Sustainable Landscape Management for Bioenergy within the Bioeconomy

IEA Bioenergy Task 43

Biljana Kulišić, National Task Leader for Croatia
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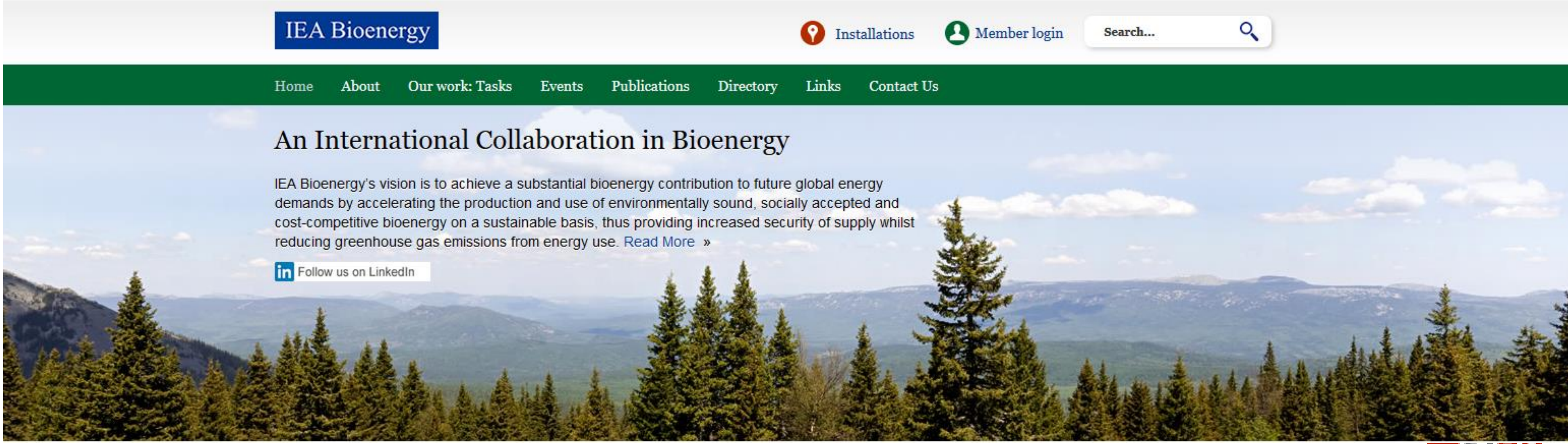
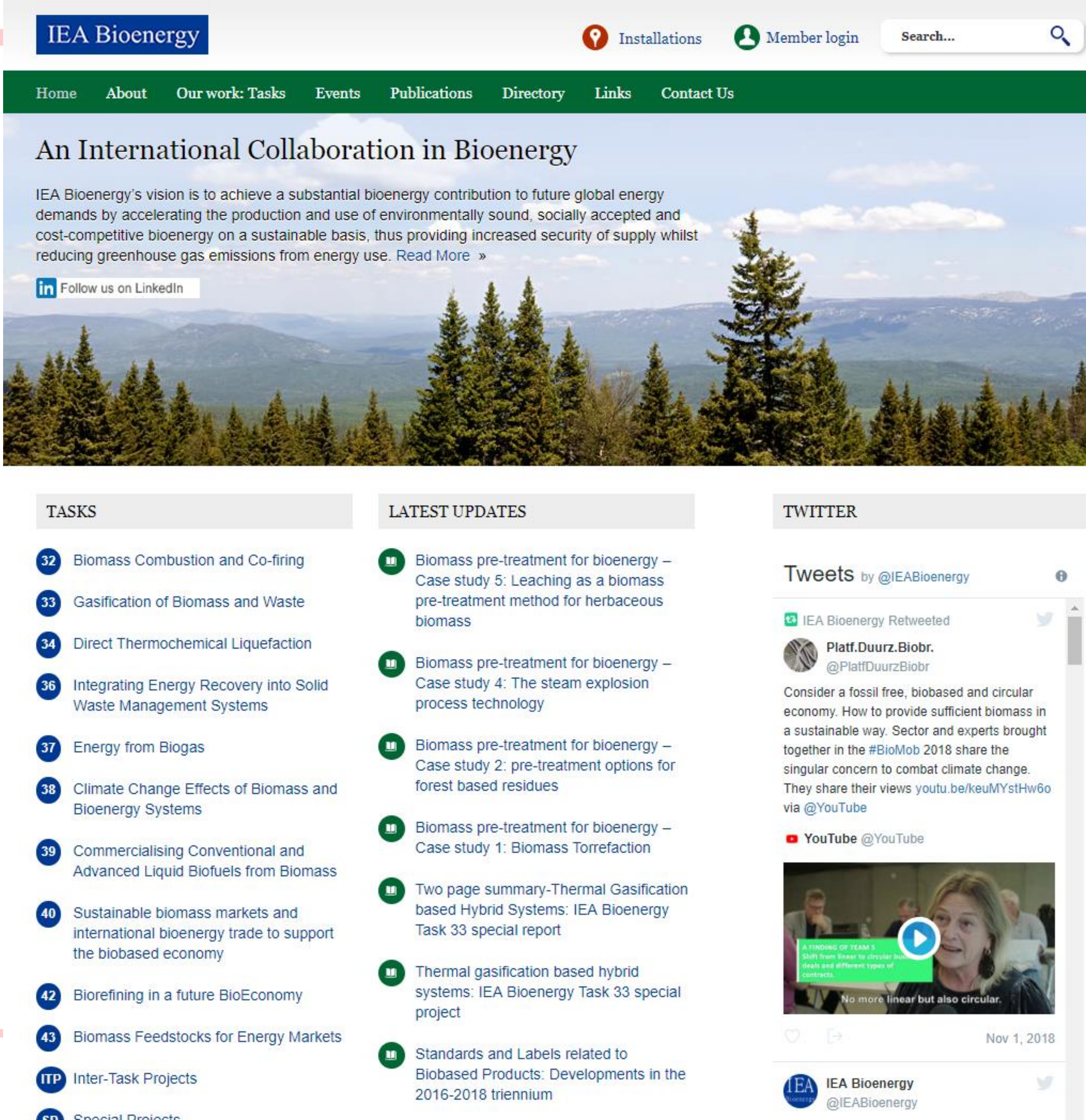
IEA Bioenergy (est-1978, by the International Energy Agency) with the aim of…

… improving cooperation and information exchange between countries that have national programmes in bioenergy research, development and deployment.



The work is set up by trienniums and divided into Tasks.

Deliverables published at websites.



IEA Bioenergy

Bio-CCS and Bio-CCU

Climate change mitigation and extended use of biomass raw material

Summary Series

IEA Bioenergy: Task 41: 05 2018

Authors: Kristin Onarheim and Antti Arasto, VTT Technical Research Centre of Finland

What is Bio-CCS?

The term Bio-CCS describes concepts that combine biomass use with carbon capture and permanent underground storage (CCS). As opposed to fossil CCS, which at best only decreases the amount of CO_2 entering the atmosphere, Bio-CCS has the potential to provide net removal of CO_2 from the atmosphere. By binding atmospheric carbon during growth of biomass and subsequently capturing CO_2 from the biomass conversion process for permanent storage in geological formations, carbon is extracted from the carbon cycle, while at the same time avoiding fossil energy use (and associated CO_2 emissions). In order for Bio-CCS to provide net negative emissions, it is essential that the biomass production and use is sustainable. Bio-CCS can thus remove historic CO_2 emissions from the atmosphere and offset CO_2 emissions from sectors more challenging to decarbonize.

What is carbon capture and utilization (CCU)?

Carbon Capture and Utilization refers to the use of pure CO_2 or CO_2-containing gas mixtures as a feedstock to produce fuels, chemicals and materials. When fuels, chemicals and materials are produced using low-carbon energy sources, these products could displace their fossil counterparts and thus reduce net carbon emissions to the atmosphere.

The CO_2 molecule has little energy potential and the conversion of CO_2 into fuels or chemicals is highly energy-intensive. Consequently, the effectiveness of the CCU system as a climate mitigation option depends strongly on two conditions:

- Whether the energy input for CO_2 conversion originates from low-carbon or fossil sources;
- Whether the CO_2 utilized as feedstock comes from a fossil or atmospheric source.

In traditional, fossil resource based processes, carbon and energy originate from the same (fossil) source. CCU enables different inputs for energy (e.g. electricity) and carbon (CO_2). Here, carbon originating from the atmosphere (mixture of biogenic and fossil), captured either through direct air capture or from conversion of sustainable biomass, is defined as atmospheric carbon.

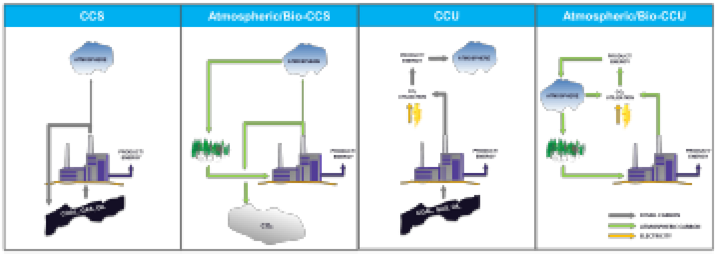


Figure 1 Conceptual comparison of carbon flows in fossil and biomass based CCU and CCS.

