ecological process) and synergies of the functionalities
- Use of new **bio-inspired molecules** for crop protection, defense stimulation…
- Reduction of industrial inputs
- Improve yields
- Sequestrate carbone

DIGITAL REVOLUTION

- New coordinated- **integrated techniques: sensors- connected objects – software -robots**
- Leading to **ecological precision and efficiency** in agriculture and livestock production
- And to circular economy
- Allowing **high productivity and quality of products for export**

RESILIENCE FOR A SUSTAINABLE BIOECONOMY

- **Diversification and aggradation** of productive ecosystems will **reinforce resilience**
- Complexity brings resilience (examples):
  - more cover crops → less weeds;
  - increase habitats and auxiliaries → less invasive species
- Economic and social perspectives of stabilization

A NEW ENERGY LANDSCAPE

- Abandoning fossil-fuel based energy and process
- Emerging renewable energy resources, particularly highly efficient photovoltaic –H2- fuel and electricity pechnology
- **Transition of the energy landscape have to be prepared particularly for biomass** (agriculture, forestry)
- **The role of biomass will be locally specific:** Northern Europe is very different of central or Southern in terms of resources and firms)

NEW BUSINESS AND POLICY MODELS

- Circularity and cascading implies
  - **new ways of designing and manufacturing products and recycling** components
  - New relationships between economic actors
- Public goods are part of the new production (ecosystem services) and could involve public sector
- **The value-added chain will need new business models**

SOCIO-CULTURAL DIMENSIONS

- Necessary having knowledge about **social and economic impacts**: consumers, firms, producers organizations
- Agriculture producers will produce more amenities and ecological services. It is a major change
- Resistances to change?

GOVERNANCE & POLITICAL ECONOMY

- More **instability** and volatility in prices?
- Diversification of income for producers
- Risks : **capacity to control the new techniques**, for example in agroecology →how to insure economic sustainability of the transition?
- Capacities of the **policy incentives** to produce the complex expected impacts

FORESIGHT FOR THE BIOSPHERE

- **Follow up** of the impacts on the biosphere of the development of the bioeconomy sector
- **Need for modeling platforms** including demography transition, energy transition, agriculture transition, food and feed transition, materials transition, climate change, biodiversity evolution, sustainability of the biosphere…

KIS : KNOWLEDGE & INNOVATION SYSTEMS

- Need for **fast diffusion** of knowledge
- Allowed by the e-learning revolution
- Need for **more flexibility in innovation**: funding, risk assessment, market anticipation, investment
- Policies for start-up enterprises

CHALLENGE ORIENTED RESEARSH

- Rather than being driven only by scientific curiosity, the KIS should be **challenge oriented**
- EC could Propose **new Challenge programs** dedicated to reduce bottlenecks and bolts: Grand Challenges of the Bioeconomy
- Need for **strategic research programming**

TRANSDISCIPLINARITY

- More than pluridisciplinarity and interdisciplinarity, transdisciplinarity is absolutely necessary (tanscends the pre-existing disciplines). **Disciplines can be obstacles** if they remain closed
- Transdisciplinarity is “consubstancial” to challenge research

SOCIALLY DISTRIBUTED BIOECONOMY

- Socially distributed knowledge is a condition for having a **flexible, innovation reactive, and fast development** bioeconomy
- Insist on a part of public good character of a lot of potential innovations, because of their impact (environment particularly)
- **Open access and open innovation** is welcome as much as possible

REFLEXIVE RESEARCH

- **Participatory, multi-actor participation and stakeholder engagement** in projects and in programming
- Conflict anticipation and resolution by delivering information on science and technology perspectives

NEW REWARDING AND ASSESSMENT

- **Quality control transcends the classical peer review** as transdisciplinarity makes old taxonomies irrelevant
- **The concept of quality is broadening** because of the integration of different actors in the R&D-I process
- Thus, the **rewarding/ assessment system have to change**

COMPETENCIES AND CAPACITIES

- All actors, and particularly researchers have to **acquire new sets of skills and competencies** in relation with
  - **Flexibility of the R&D-I process** (challenge oriented research)
  - **Transdisciplinarity**
  - **Acceleration of research technology** (digital – in silico …) and knowledge production.

Natura non nisi parendo vincitur

TO CONTROL NATURE, FIRST OBEY TO HER

FRANCIS BACON :

NOVUM ORGANUM, I- APHORISM129

The bioeconomy, being inspired by life and life sciences (biology, ecology…) has to dedicate huge investment in discovery science and in innovation in order to better control ecosystem production, and guarantee its long term viability and sustainability.