ARISTOTLE UNIVERSITY OF THESSALONIKI

Biomass Group
LABORATORY OF CHEMICAL PROCESS AND PLANT DESIGN

Sustainable use of bio-resources in the context of Bioeconomy and Circular Economy

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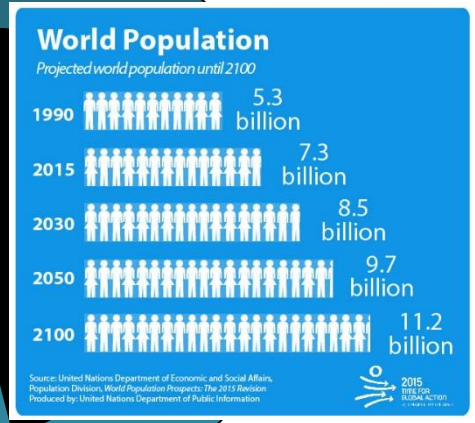
Gela, 25-27 May 2017

CHALLENGES WE FACE TODAY

Beyond Climate Change

PRODUCTION AND CONSUMPTION



INCREASED ENERGY NEEDS DUE TO HIGH ANNUAL PRODUCTION OF GOODS


From our planet's point of view,
there's no throwing garbage out.
Because there is no "out".
Bank of the Planet.
Investments generating
information and actions.
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Bank of the
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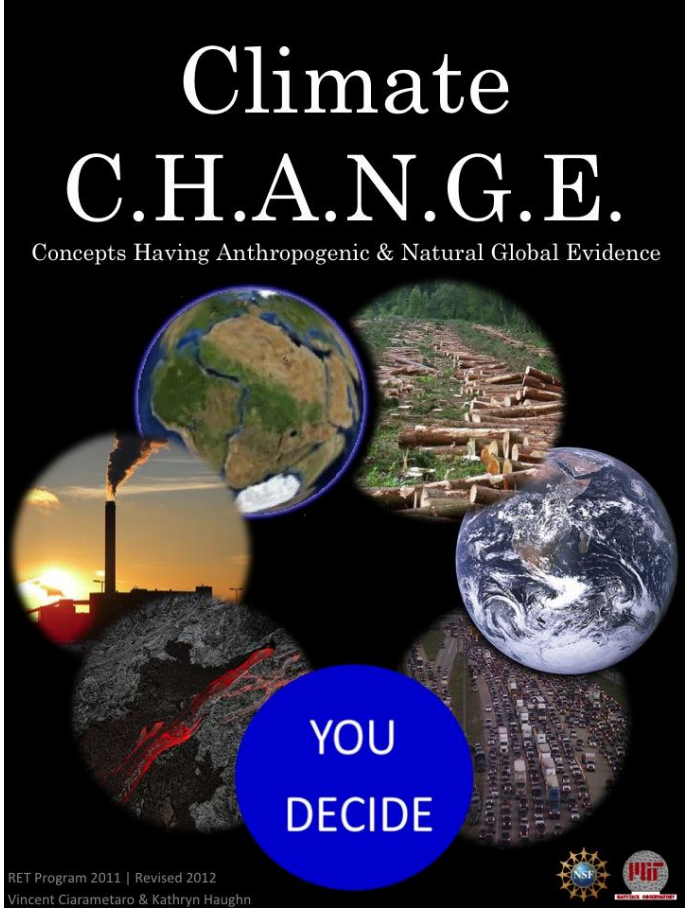


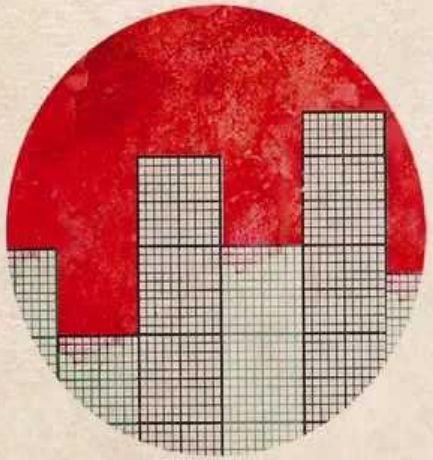
Anthropogenic Climate Changes and Social Upheavals

Mediterranean
Economic crisis, unemployment, immigration

RE-THINK

Come **TOGETHER**
let's think
DIFFERENTLY"

GREEN ECONOMY=



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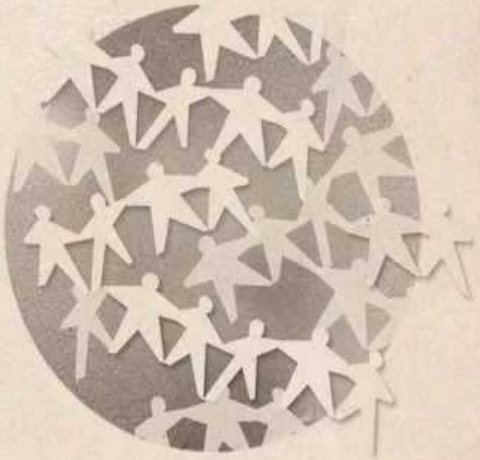


LOW CARBON GROWTH

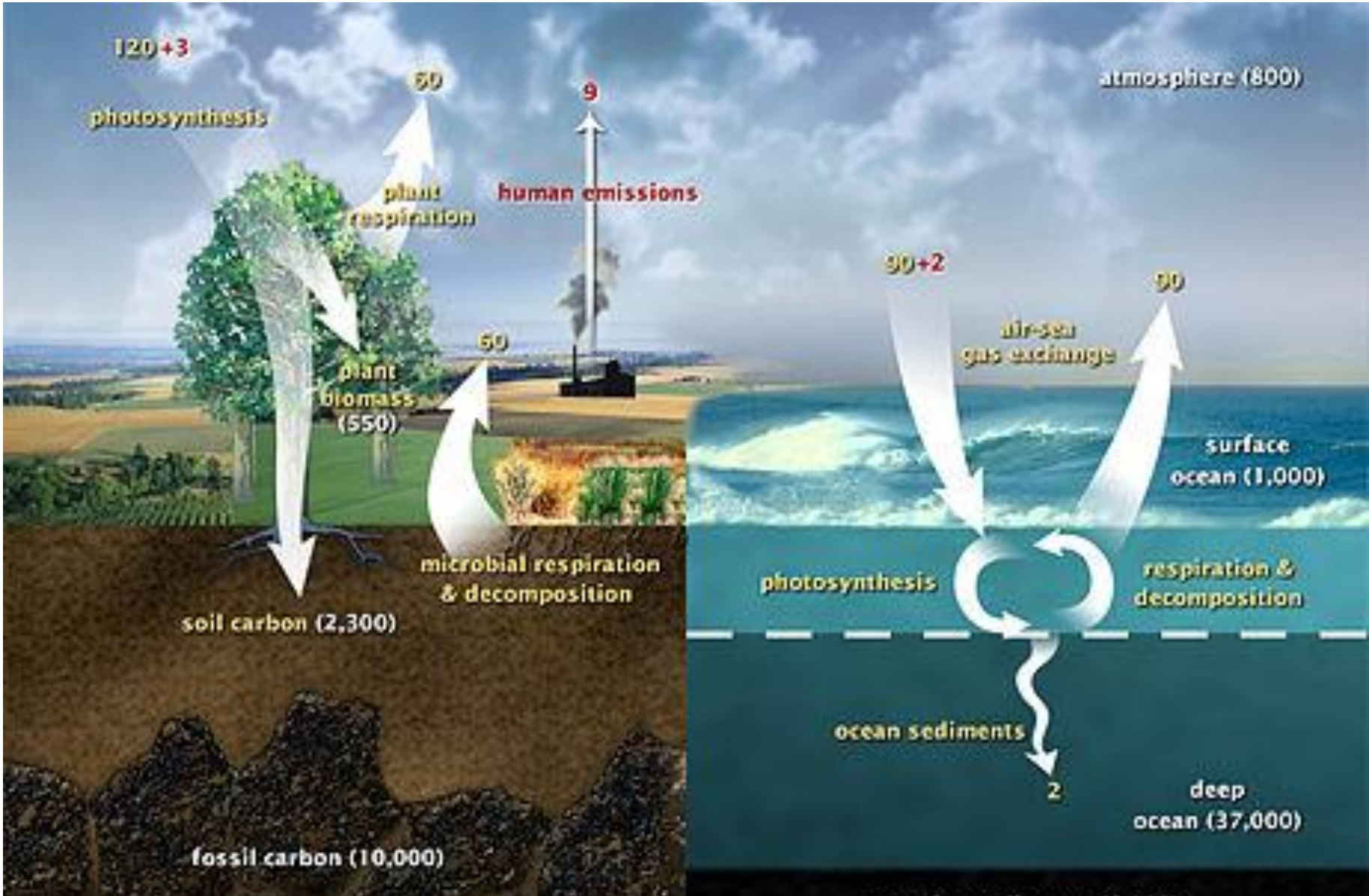
RESOURCE EFFICIENCY

SOCIAL INCLUSIVITY

=SUSTAINABLE DEVELOPMENT?

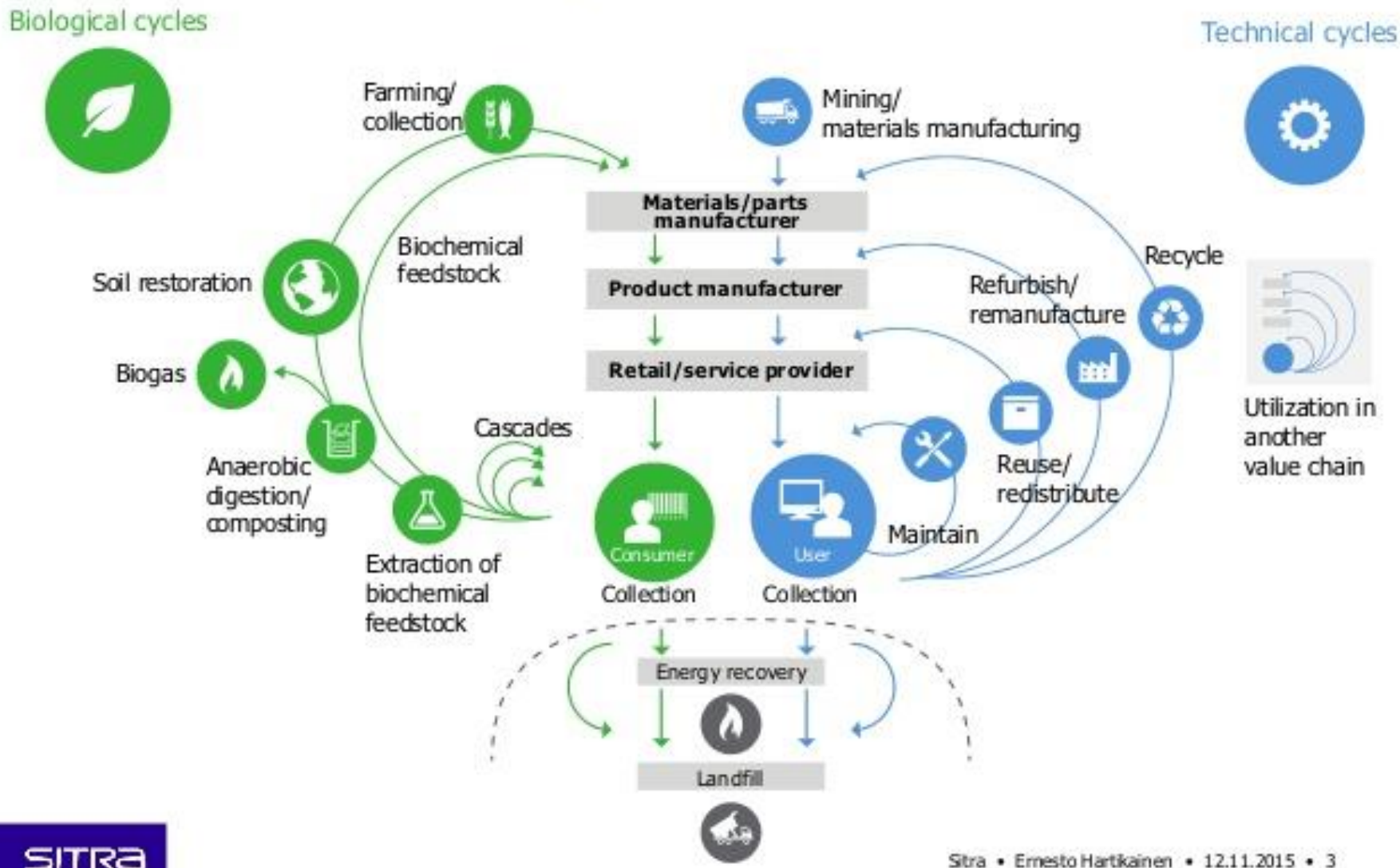
Photosyntesis – GENESIS

Terrestrial and Marine Biomass



Wasted matter
We don’t see everything !!!