CCS, CCU and climate impact

Bio-CCS can provide permanent removal of CO_2 from the atmosphere. Bio-CCU, on the other hand, can be climate neutral at best, because the carbon is released at the end of the product life. For CCU to be able to offer very low emission solutions as a climate mitigation measure there are two essential requirements:

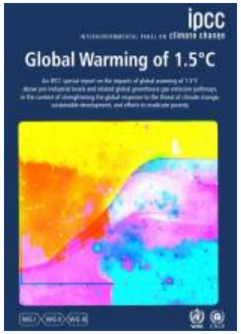
- Low-carbon/carbon neutral energy input for CO_2 conversion
- Carbon/CO_2 used as feedstock needs to be atmospheric

Unless these two prerequisites are met, fossil CO_2 will eventually reach the atmosphere, either from fossil energy for the conversion of CO_2 to products or when releasing fossil CO_2 contained in the CCU product at the end of its lifetime. In order to have a substantial direct climate impact, the delay in emission of CO_2 should be at least in the magnitude of centuries (>100 years). The climate impact mechanism of most CCU concepts is systemic in nature, and depends on the carbon intensity of the energy input to the concept. From a systemic perspective, CCU only has a positive climate impact if it enables a higher amount of low carbon input (solar, wind, etc.) to the energy system compared to an energy system without CCU. The challenge with CCU as a climate mitigation measure is the low cyclic efficiency, making use of electricity less efficient than with direct electrification. From a climate perspective, the most important applications of Bio-CCS and Bio-CCU identified in this project are:

- Indirect electrification of sectors otherwise difficult to decarbonize (when the electricity sector on average already has a low carbon intensity).
- Boosting the output of biomass based processes, such as gasification, fermentation or anaerobic digestion with renewable electricity (sustainable resources are a limiting factor with current global biomass use, and boosting the conversion would in theory double or triple the amount of bio-product per unit resource).
- Applications where high concentration CO_2 is captured and stored simultaneously with product generation (energy, hydrocarbon, material etc.).

Between May 2016 and January 2018 a Special Project of IEA Bioenergy organized four specific workshops concentrated on various aspects around Bio-CCS and Bio-CCU. Workshop summaries are available at: http://task41project5.ieabioenergy.com/iea-publications/

Climate changes and 1,5°C goal



22 Mha energy crops

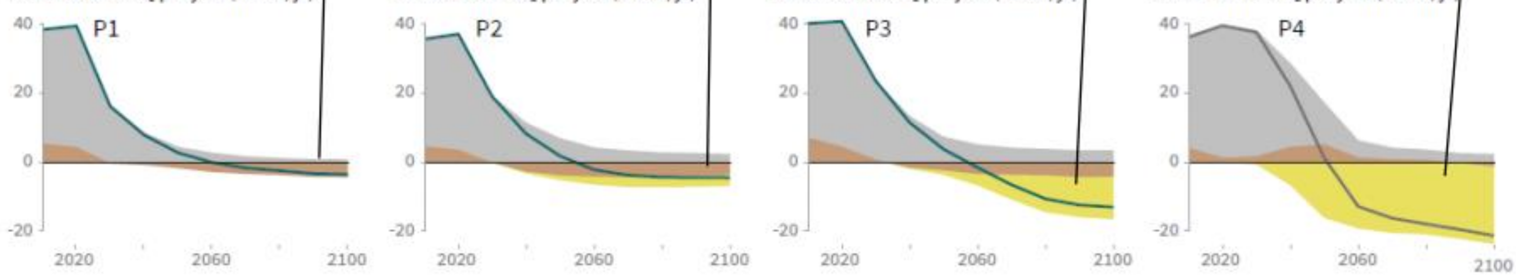
93 Mha energy crops

283 Mha energy crops

724 Mha energy crops

Breakdown of contributions to global net CO_2 emissions in four illustrative model pathways

Fossil fuel and industry · AFOLU · BECCS



P1: A scenario in which social, business, and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A down-sized energy system enables rapid decarbonisation of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

AFOLU: agriculture, forestry and other land use
BECCS: Bioenergy with carbon capture and storage

IPCC (2018.): IPCC Special report on global warming
Source:: http://www.ipcc.ch/report/sr15/

Biomass must be planted to halt the temperature increase below 1,5°C !

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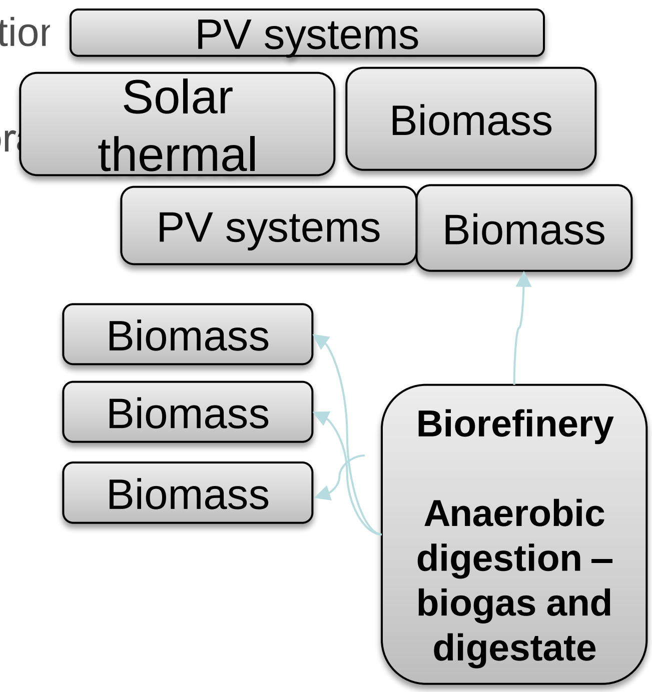
Decarbonisation of agriculture sector

- Direct utilization of fossil sources on farm:
  - Energy
    - Power (lightning, climatization, ventilation, automatizatior IT…
    - Heat (space heating, hot water, cooling, drying, evapora
    - Fuel (mechanisation, vehicles, transportation…)
- Indirect utilization of fossil sources on farm:
  - Fertilizers
  - Agrochemicals
  - Plastic packaging (produce and agro-inputs)

Low carbon alternative



Decarbonization of society

Long value chains

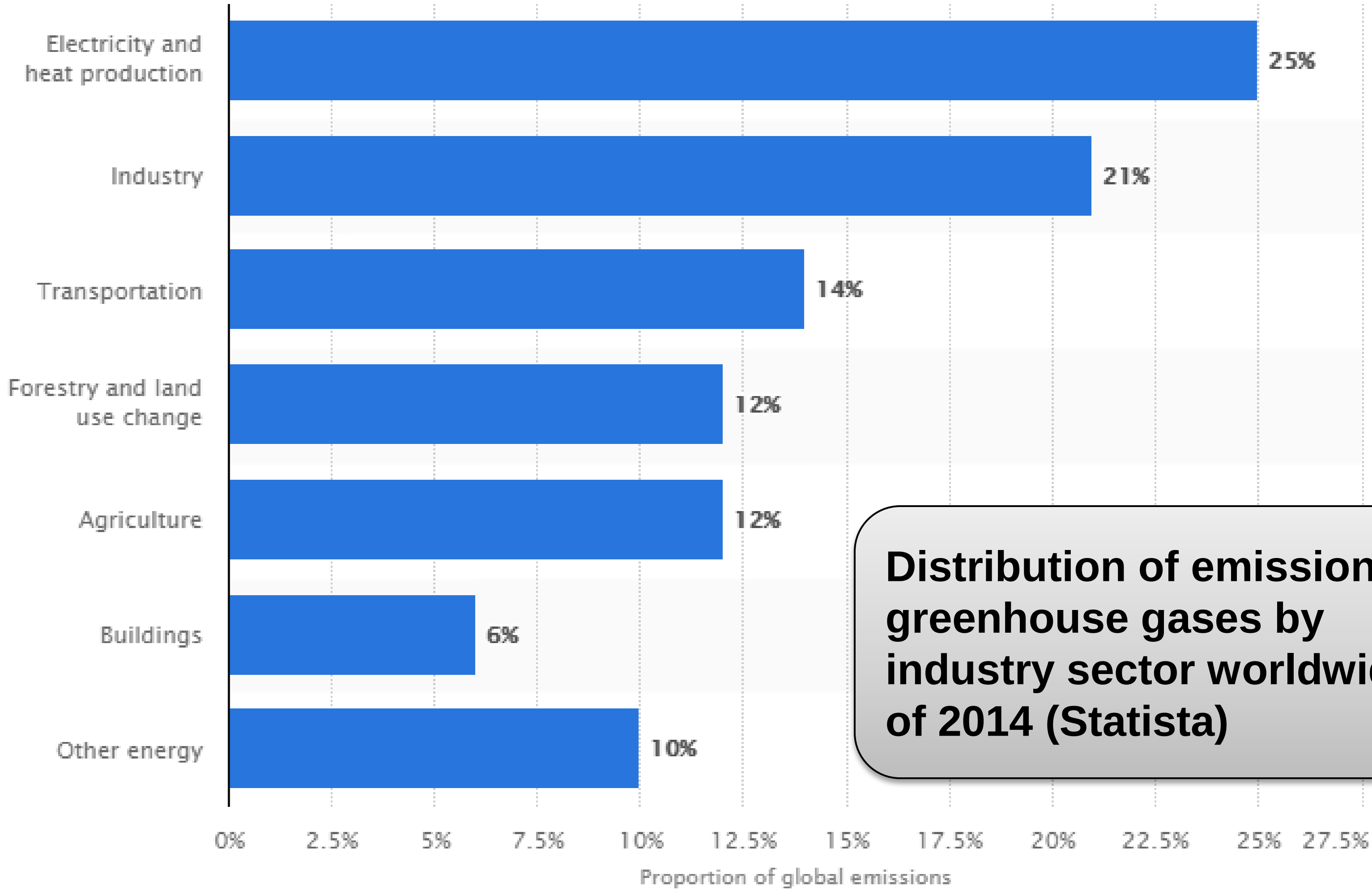
- Large scale: biorefinery
  - Farmers as biomass suppliers / land rent
  - Collection centers (Bio-hubs)
- Small scale: decentralisation, fugal innovations, collection centers (Bio-hubs), prosumers
  - Connection with production
  - Connection with market – market players