A system restorative by design to retain more volume and value within the economy



Holding out for Sustainability

FOR systemic health

FOR resilience

AT different scales, from local, to regional and global.

Back ground-policy context

Strategic objectives

Back ground-policy context

BIO ECONOMY

One of the main pillars of green growth and sustainability

the **Sustainable Development** Goals

WHY Bioeconomy

- **Sustainable and safe food** production for our growing population,
- Developing **new and more environmentally friendly sources of energy,**
- Combating **global warming**, which can have serious consequences both on land and in the oceans
- **Employment**

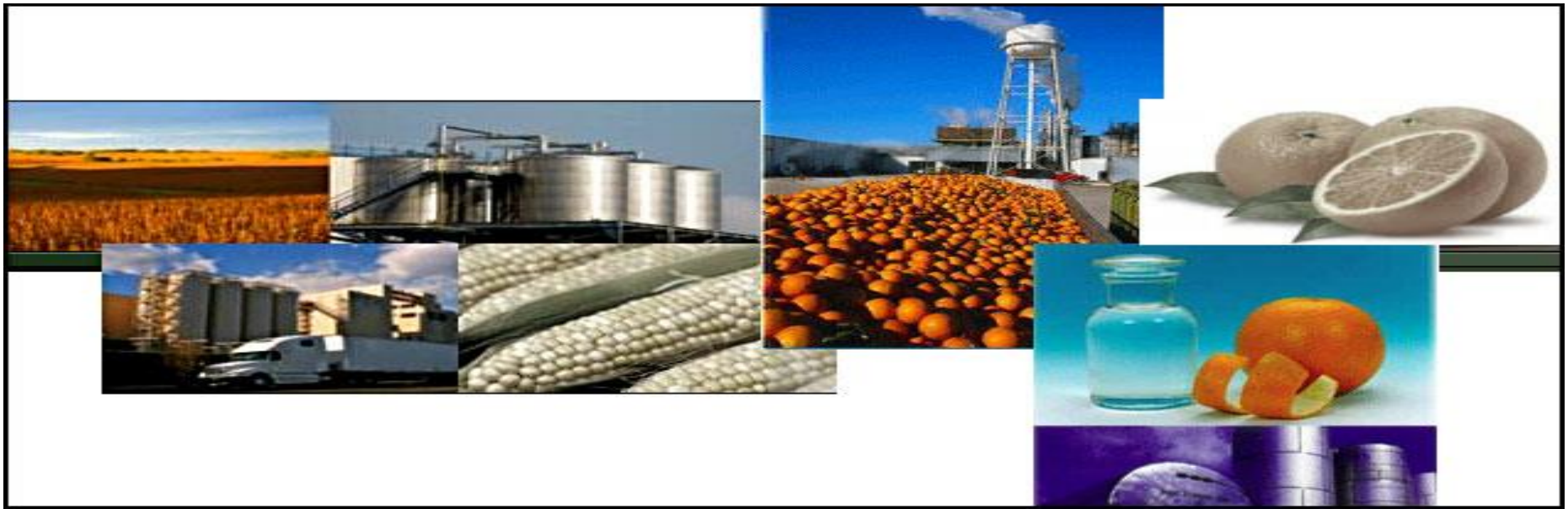
The bioeconomy challenges our centralised social model

- Sustainable well-being is based on the **smart and responsible use** of renewable resources.
- The bioeconomy can also be seen as a strategy used by society to combat urgent problems, such as **climate change**, increasing competition for **natural resources and rural and regional development.**
- The bioeconomy should be viewed as a new **economic and social order** that will challenge most of our existing practices and structures.
- As well as **agriculture, forestry, chemical, fishing, food and pharmaceutical industries** make Bioeconomy.
- **Ecotourism** can also be considered part of the bioeconomy.

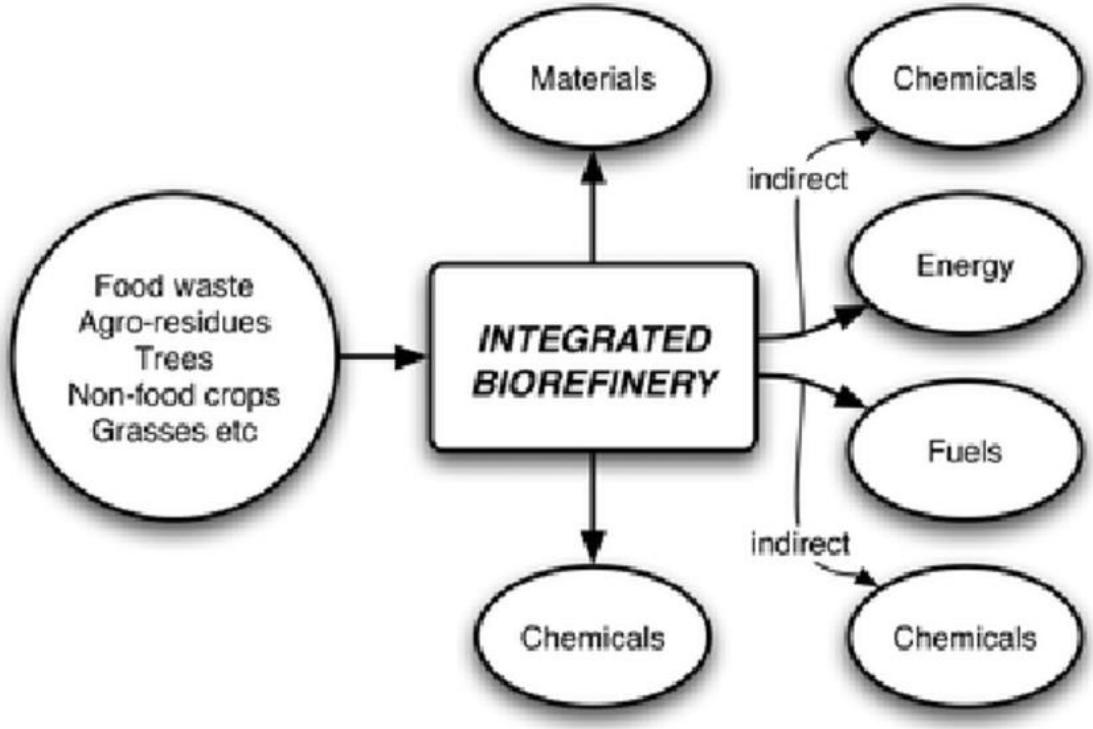
Application…….Bio-industry

It includes sectors such as
agriculture,
forestry,
fishing,
food and paper production and
energy industries.

biofuels,
biopower,
bioproducts.



Biorefinery approach



A biorefinery might, produce

one or several low-volume, but high-value, chemical products and

low-value, but high-volume liquid transportation fuel,

while generating electricity and process heat for its own use and perhaps enough for sale of electricity.

The high-value products enhance profitability,
the high-volume fuel helps meet national energy needs,
and the power production reduces costs and avoids greenhouse-gas emissions.

Back ground-policy context

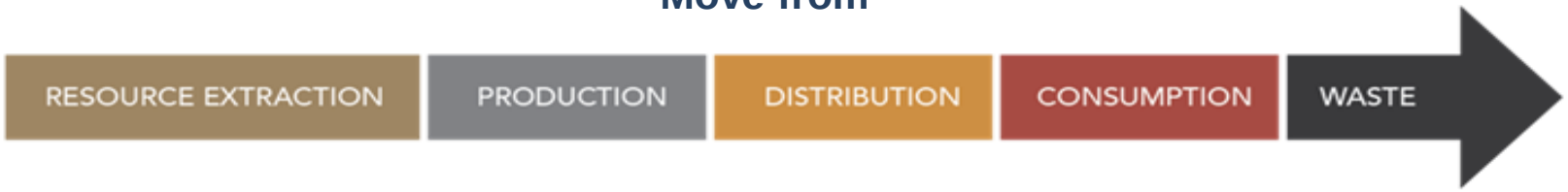
CIRCULAR ECONOMY

The 7th EU Environment Action Programme to 2020

Toward circular economy

EU target: To develop a competitive, resource efficient and low carbon economy by 2050.

Move from



To
A CIRCULAR AND REGENERATIVE MODEL

- ❑ Smart and efficient use of resources
- ❑ Turn waste into a new resource
- ❑ Sustainable and circular design of products, processes and systems.

Bioeconomy: circular by nature

A transition towards a circular bio-economy could see the traditional approaches

to circular economy and bio-economy integrated together,

leading to more **sustainable resource use at a lower cost** while

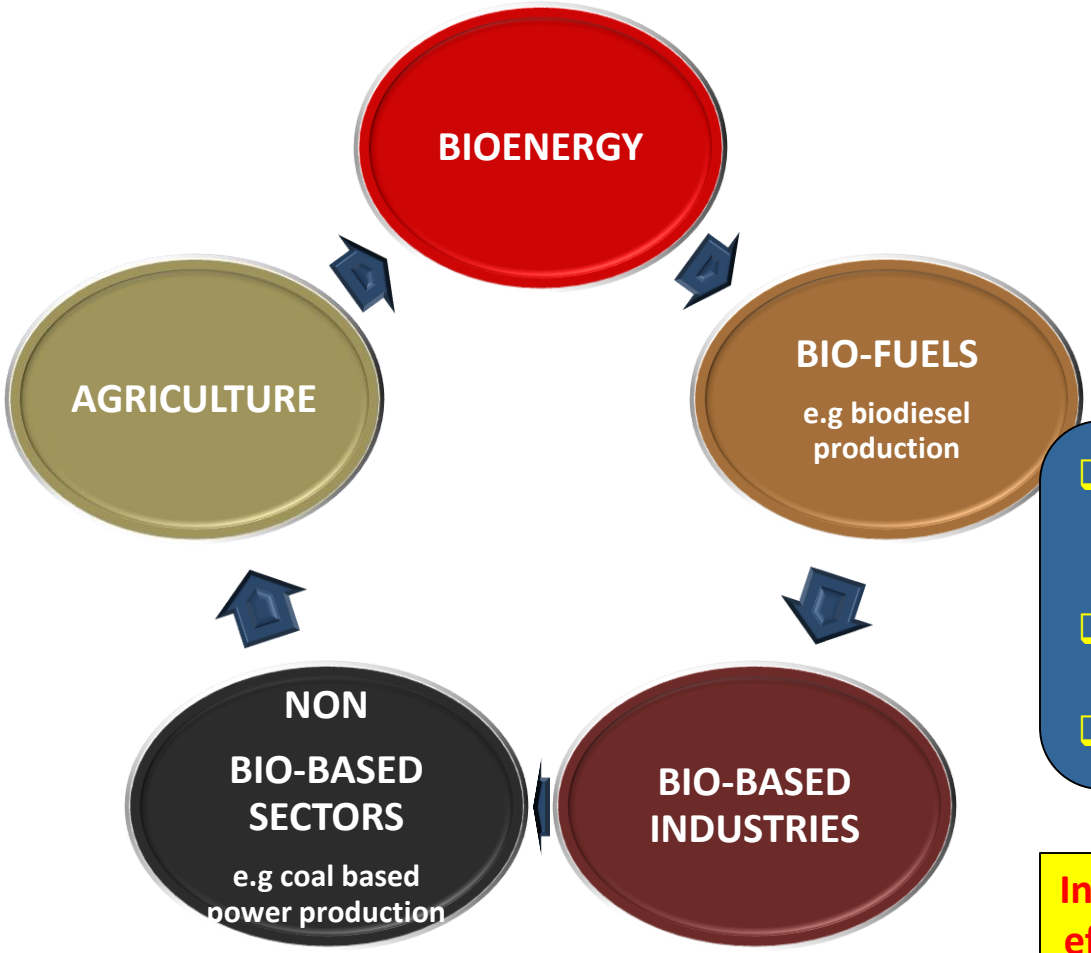
developing **new income streams**,

favouring the **emergence of new sectors,**

adding value to products and boosting jobs.