Short value chains

- **Carbon sequestration (carbon farming): engaging all agricultural land, choosing coppice with most CO2 net balance**

New source of income or limitation to a farmer?

Why bioenergy is important in bioeconomy?



Distribution of emissions of greenhouse gases by industry sector worldwide as of 2014 (Statista)

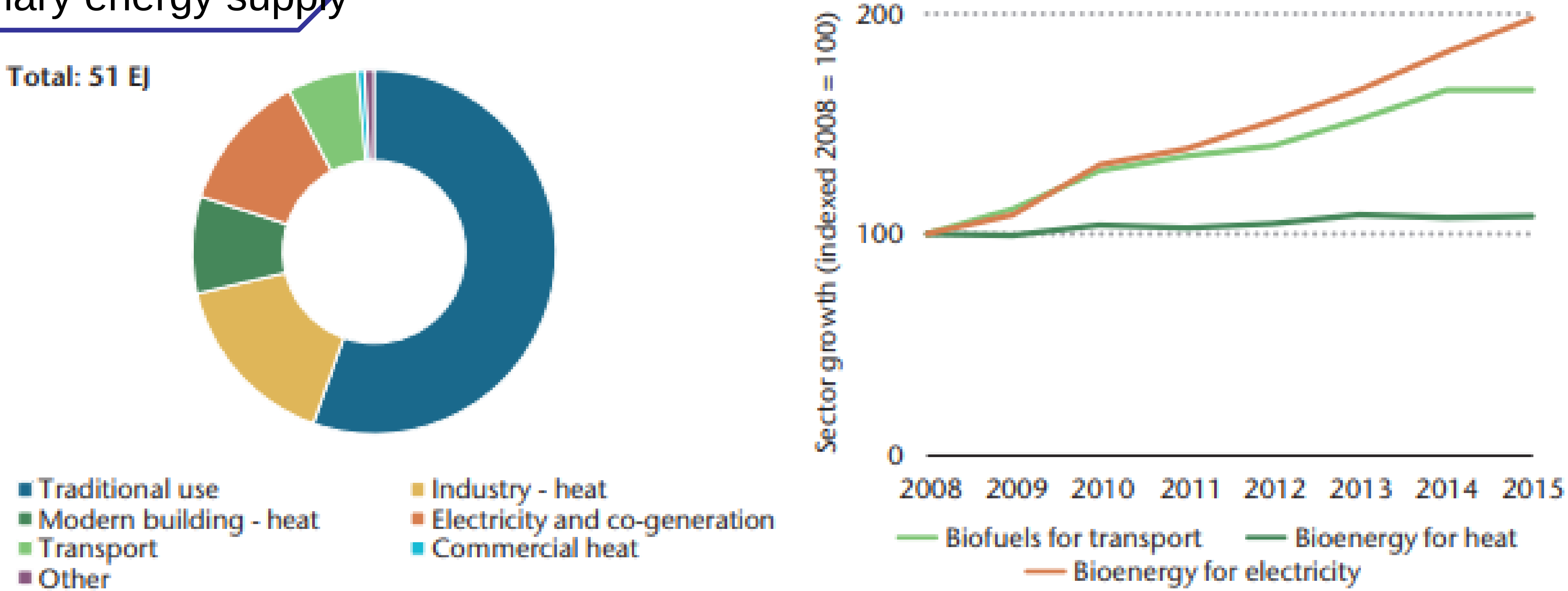
Biomass (in the eyes of energy):

- **Renewable energy fuel** derived from organic material such as trees, plants, and agricultural and urban waste.
- It can be used for heating, electricity generation, and transport fuels.
- Increasing the use of biomass in the EU can help diversify Europe's energy supply, create growth and jobs, and lower greenhouse gas emissions.
- In 2012, **biomass and waste accounted for about 2/3 of all renewable energy consumption in the EU**.

EU; https://ec.europa.eu/energy/en/topics/renewable-energy/biomass

Consumption of biomass and waste resources by end use in 2015 (left) and modern bioenergy growth by sector, 2008-15 (right)

~9% world total primary energy supply



Notes: EJ = exajoule.

Sources: IEA (2017d), *World Energy Statistics and Balances 2017*, www.iea.org/statistics/; IEA (2017c), *Market Report Series: Renewables 2017*; IEA (2017e), *World Energy Outlook 2017*.

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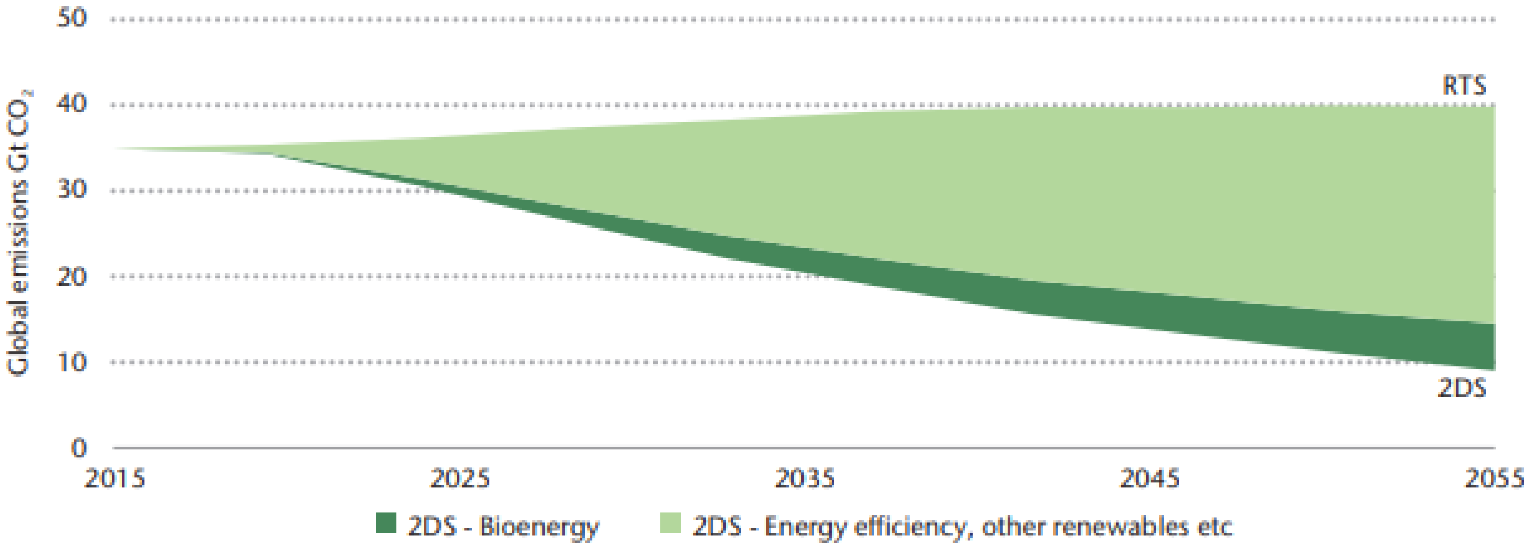
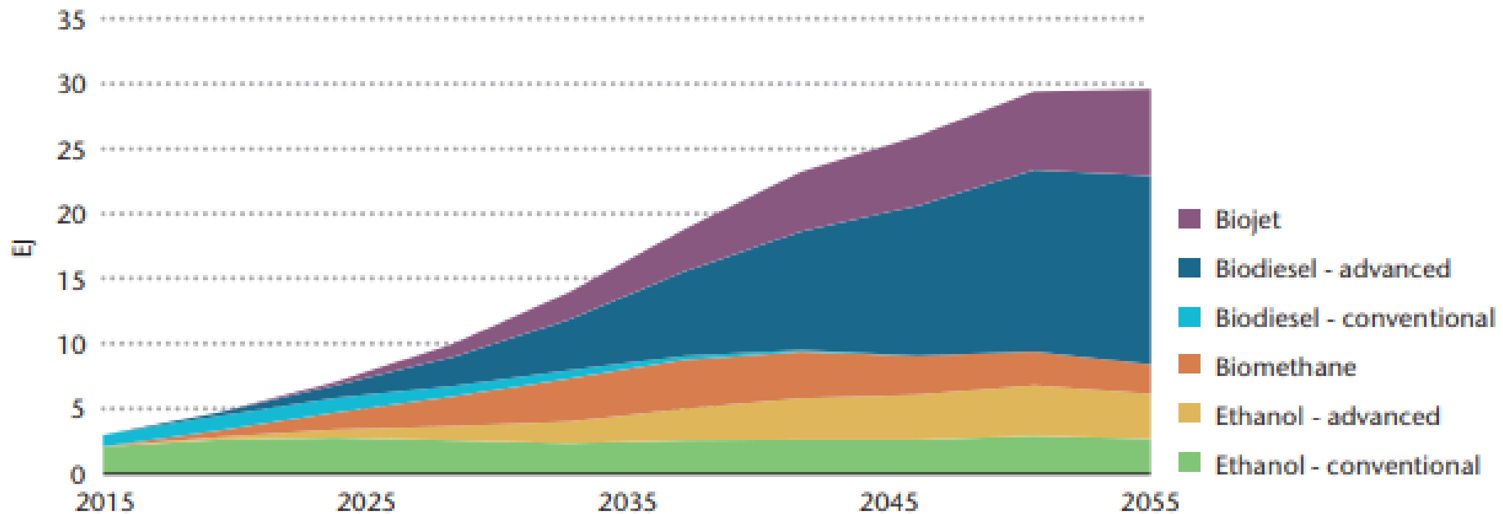
the 2°C scenario



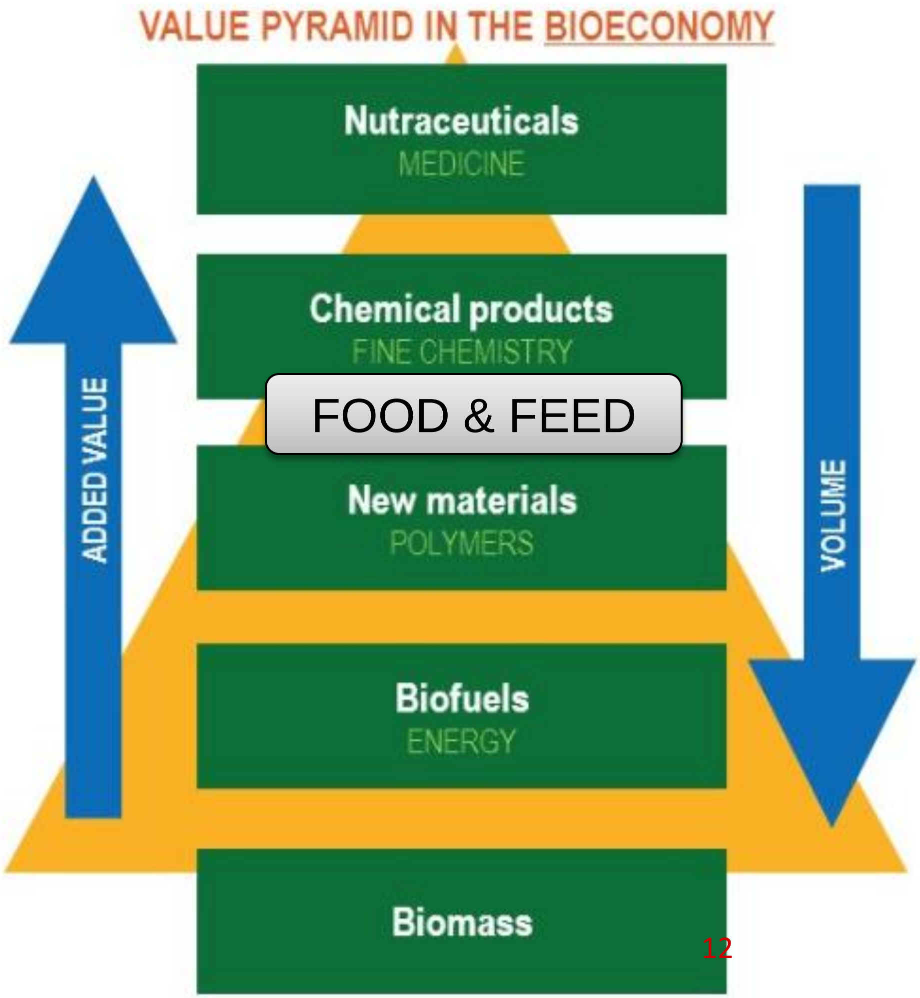


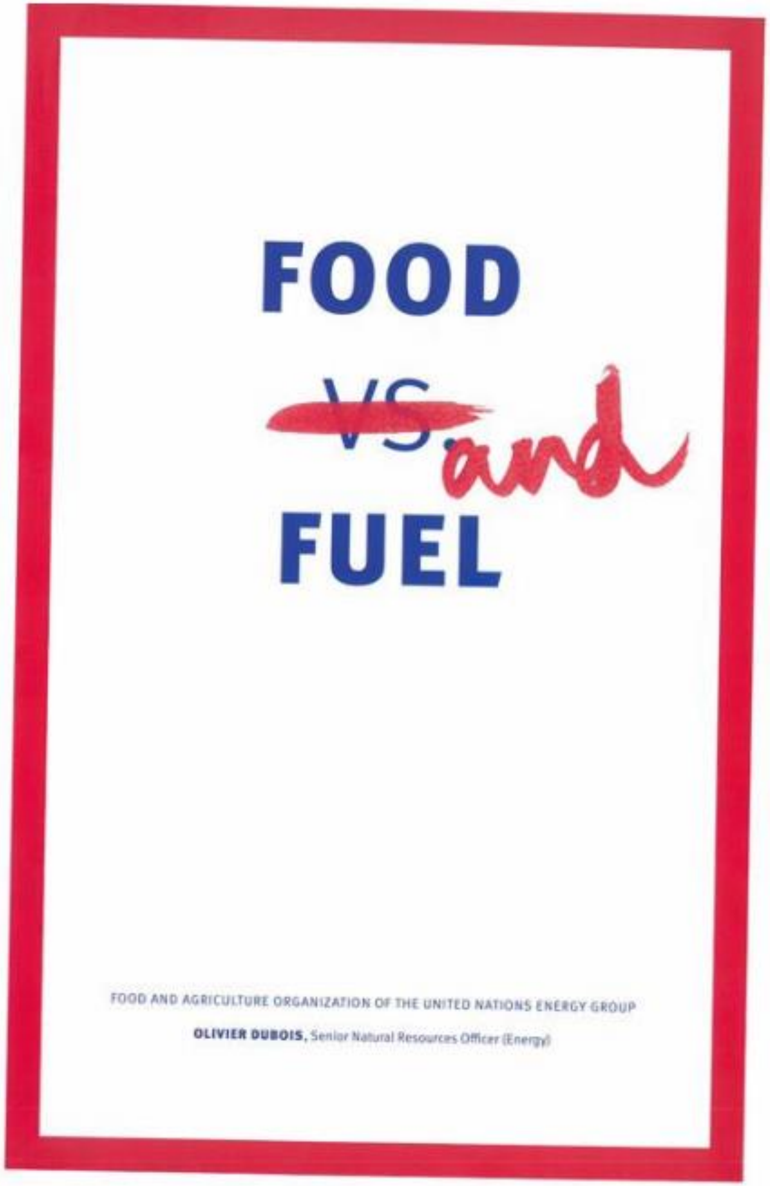
Notes: Conventional biodiesel refers to crop-based FAME biodiesel; advanced biodiesel refers to a range of advanced biofuels suitable for use in the diesel pool.

How to make a farmer bioeconomy player?

Why Bioeconomy?

- New products and materials.
- Fossil fuels replacement.
- Job creation and regional development.
- Energy security.
- Reduction of carbon footprint.
- Positive perception by society.