Towards Circular bioeconomy

Link and integrate with different sectors

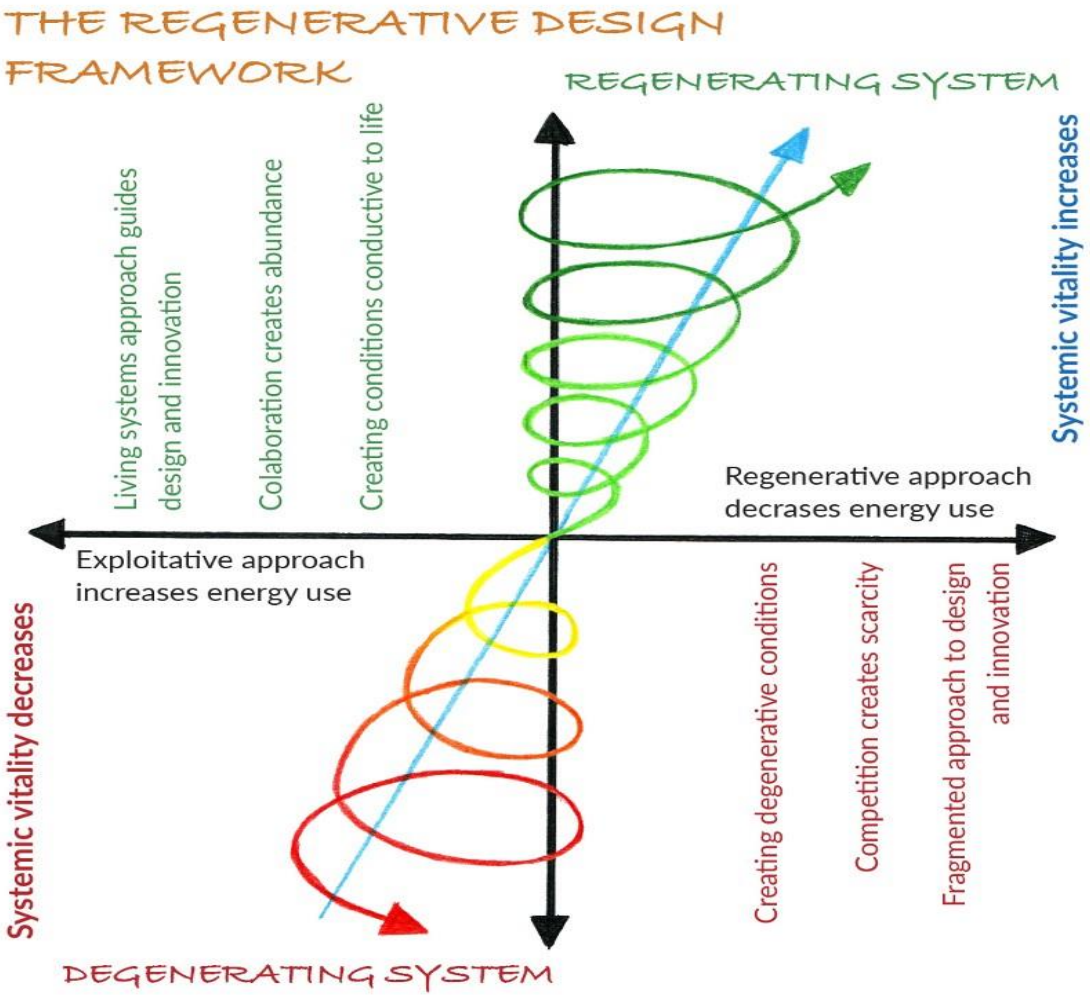


- Symbiotic synergies between industrial partners
- Tailored made solutions
- Energy & material closed loop systems

Increase resource and energy efficiency

Sustainability is not enough; we need regenerative cultures

Regenerative cultures safeguard and grow biocultural abundance for future generations of humanity



Source: Designing Regenerative Cultures, 2016 - www.danielchristianwahl.com; Graphics: www.flaviagargiulo.com

Regenerative
Appropiate participation and deisgn as nature.

Reconciliatory
Reintegrating humans as integral parts of nature.

Restorative
Humans doing thing to nature.

Sustainable
Neutral point of not doing any more damage.

Green
Relative improvements.

Conventional practice
Compliants to avoid legal actions.

Building Circular Bioeconomy

- The first step of that is building up understanding of
  - ecological,
  - economic and
  - social ecosystems

at

the local level,

and integration of all the dimensions of the ecosystem by a mutual holistic view.

Regenerative Biorefineries

Respect the specific characteristics of the territories and resource efficiency

- **integrated biorefineries in local areas**,
- respecting the specific characteristics of the **territories** and in partnership with farmers
- with a **cascade approach** in the use of biomass and in partnership with the various industry players.

Its not simple

Creating regenerative systems is not simply a technical, economic, ecological or social shift:

It has to go hand-in-hand with an underlying shift in the way we think about ourselves,

Our relationships with each other and planet with life as a whole.

Broader view

We need to apply a broad view on **regional development** including the importance of

- natural and
- cultural heritage to
- human health,
- well-being,
- social inclusion and
- local identity.

Regenerative agriculture:

call for a beyond-modern approach, combining the best of traditional agriculture with the finest science

3 circular principles for h

Ασφαλές | https://www.greenbiz.com/article/3-circular-principles-healthy-agriculture

Saturday, February 11, 2017 - 2:00am

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Hunter Lovins

President

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Local Resources Availability

SOUTH

NORTH

Forest Based Bio and Circular Economy

Climate-KIC

The Bioeconomy Strategy of Finland

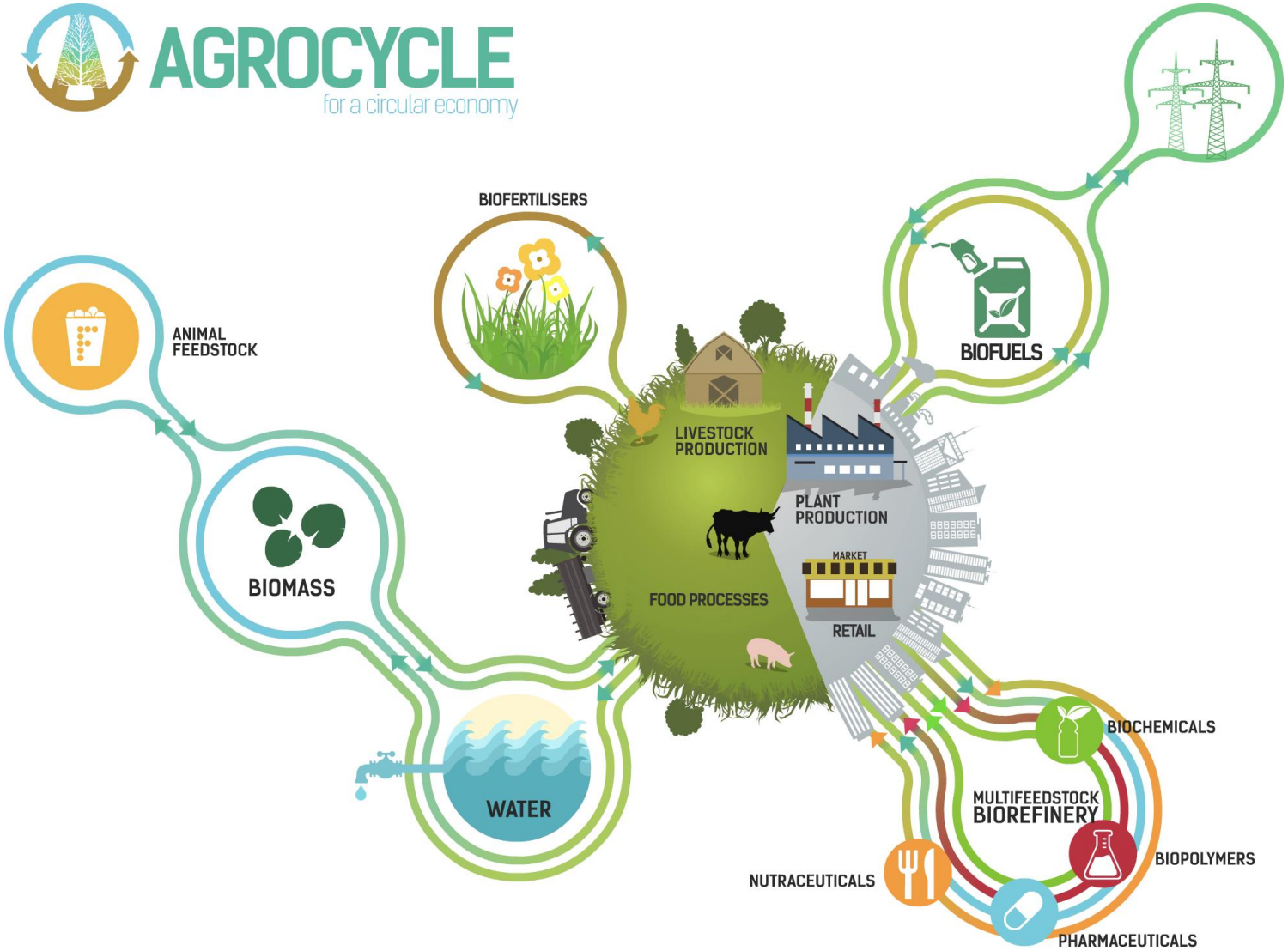
- Finnish Bioeconomy Strategy aims to generate new economic growth and new jobs from an increase in the bioeconomy business and from high added value products and services while securing the operating conditions for the nature's ecosystems.

- Goals of the Finnish Bioeconomy Strategy:
  1. A competitive operating environment for the bioeconomy,
  2. New business to derive from bioeconomy,
  3. A strong bioeconomy competence base,
  4. Accessibility and sustainability of biomasses.

- The objective of the Bioeconomy Strategy is to push the Finnish bioeconomy output up to EUR 100 billion by 2025 and to create 100,000 new jobs

Linnu

Agro-industrial residues based Circular bioeconomy



Nutrient recycling

A national resource efficiency programme should be prepared.

- **Business opportunities** created by the need to restore and close material cycles should be promoted.
- Their **effectiveness should then be tested in practice**.

Local biorefinery activities should be created as regional networks

- **Biorefineries**
- The establishment of biorefineries that process organic materials to produce energy and new raw materials should be promoted.
- Technologies and business models should be developed to promote the utilisation of **diverse local biomaterials through regional networks.**
- Models for the development of **logistics chains** for biomaterial procurement and new purification techniques should be created and tested.

Product-centred resource efficiency

- A **network of expertise** on product-centred environmental management should be set up to bring together expertise in this field.
- systems. Resource *efficiency thinking* should be integrated into public sector purchasing policies.
- Product labelling systems based on material flows and life cycle analyses should be created and adopted for application in evaluating both material and energy solutions.