FOOD AND AGRICULTURE
ORGANIZATION OF
THE UNITED NATIONS
ENERGY GROUP

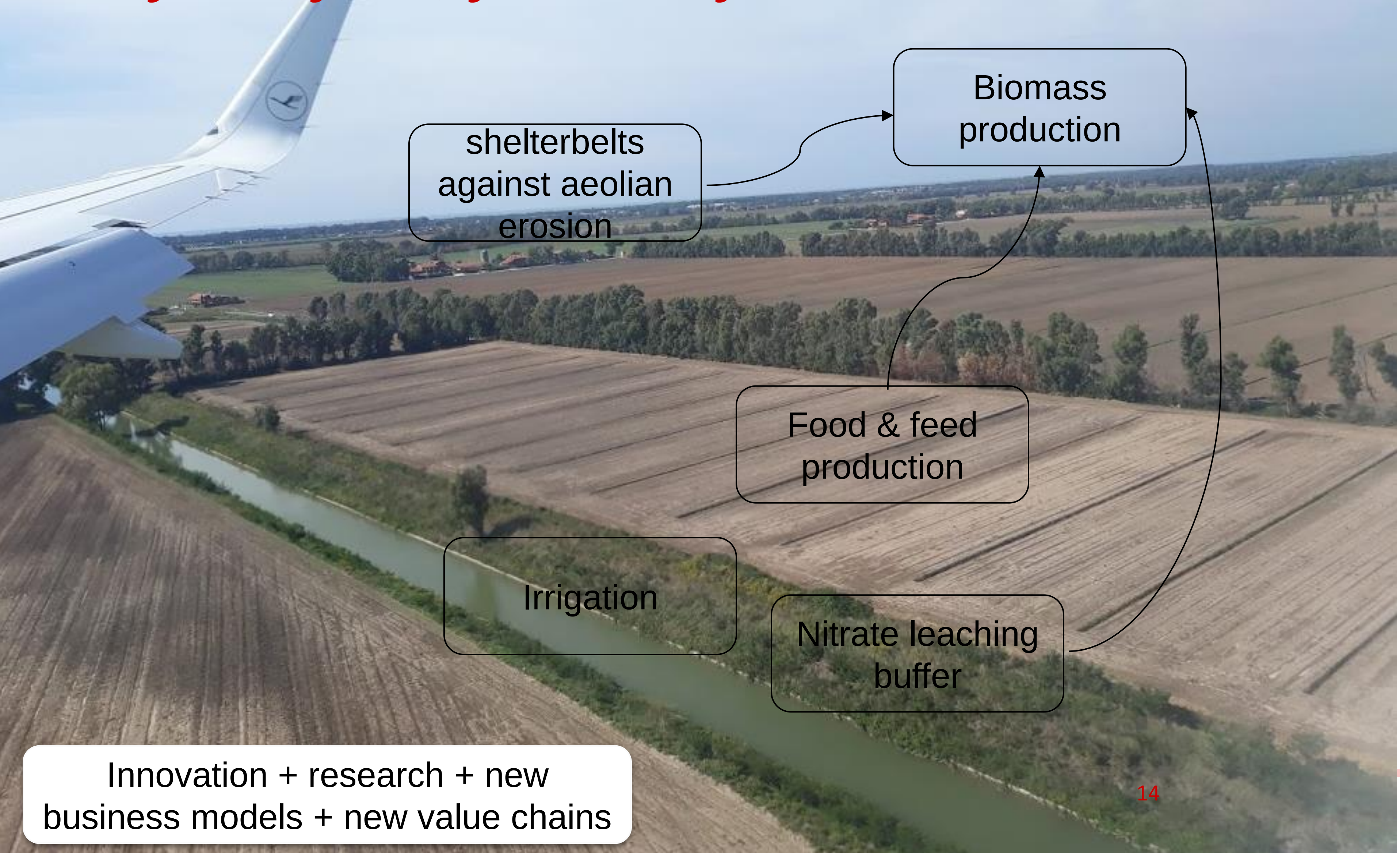
OLIVIER DUBOIS,
Senior Natural Resources Officer (Energy)

In 2015 the FAO changed their mind and agreed that biofuels on arable land can give farmers a cash crop to develop agriculture instead of seeing biofuls as a threath causing food shortage.

SVEBIO

Sustainable Landscape Management for Bioenergy and the Bioeconomy, FAO&IEA Bioenergy Task 43 workshop, Rome, October 2018
Source: http://task43.ieabioenergy.com/wp-content/uploads/2018/10/Gustav-Melin_Grain-production-and-population.pdf

Integrated landscape management for food, feed, fuel and fibre



IEA Bioenergy

Task 43

Biomass Feedstocks for Energy Markets

Home | About | Publications | Events | Projects | Members

"Sustainable Landscape Management for Bioenergy and the Bioeconomy" , a joint IEA Bioenergy Task 43 & FAO Workshop, October 11-12, 2018, The FAO Headquarters, Vialedelle Terme di Caracalla, Rome, Italy. For full details here

Date Oct 2018

Workshop Documents

- FAO_Task43_Workshop_Agenda_Final
- 00_ Dimitriou_Welcome IEA Bioenergy Task 43
- 01_1_Dubois_The Energy-Smart Food for People and Climate Programme
- 01_2_Berndes_WP1 Landscape management and design for bioenergy and the bioeconomy
- 01_4_FAO_Maltsoglou I_Bioenergy Potential from Crop and Livestock Residues in Egypt and Turkey–through the BEFS RA methodology
- 01_5_Bentsen_Grass based biorefinery systems producing biofuels-biomaterials-feed
- 01_6_Kline_Negri_Implementing bioenergy at the landscape level to reduce land use impacts and improve resource use efficiency
- 01_7_Skeers_Armitage A set of integrated practices a multi-faceted market-led approach to improving food and energy security and adaptation to climate change-Zambia
- 01_8_FAO-Dubois_Water-energy-food nexus in bioenergy-landscapes
- 01_9_Bezzi_Biogas done right
- 02_1_Dale FAO Rome 2018 final
- 02_2_FAO_Colangeli M_Web-based sustainability assessment tools for Bioenergy projects on underutilized lands in Europe
- 02_3_ Thiffault et al_Opportunities for making use of unloved wood
- BIOEAST Task43 FAO 12_10_2018
- Gustav Melin_Grain production and population

BIOEAST Task43 FAO 12_10_2018

Recent Publications

- Bioenergy and grasslands – Different approaches to addressing biodiversity and their influence on biomass supply potentials.
- Suitable Land Slots for SRC plantations – Multi Criteria Decision Analysis
- Outline of a sustainable and efficient bioenergy policy framework TR2018-02
- How to analyse ecosystem services in landscapes. IEA Bioenergy ExCo Report 2018-03
- Feasibility of verifying sustainable forest management principles for secondary feedstock to produce wood pellets for co-generation of electricity in the Netherlands. IEA Bioenergy Task 43 TR2018-01
- Letter: Forests, bioenergy and climate change mitigation: are the worries justified?
- Attractive systems for Bioenergy Feedstock Production in Sustainably Managed Landscapes

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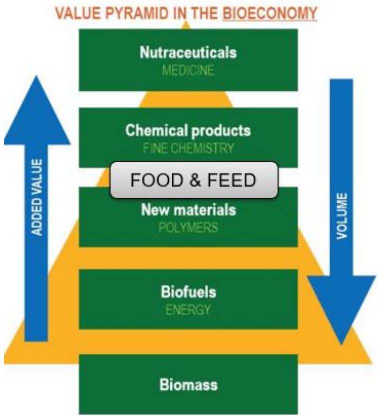
Farm as a "prosumer" *= simultaneous production and use of bio-based products (food, feed, bioenergy, agrochemicals, biofertilizers) at the same location*

- Intersectoral effect: households, industry, transport, tourism…
- Farmer is motivated by benefits, not penalties
- Farmers seeks for the opportunity for the secondary produce*
- Adaptation of rural development measures
- Adaptation of legal framework
- Networking and synergy of agriculture with

science and business sector

- **Revival of rural areas - Smart villages**



Shorter value chains

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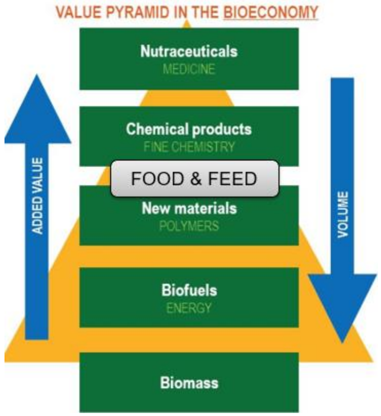
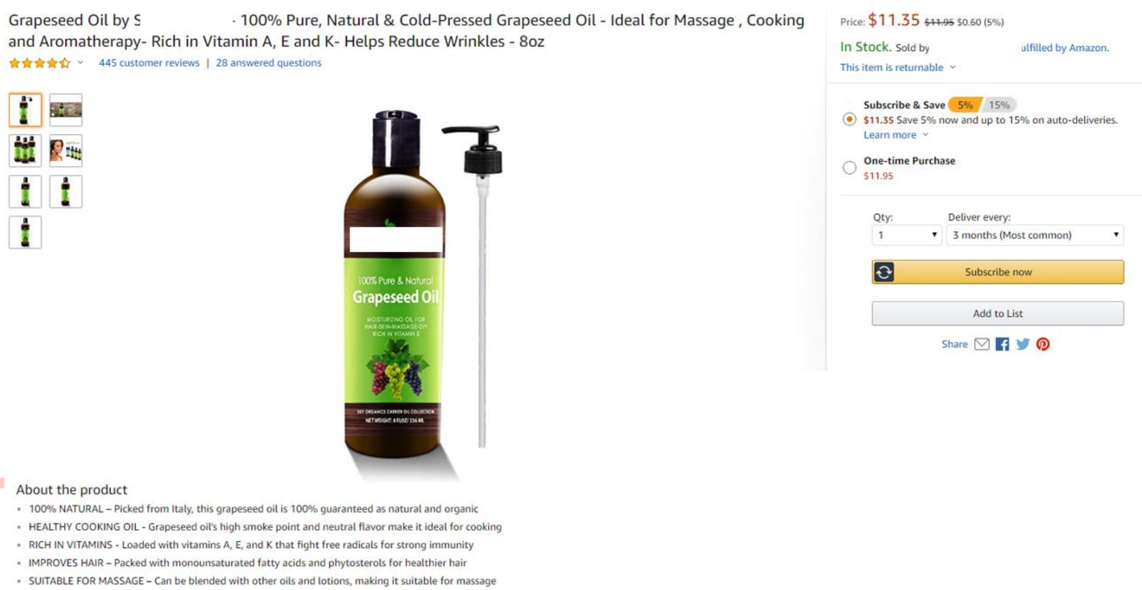
Wine production in bioeconomy – example of business case

1000 kg of grapes:

= 2,75 l grapeseed oil	40 €/l =	110
= 200 kg bioactive flour	25 €/kg =	5000
= 750 l wine	**10 €/l =**	**7500**
= 500 kg prunings	2 €/kg =	1000 +
		= 13610 €



Stalks as mulch /organic matter



Source: http://task43.ieabioenergy.com/wp-content/uploads/2017/12/6_BKulisic.pdf

Contribution of SRC to long term ragweed eradication in the City of Osijek

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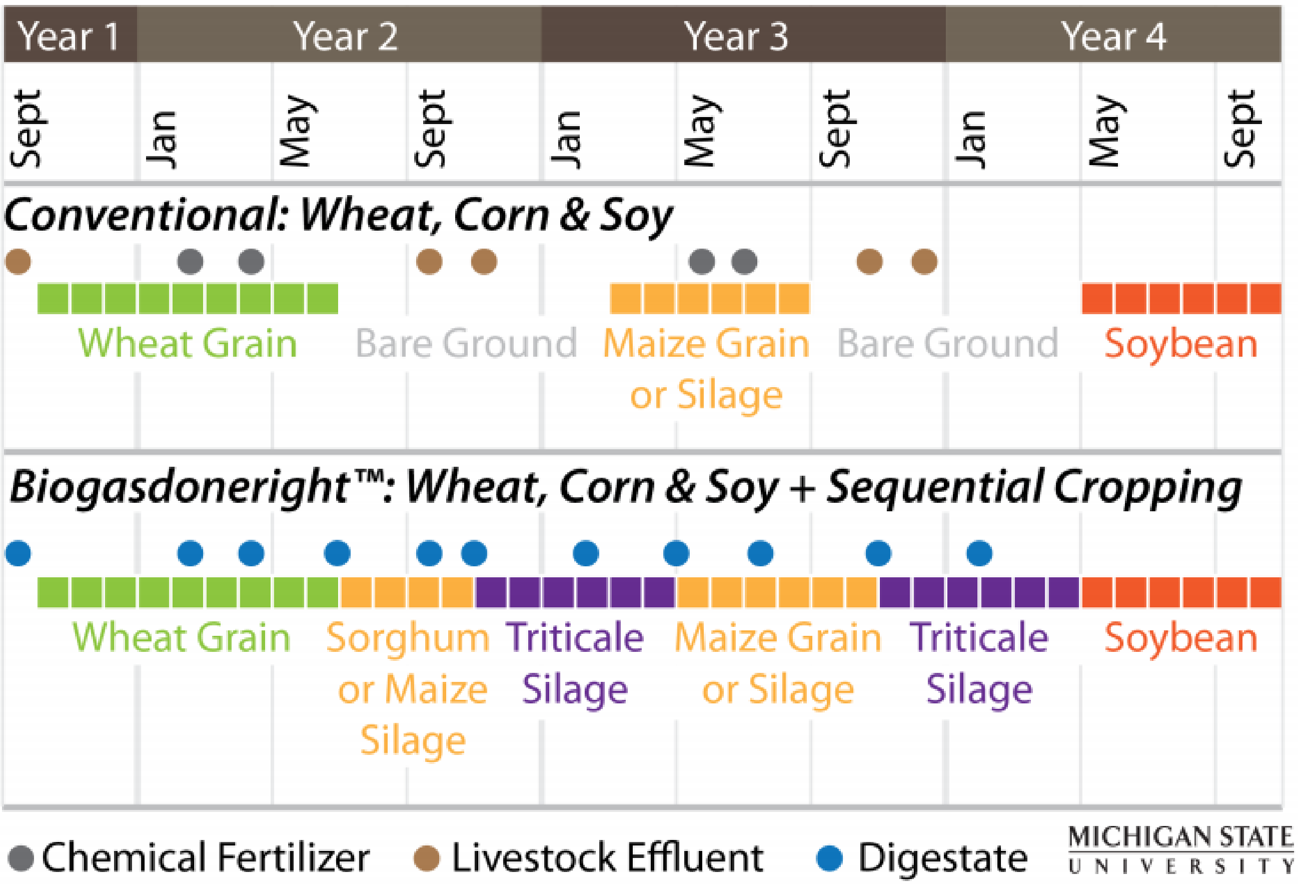
IEA Bioenergy Task 43 workshop
„Attractive Systems for Bioenergy Feedstock Production in Sustainably Managed Landscapes"
November 20, 2017 at Sydney, Australia

Bezzi (2018): BiogasDoneRight®

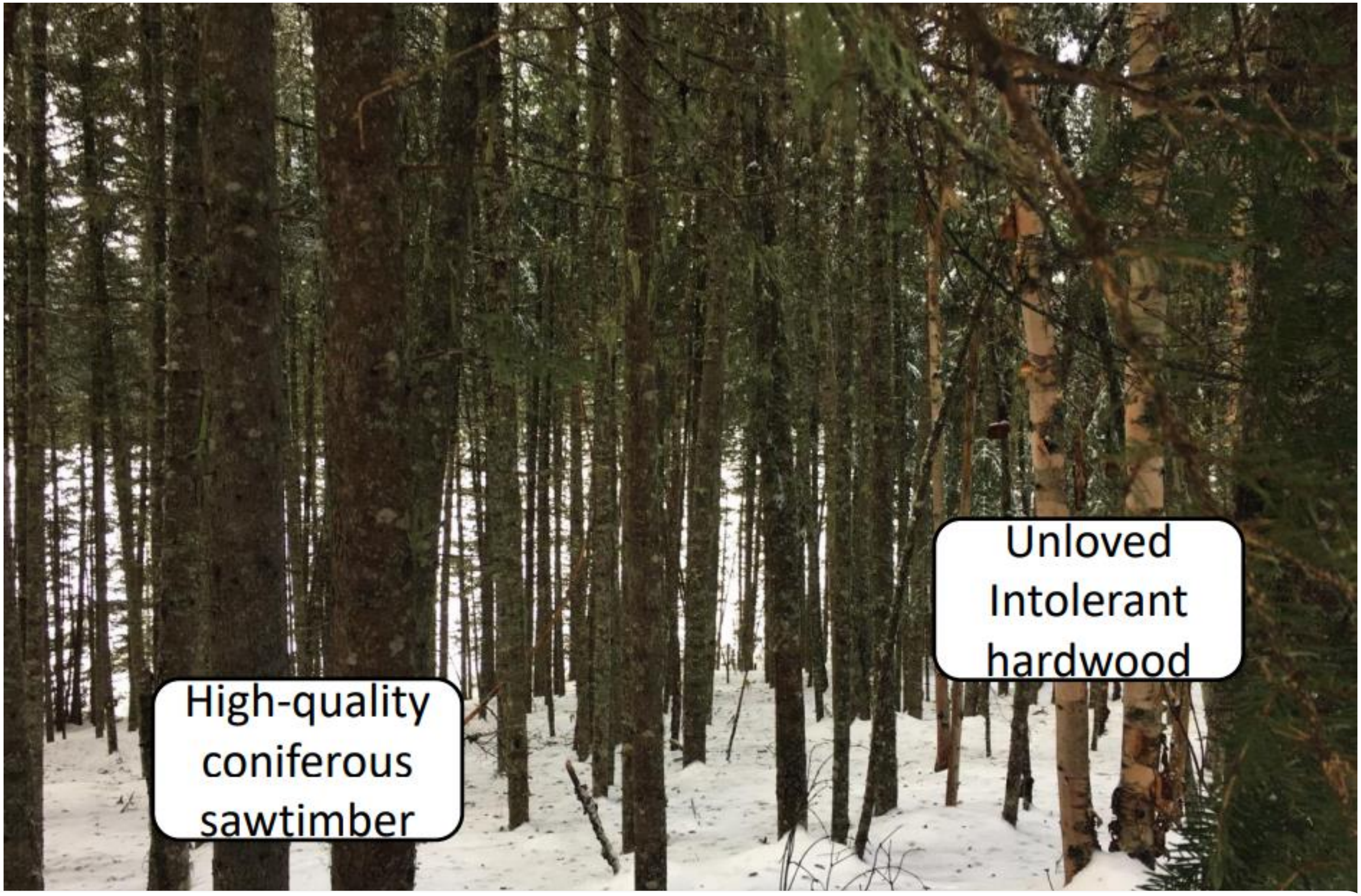
Sequential cropping Triticale/Maize



Sustainable Landscape Management for Bioenergy and the Bioeconomy, FAO&IEA Bioenergy Task 43 workshop, Rome, October 2018