Restoring and closing cycles

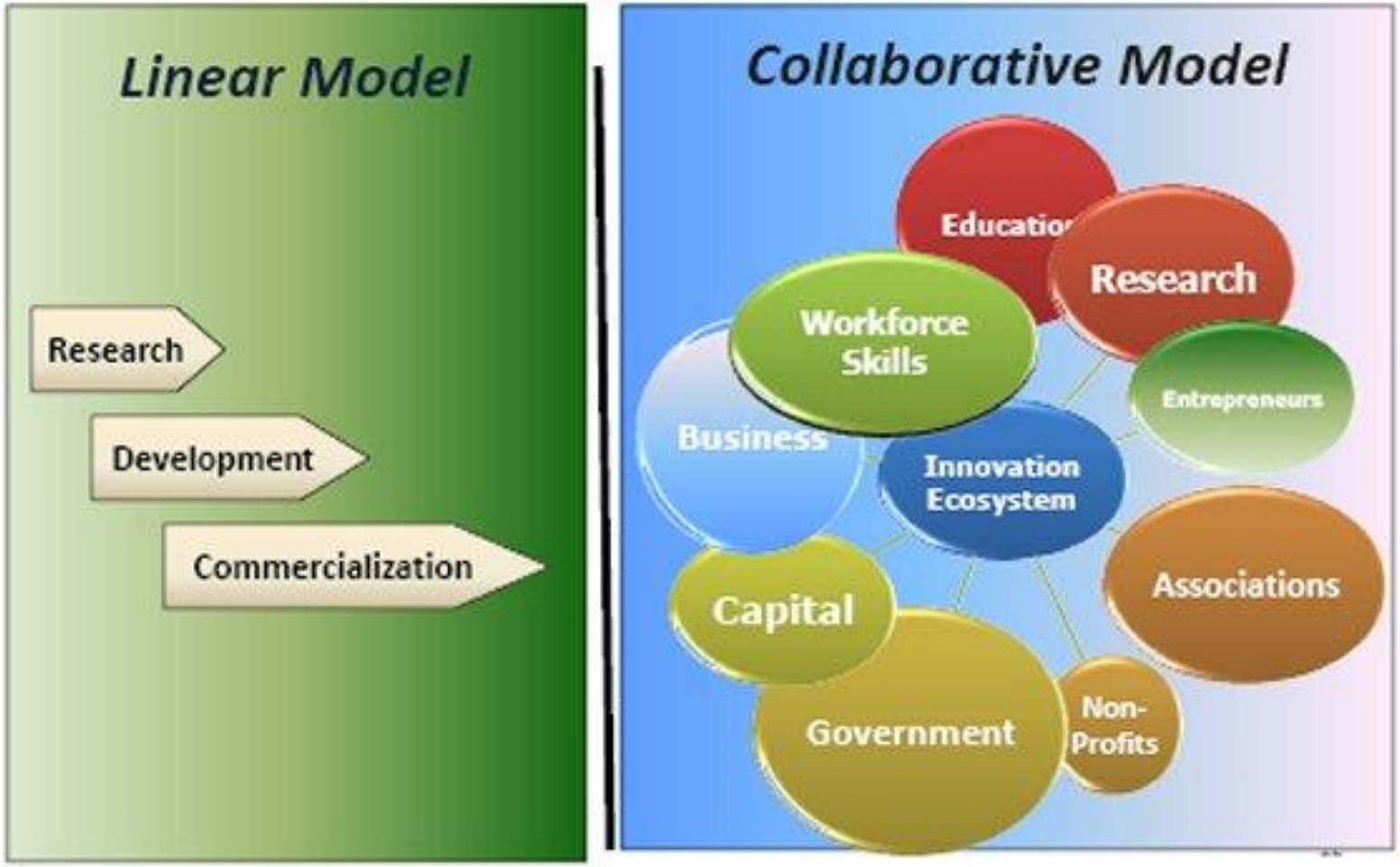
The utilisation of **side streams** in production systems as raw materials and sources of energy should be promoted.

Measures to close local cycles of materials such as **biochar** and ash, or **restore such materials to wider nutrient cycles**, should be promoted.

Business opportunities created by the need to restore and close material cycles should be promoted.

Multidisciplinary networks for forecasting natural resource issues should be developed

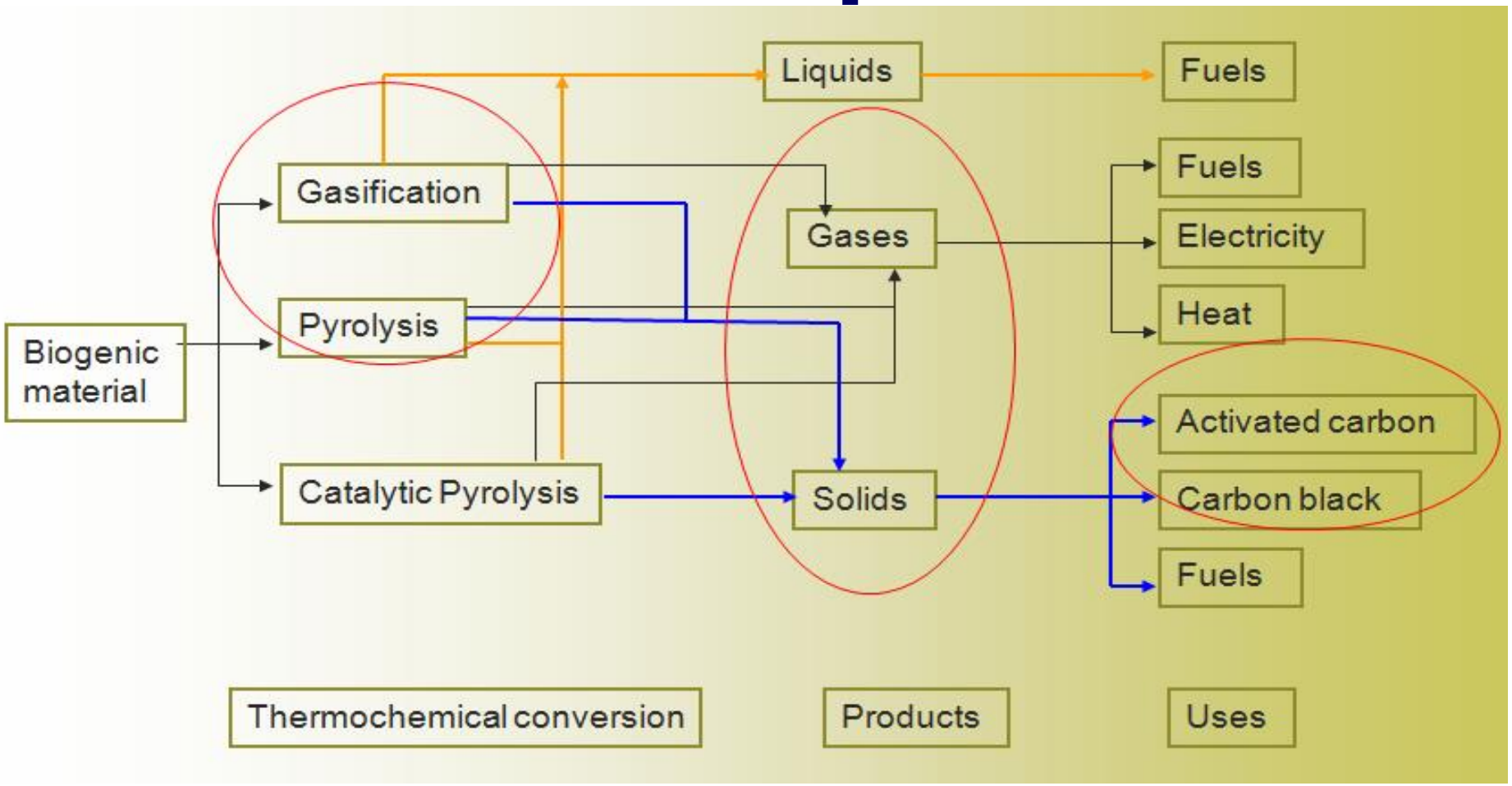
Towards a collaborative Model



TECHNOLOGICAL PATHWAYS

The thermochemical pathway in Circular Bioeconomy

Thermochemical platforms



The thermochemical platform involves breaking down biomass into its elemental components by using heat and chemical synthesis.

It include pyrolysis and gasification, followed by a chemical synthesis process.

The most prevalent emerging technology is gasification, followed by catalytic conversion of the synthesis gas to ethanol or other high-value products.

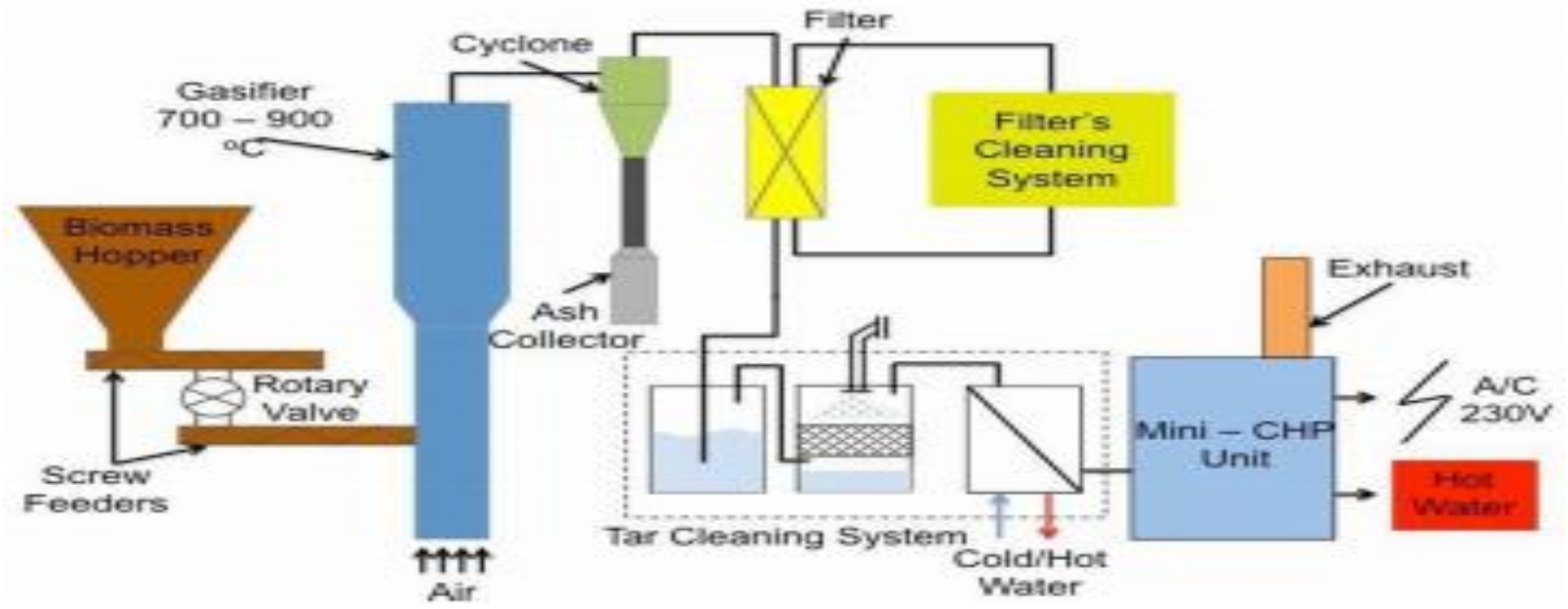
The gasification pathway

the biomass is first thermally fragmented to synthesis gas consisting of rather simple molecules such as: hydrogen, carbon monoxide, carbon dioxide, water, methane, etc.