Source: http://task43.ieabioenergy.com/wp-content/uploads/2018/10/01_9_Bezzi_Biogas-done-right.pdf

Thiffault (2018): From unloved wood to desirable bioenergy: warming the heart of communities



How Attractive Systems for Bioenergy Feedstock Production in Sustainably Managed Landscapes are for Rural Development, IEA Bioenergy Task 43 workshop, Osijek, March 2018
Source: http://task43.ieabioenergy.com/wp-content/uploads/2018/04/2_Thiffault.pdf

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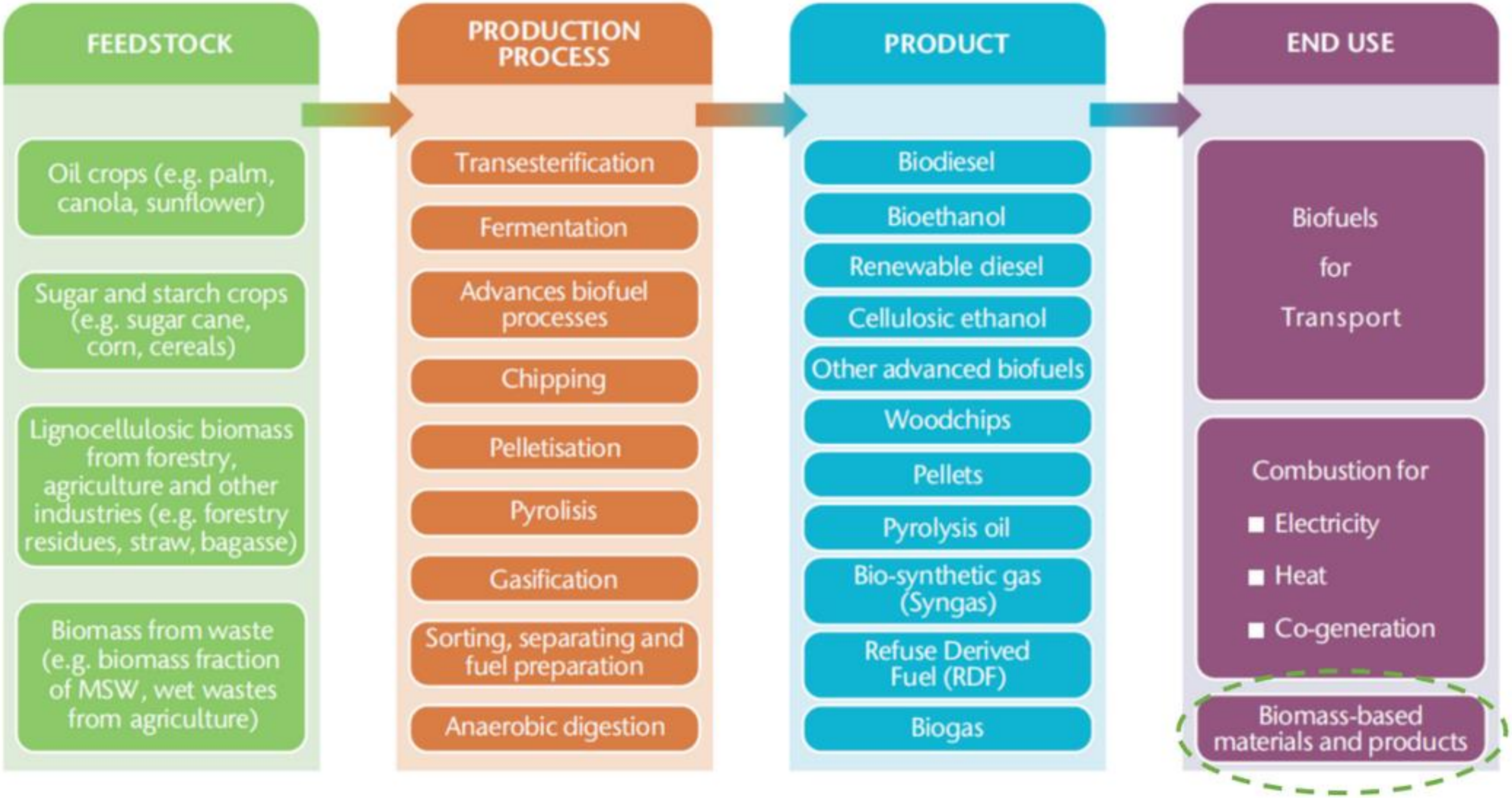
ZAGREBAČKI
HOLDING
H 440

Biomass Pathways in the IEA Bioenergy Roadmap (2017)



Source: IEA (2017): *Technology Roadmap: Delivering Sustainable Bioenergy; green dashed circle added*

What lessons for bioeconomy can be learned from bioenergy market?

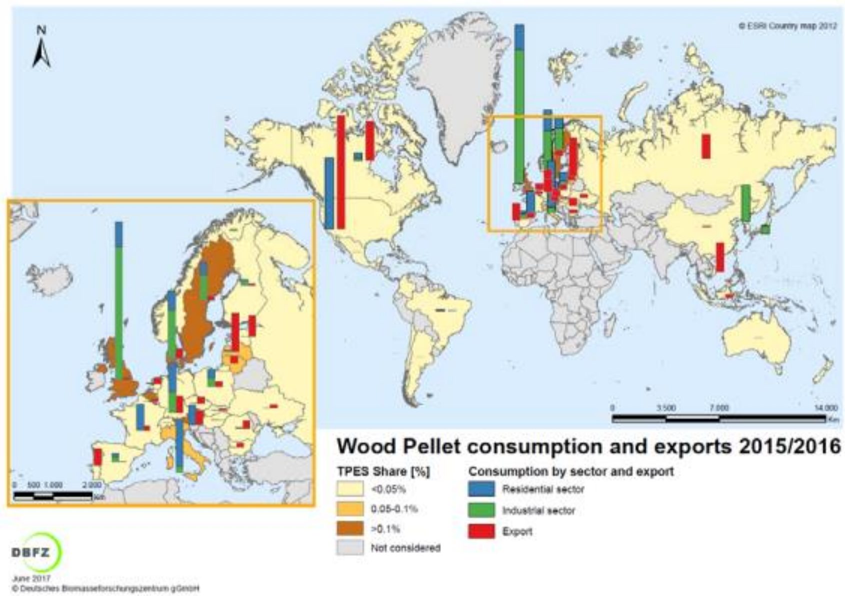
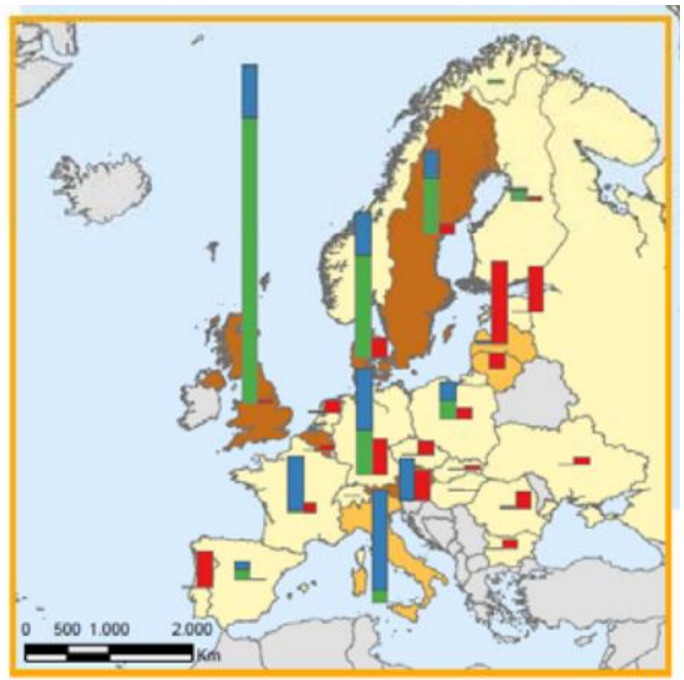


Figure 0.2 - Countries with relevant wood pellet consumption and/or export in 2015



Biomass is internationally tradable good.

http://task40.ieabioenergy.com/wp-content/uploads/2013/09/IEA-Wood-Pellet-Study_final-2017-06.pdf