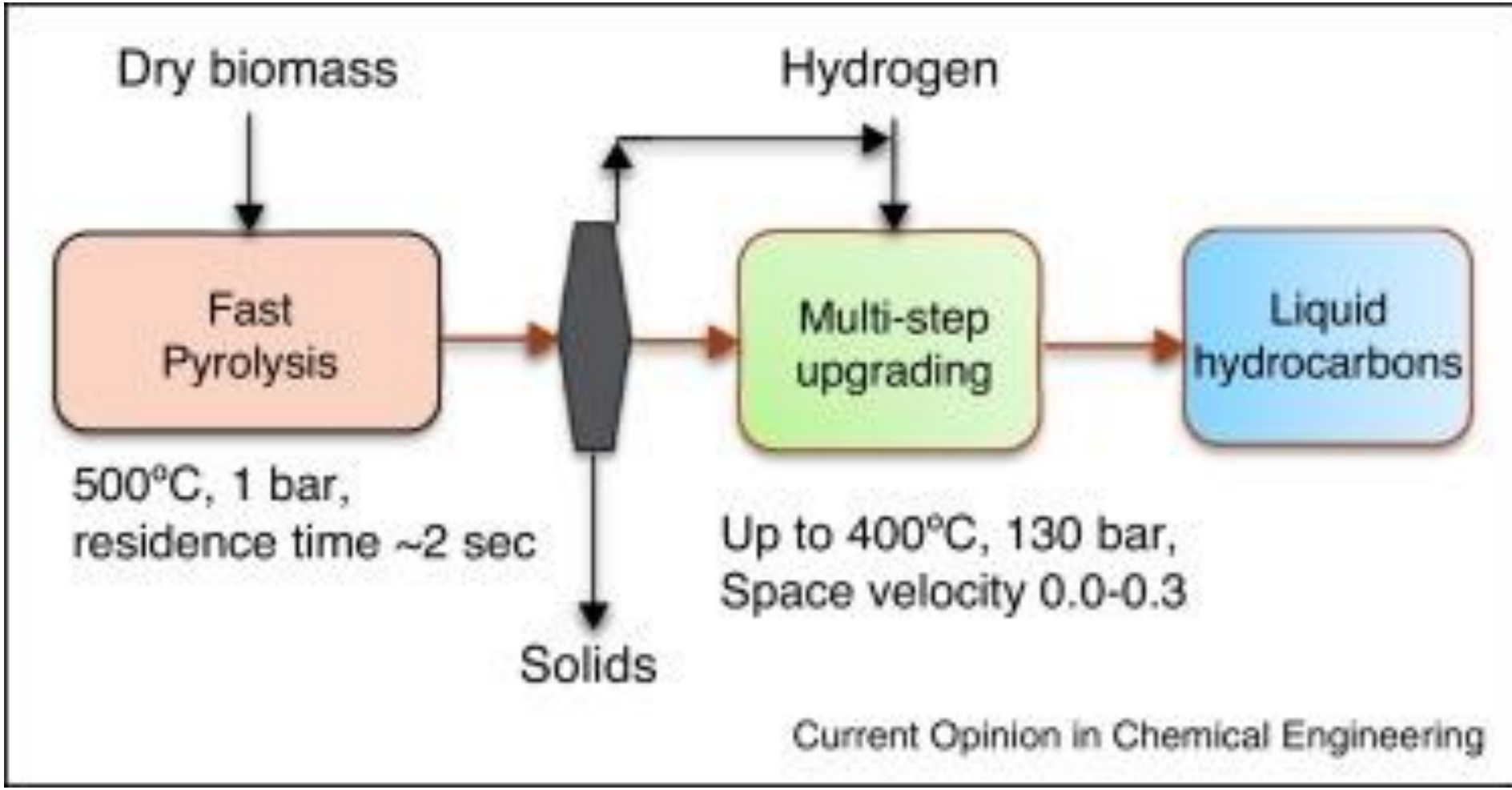
These gaseous material are then chemically re-synthesized to biofuels.

- ✓ The Fischer-Tropsch process for production of diesel from biomass
- ✓ Methanation to obtain bio-SNG as a substitute for natural gas
- ✓ Synthesis into mixed alcohols
- ✓ Production of BioDME

CHP


Filter
Cyclone
Gasifier
700 – 900
°C
Filter's
Cleaning
System
Biomass
Hopper
Exhaust
Ash
Collector
Rotary
Valve
A/C
230V
Mini – CHP
Unit
Screw
Feeders
Hot
Water
Tar Cleaning System
Cold/Hot
Water
Air

The pyrolysis pathway



Biochar-closing the loop

- Efforts to compost carbon-based flows so that the nutrients can be returned to the soil are important.
- Using **pyrolysis**, any organic material can be heated at low temperatures with little oxygen until it is carbonized.

ELSEVIER

Environmental Development

Volume 14, April 2015, Pages 22–36

Boosting circular economy and closing the loop in agriculture: Case study of a small-scale pyrolysis–biochar based system integrated in an olive farm in symbiosis with an olive mill

A. Zabaniotou[a, b], D. Rovas[a], A. Libutti[b], M. Monteleone[b]

Show more

https://doi.org/10.1016/j.envdev.2014.12.002

SMALL SCALE

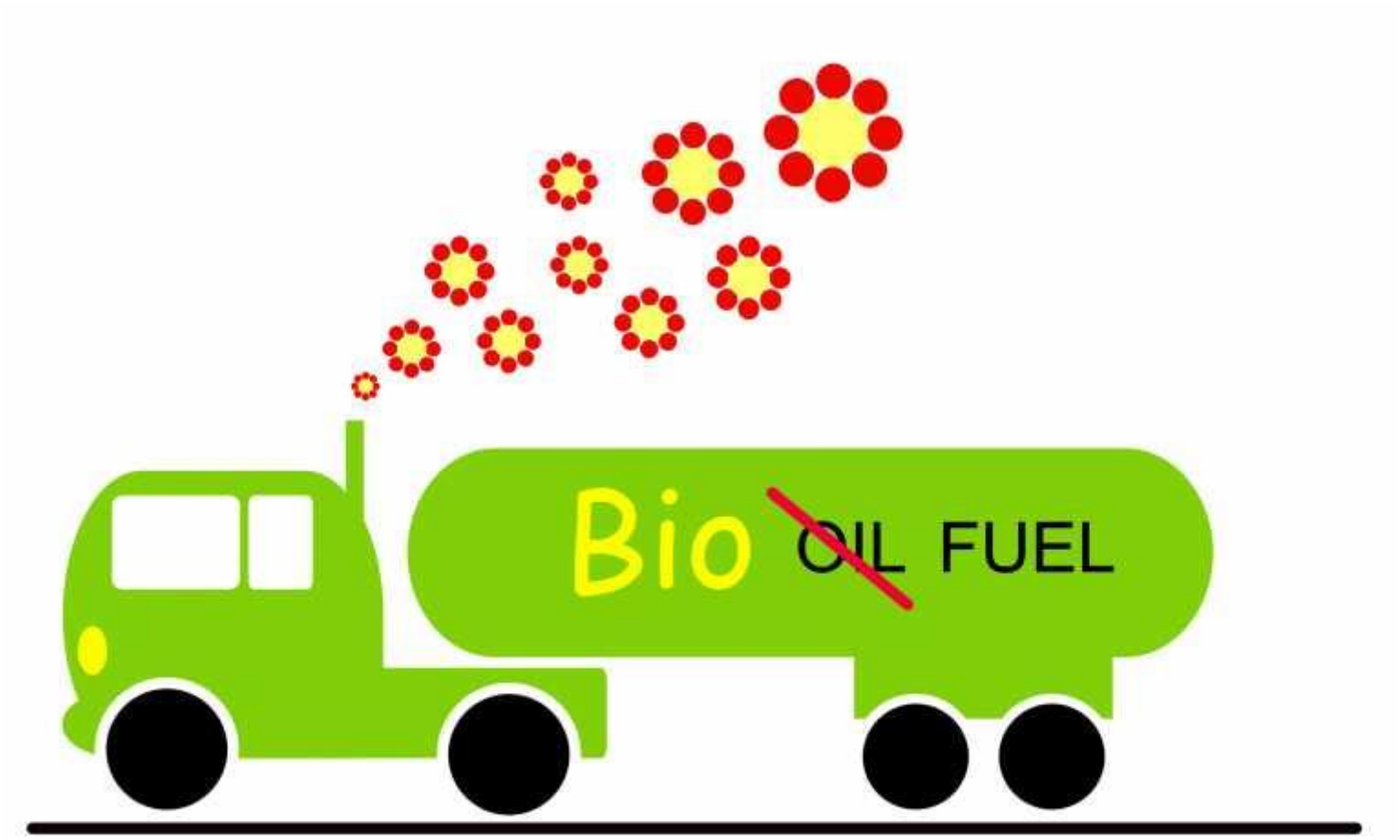
Thermochemical for CHP

Agro-industrial sector

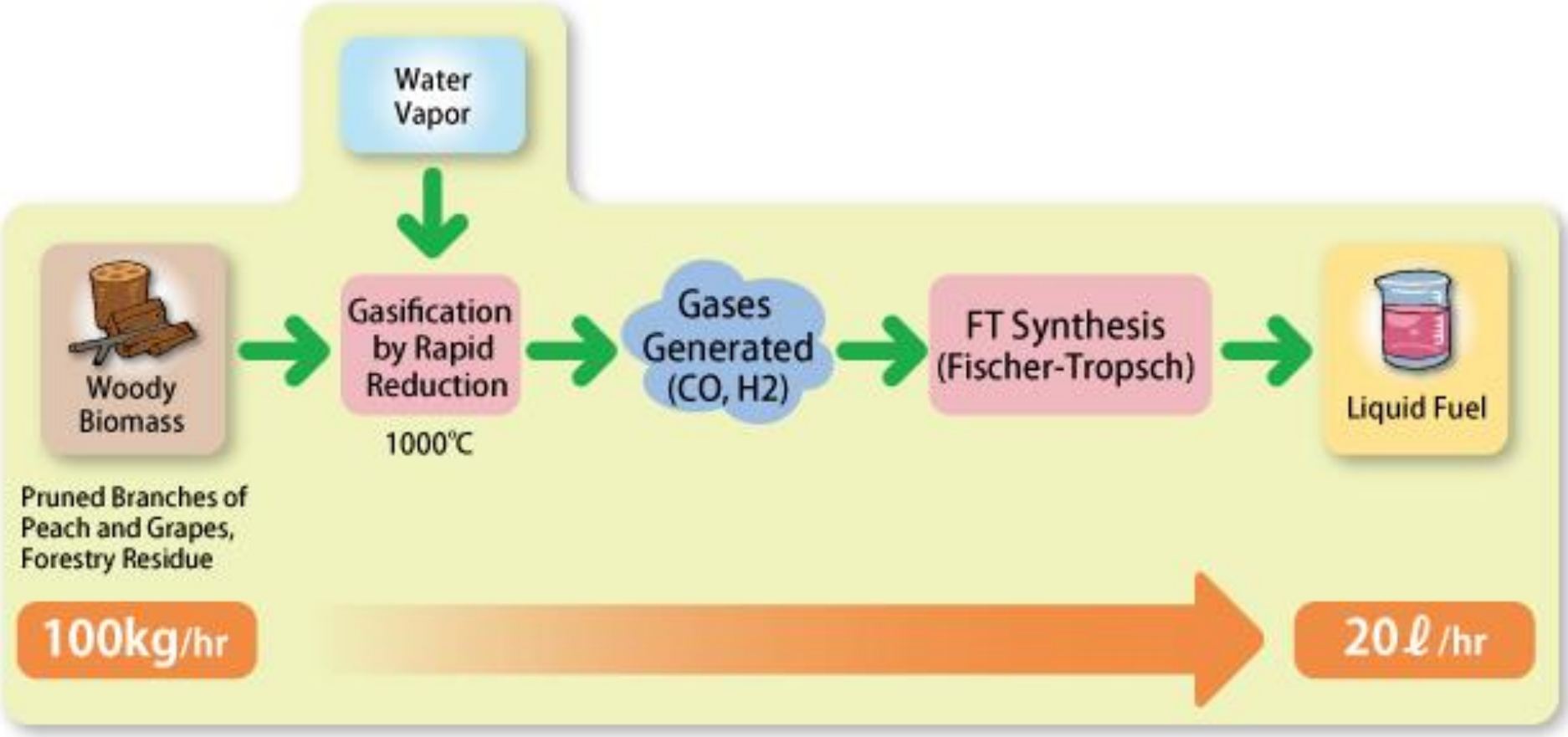
Mobile Pyrolysis in Utah

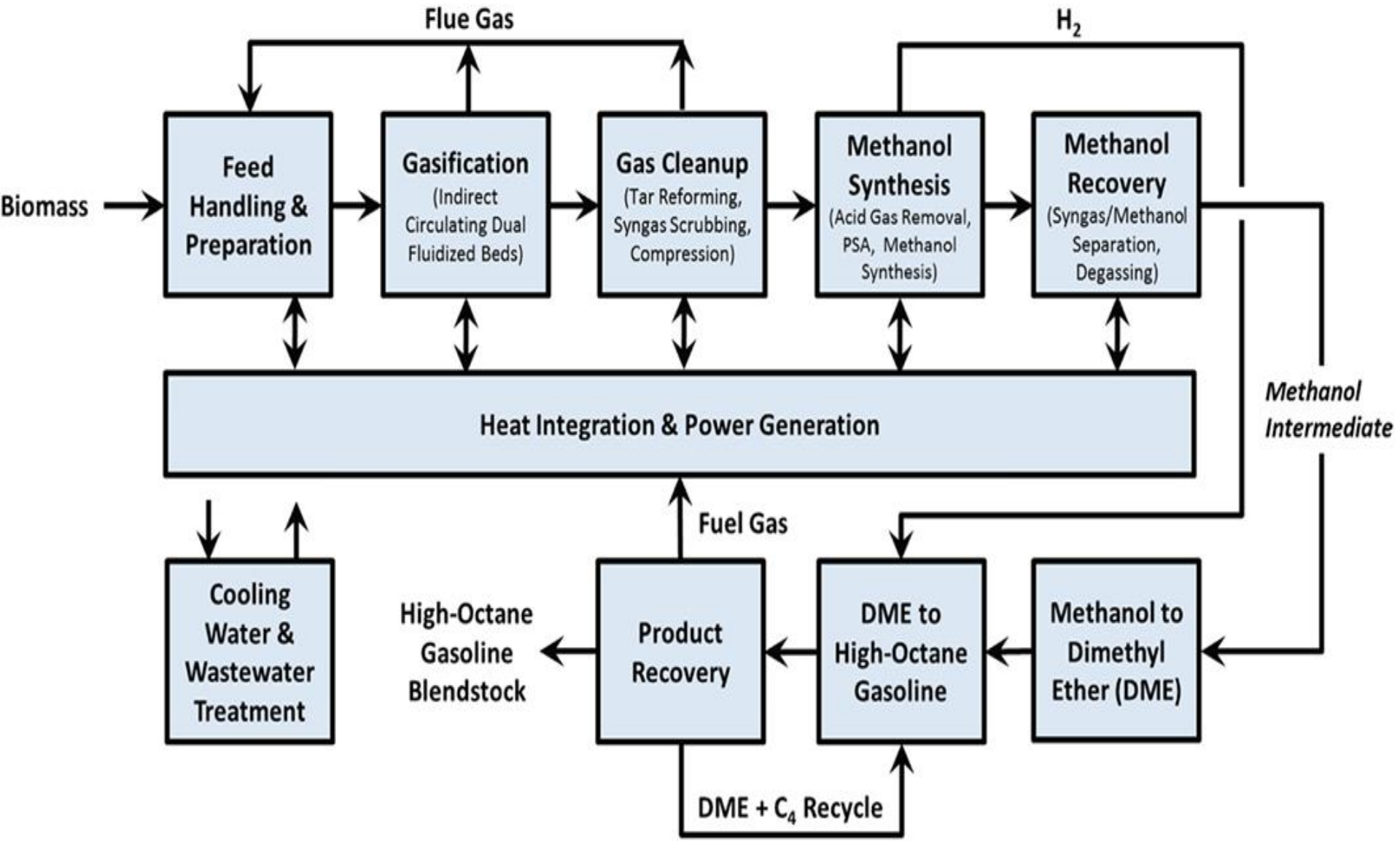
LARGE SCALE

Thermochemical for transport biofuels



BTL


Water Vapor
Woody Biomass
Pruned Branches of Peach and Grapes, Forestry Residue
Gasification by Rapid Reduction
1000℃
Gases Generated (CO, H2)
FT Synthesis (Fischer-Tropsch)
Liquid Fuel
100kg/hr
20ℓ/hr



Conceptual process design and economics for the production of high-octane gasoline blendstock via indirect liquefaction of biomass through methanol/dimethyl ether intermediates

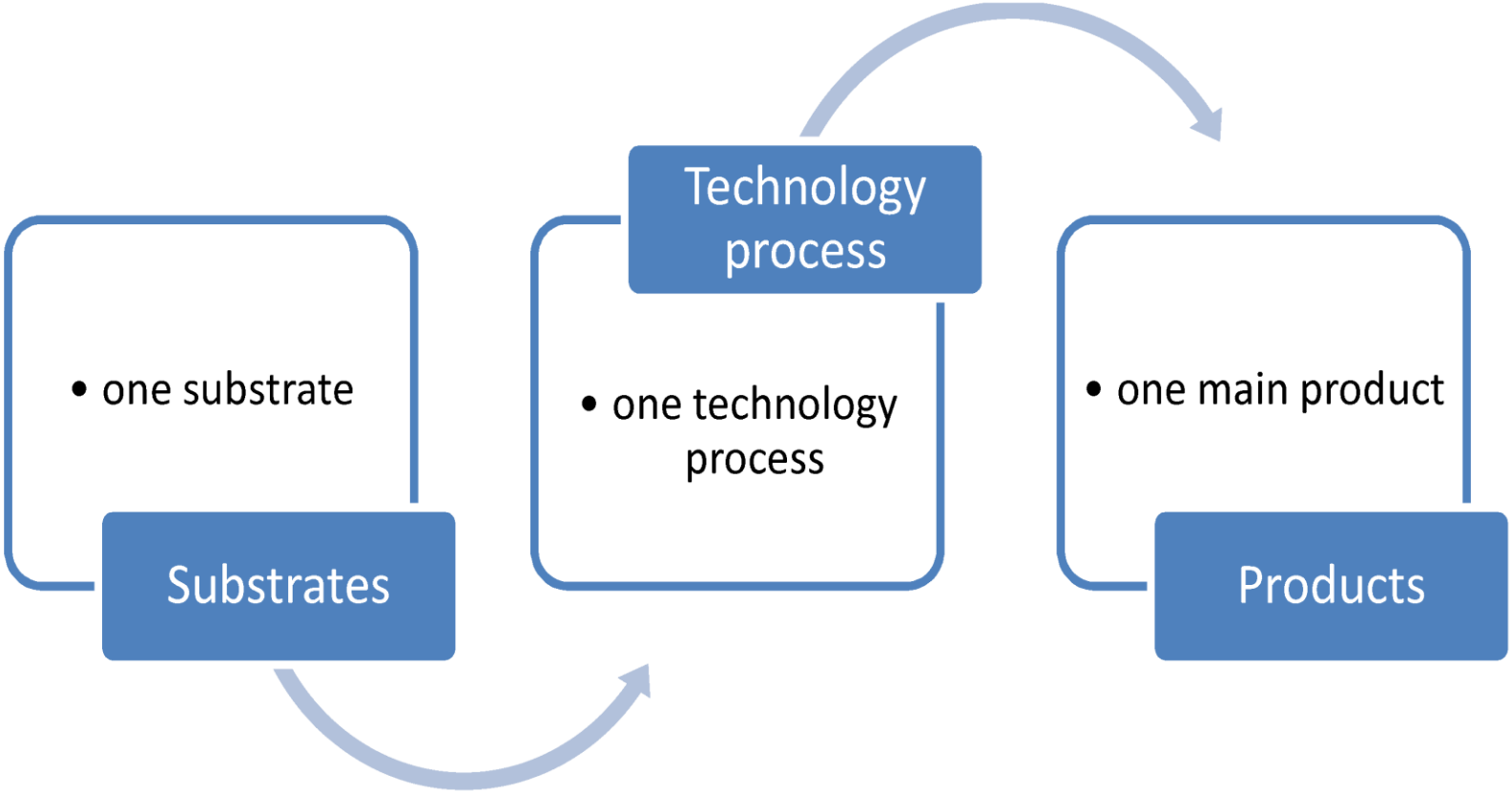
Authors Eric CD Tan, Michael Talmadge, Abhijit Dutta, Jesse Hensley, Lesley J. Snowden-Swan, David Humbird, Joshua Schaidle, Mary Biddy

PRESS RELEASES
Europe's love affair with biofuels is on the rocks

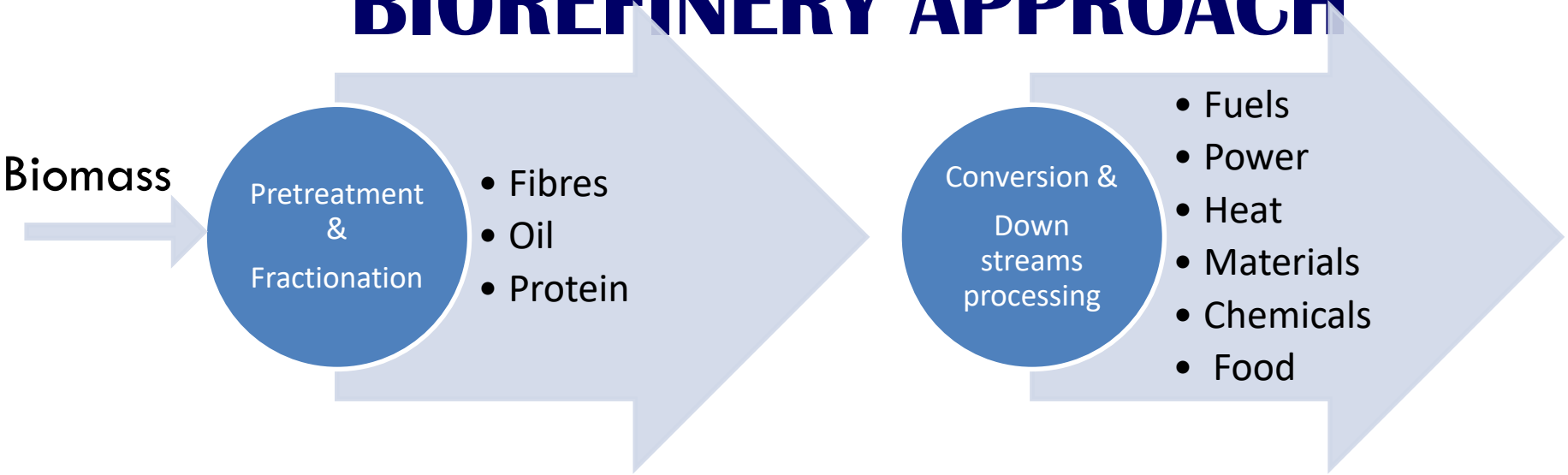
Published on April 6, 2017 [William Todts]

But because there were no adequate quality controls, the market was flooded with biofuels that are worse for the climate than fossil fuels.
For example, crop biodiesel – which makes up 80% of the market – is, on average, 80% worse for the climate than fossil diesel and is increasingly sourced from palm oil.

FROM A MONO PROCESS...



Multi processes-multi products
CASCADE
BIOREFINERY APPROACH



Thermochemical biorefineries with multiproduction using a platform chemical

Multiproduction is a promising option for thermochemical biorefineries in order to reduce the **risk of investment**.

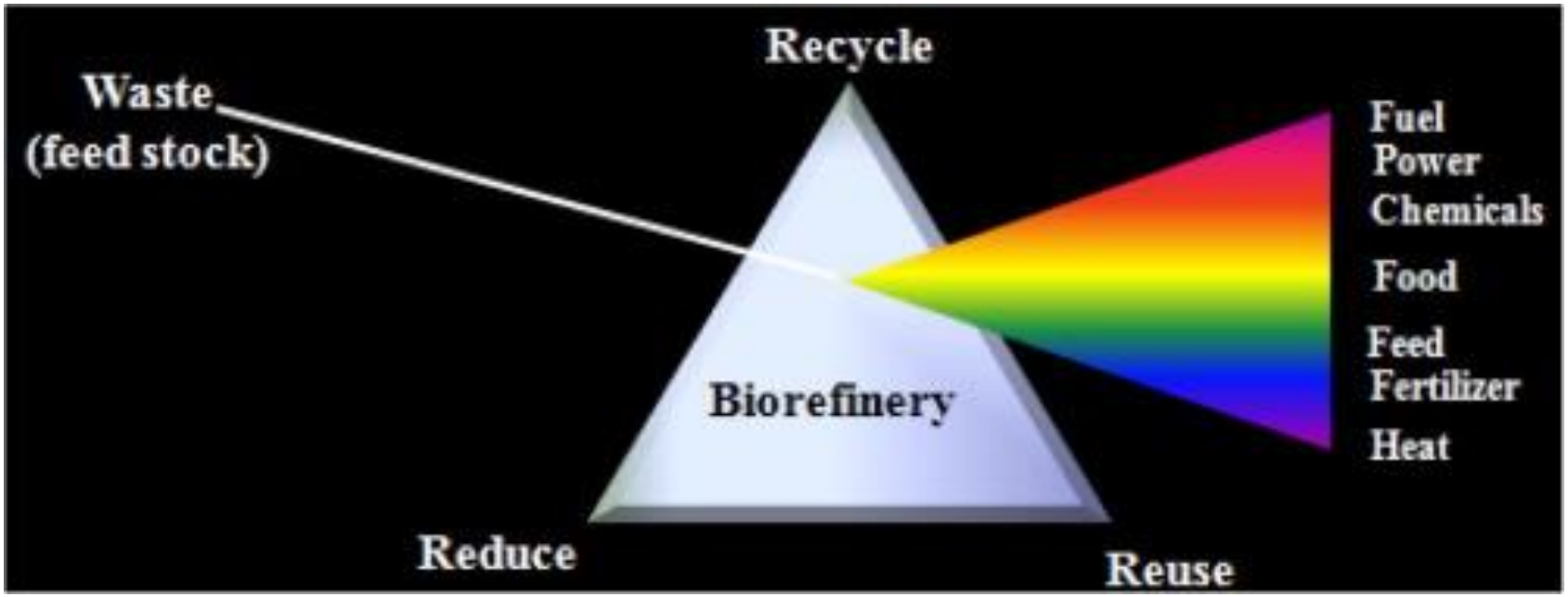
It promotes the diversification of revenue, allows a better material and energy integration, and **enhances profitability**

In the case of sustainability, it is necessary to know how to allocate the **greenhouse gas (GHG) emissions of each product (including electricity)**.

The incorporation of **bioenergy** with carbon capture and storage is assessed as a potential income

platform chemical: are able to co-produce low-value high-volume products like fuels along with high-value low-volume products like solvents and chemicals, which have been demonstrated by conventional oil refineries to be highly profitable

Waste biorefinery models

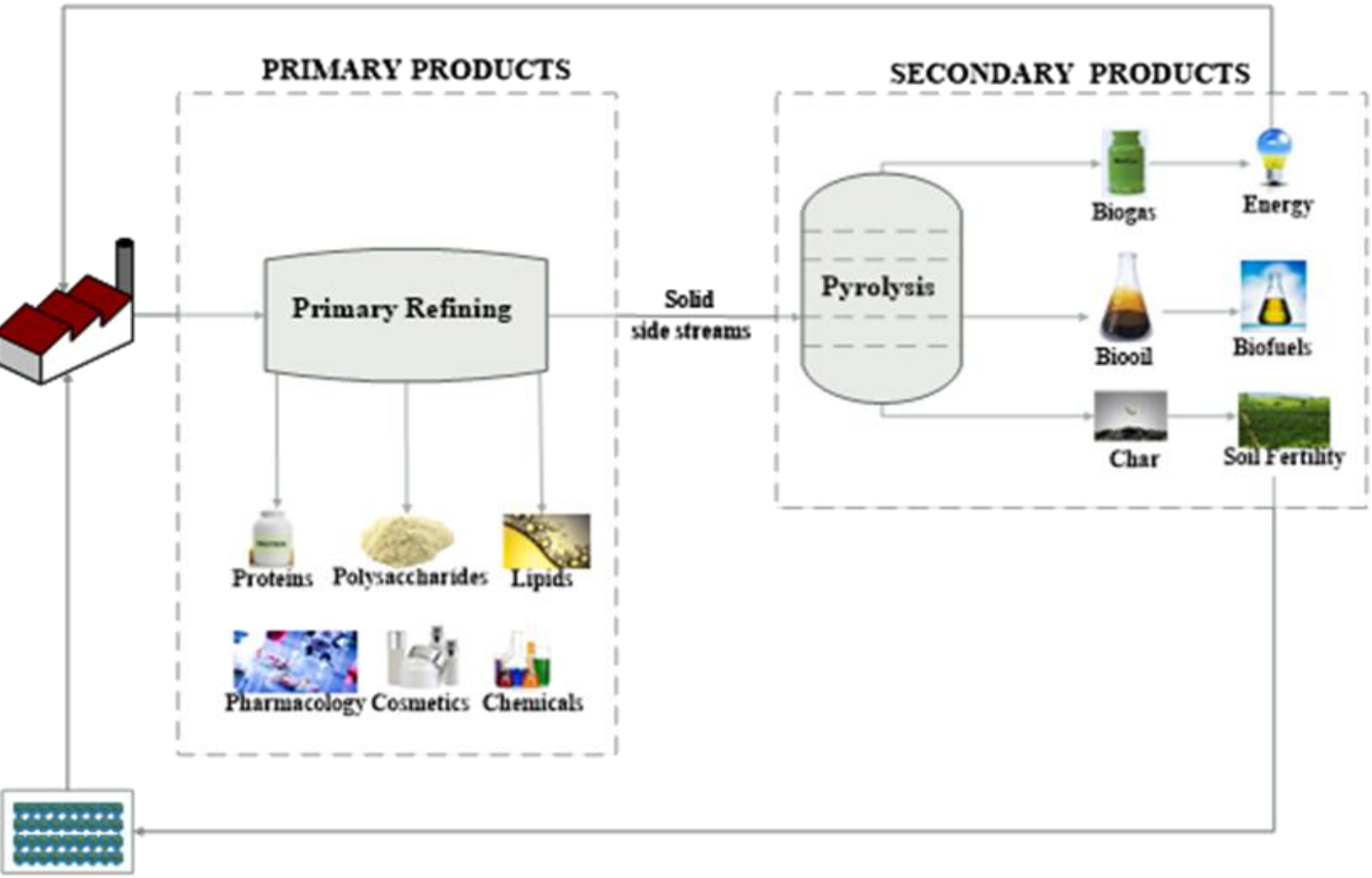


Cascade Biorefinery

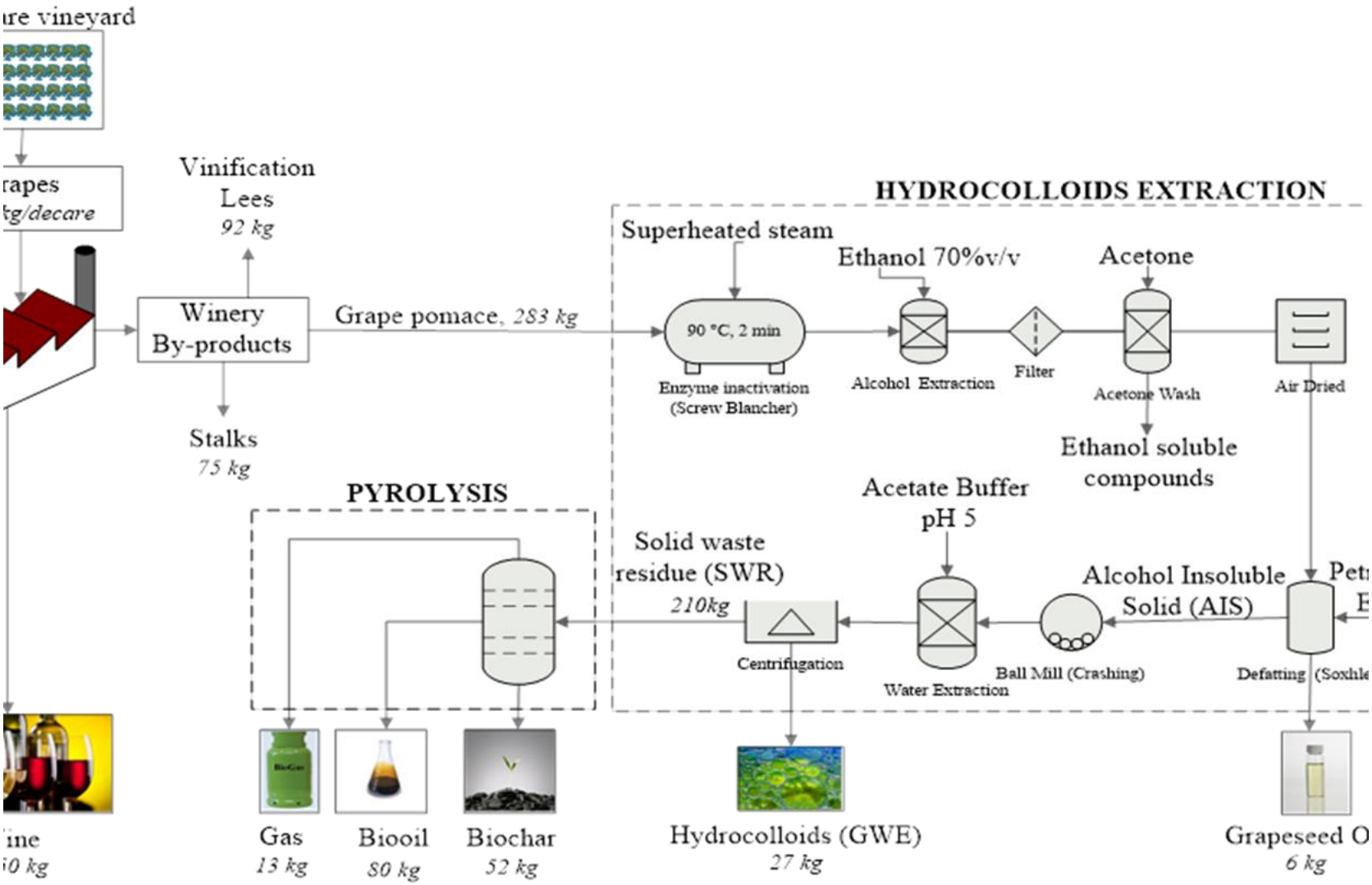
This principle is called cascading.

- Various components in biomass can be isolated using biorefining technologies, such as pretreatment, fractionation and separation techniques.
- In this way cascading and biorefinery concepts allow to increase the economic value of biomass.

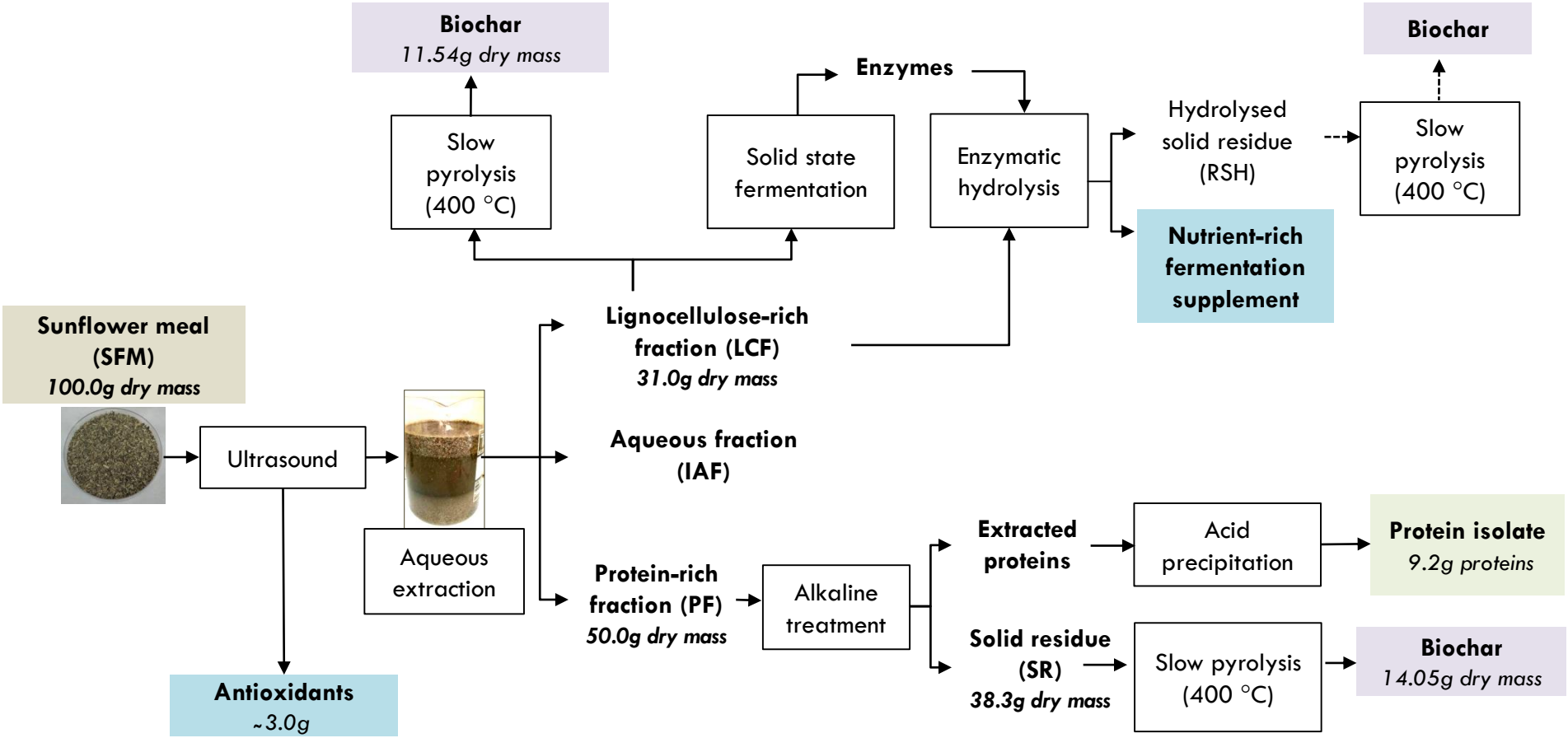
CASCADE BIOREFINERY



Winery cascade biorefinery



Sunflower meal biorefinery
Biochar production



ENVIRONMENTAL, SOCIAL & ECONOMIC METRICS AND LCA

Our Mediterranean

The manifesto of Messogiorno

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Journal of Cleaner Production

Available online 5 May 2017

In Press, Corrected Proof — Note to users

Targeting sustainable bioeconomy: A new development strategy for Southern European countries. The Manifesto of the European Mezzogiorno

Emmanuel Koukios[a], (Director), Massimo Monteleone[b], (Coordinator), Manuel Jose Texeira Carrondo[c], (Vice President), Anthi Charalambous[d], (Director), Francisco Girio[e], (Head), Eva López Hernández[f], (Project Manager), Sofia Mannelli[g], (President), Juan Carlos Parajó[h], (Professor), Polycarpos Polycarpou[i], (Chief Agricultural Research Officer), Anastasia Zabaniotou[j], (Professor)

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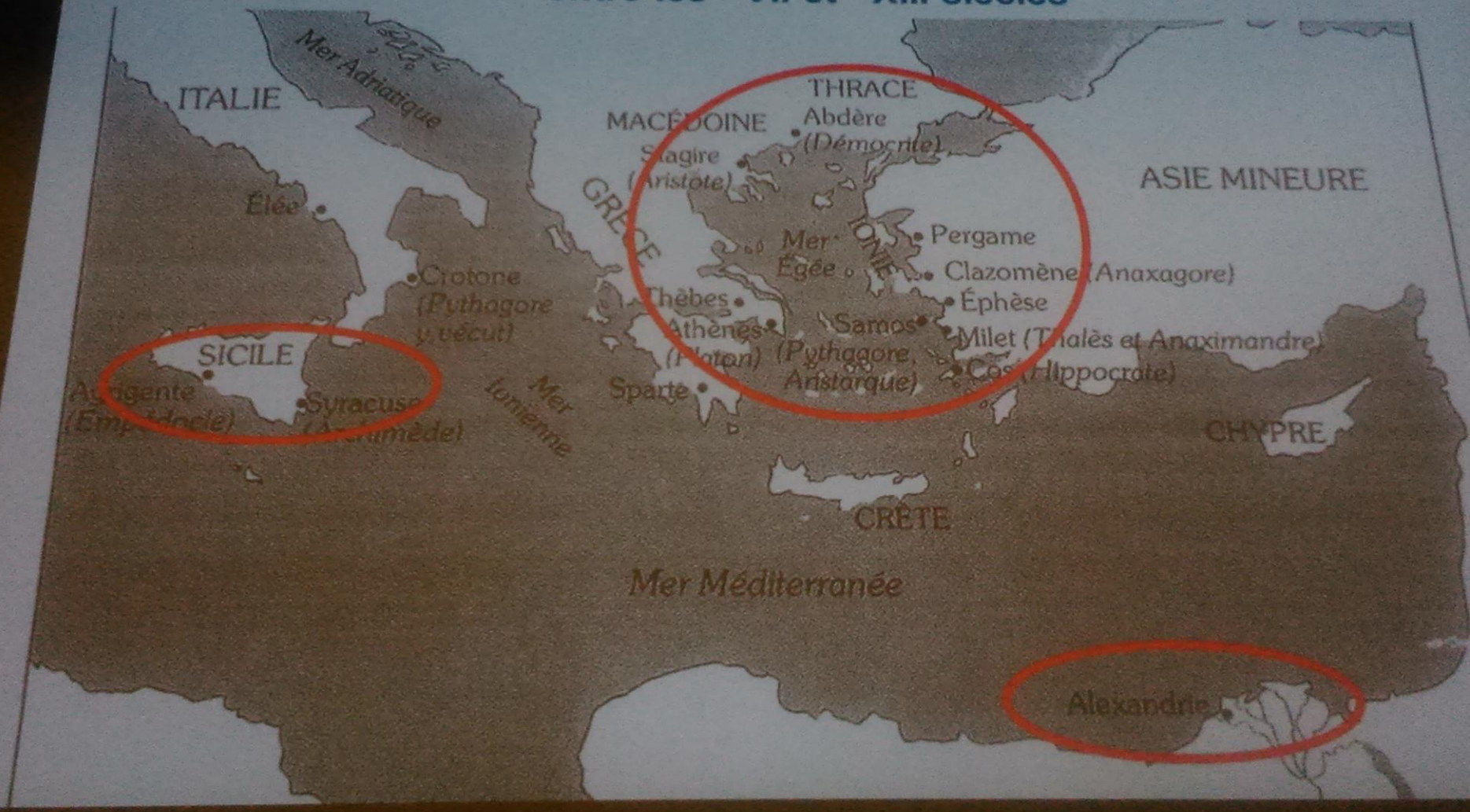
[j] Department of Chemical Engineering, Aristotle University of Thessaloniki, Greece

Received 13 August 2016, Revised 5 April 2017, Accepted 5 May 2017, Available online 5 May 2017

La science a commencé sur les bords de la Méditerranée, les débuts de la physique - de l'Ionnie à Alexandrie, et a été transmise à l'Europe et développée par le monde arabo-musulman entre les ~VII et ~XIII siècles

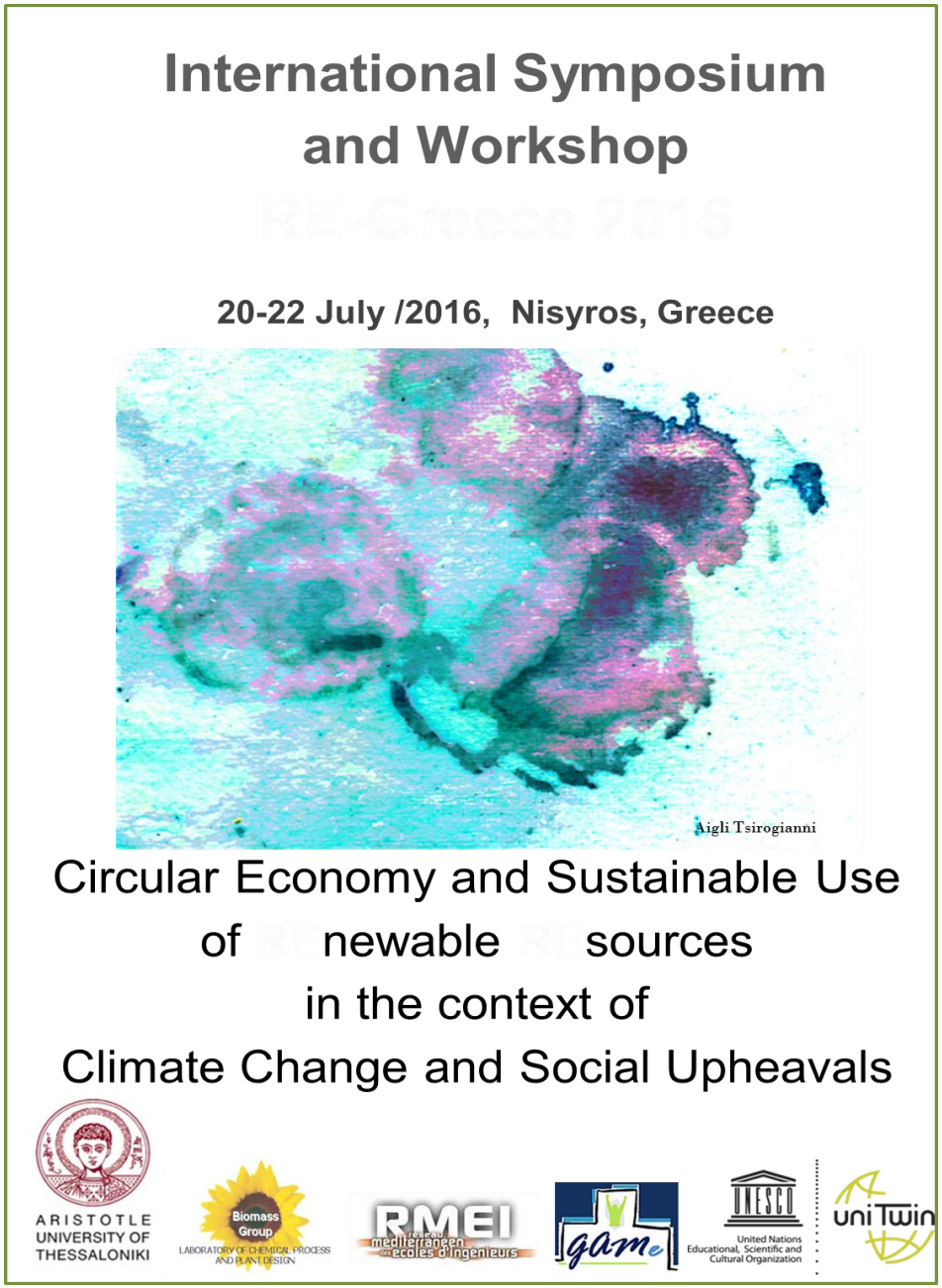


Conclusion

support sustainable management and usage of natural renewable resources, based upon **ethical, ecological, sustainable practices** at the local, European and Global scales.

accelerating the transition to Equitable, Sustainable, Circular Bioeconomy

Intercultural, multidisciplinary and systemic approaches are essential with WISDOM



Thank you!!

azampani@gmail.com