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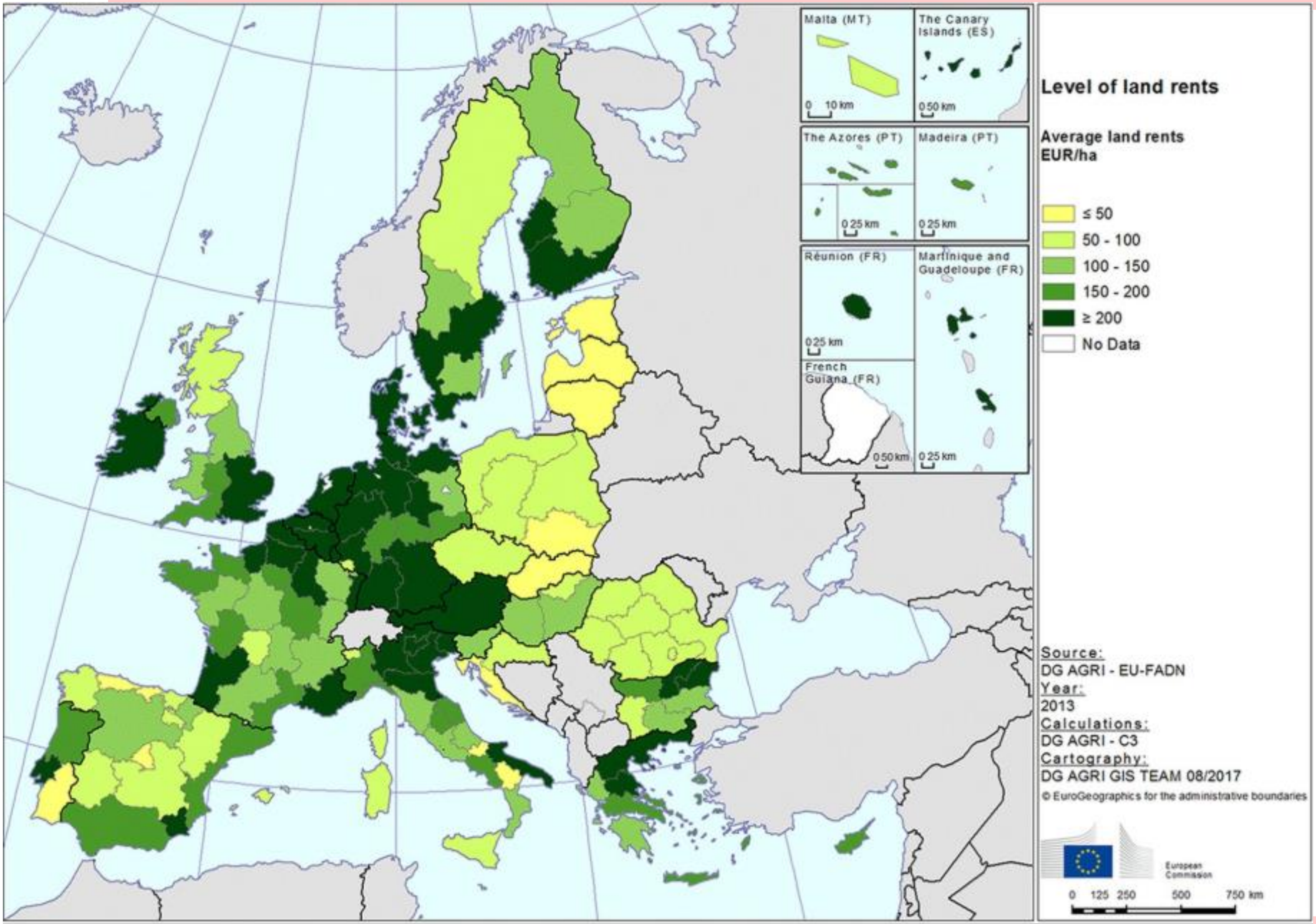
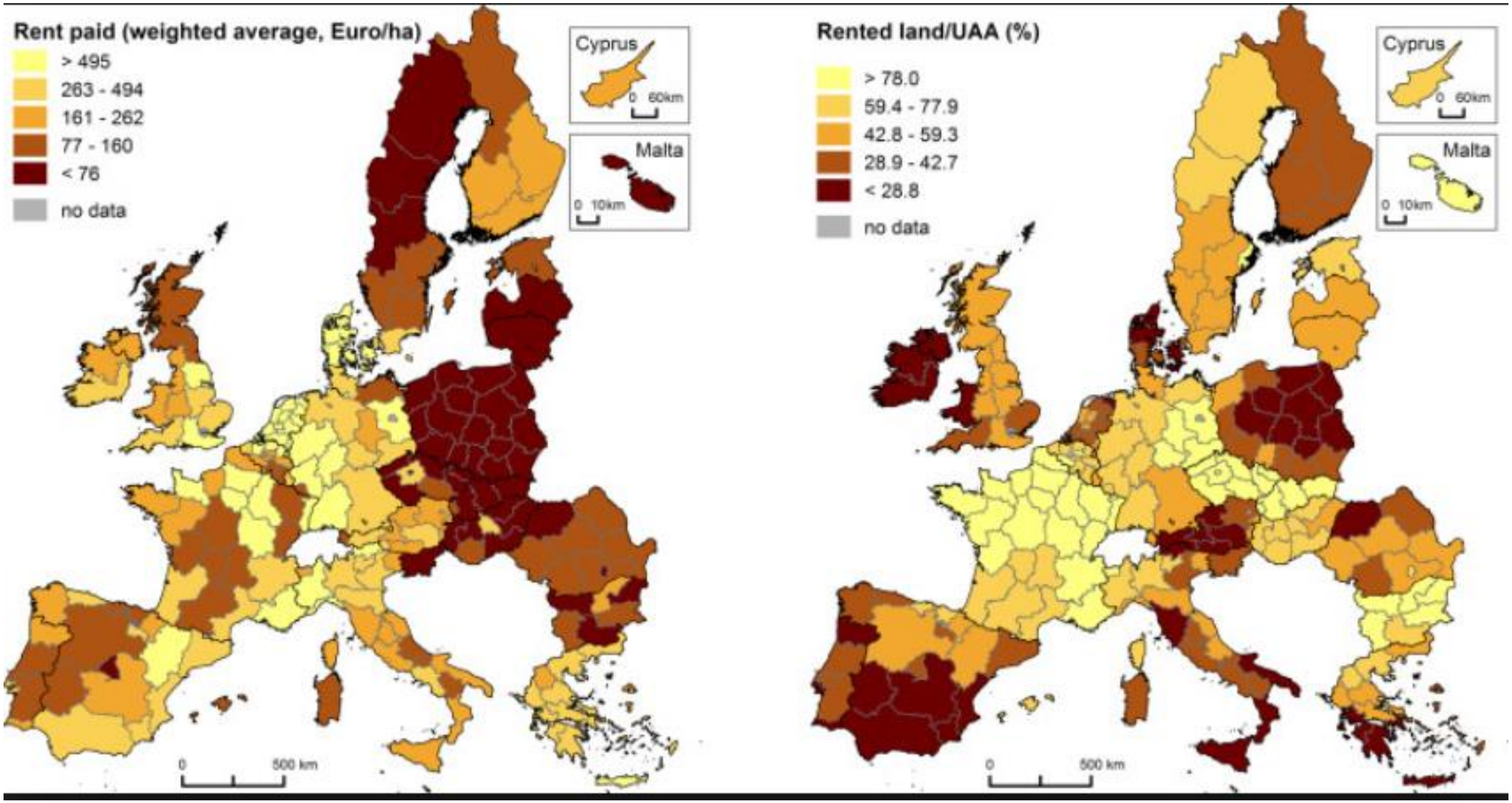
Pathways from biomass into the energy system

DBFZ (2012) Systemic contribution of biomass
https://www.dbfz.de/en/focus-areas/systemic-contribution-of-biomass.html


Malta (MT)
0 10 km
The Canary Islands (ES)
0 50 km
The Azores (PT)
0 25 km
Madeira (PT)
0 25 km
Réunion (FR)
0 25 km
Martinique and Guadeloupe (FR)
0 25 km
French Guiana (FR)
0 50 km
Level of land rents
Average land rents EUR/ha
≤ 50
50 - 100
100 - 150
150 - 200
≥ 200
No Data
Source:
DG AGRI - EU-FADN
Year:
2013
Calculations:
DG AGRI - C3
Cartography:
DG AGRI GIS TEAM 08/2017
© EuroGeographics for the administrative boundaries
European Commission
0 125 250 500 750 km

EIHP



Source: Terres, J.-M., Scacchiafichi, L. N., Wania, A., Ambar, M., Anguiano, E., Buckwell, A., … Zobena, A. (2015). Farmland abandonment in Europe: Identification of drivers and indicators, and development of a composite indicator of risk. Land Use Policy, 49, 20–34.

New triennium 2019-2021
Task 43: SUSTAINABLE BIOMASS SUPPLY INTEGRATION FOR BIOENERGY WITHIN THE BROADER BIOECONOMY

Focus is on **deployment, application and management of best practice in technology and economic systems in integrated biomass production and supply chains systems.**

WP1 - Biomass production systems for sustainable bioenergy within the bioeconomy

WP2 - Integrated supply chain and logistics for sustainable bioenergy within the bioeconomy

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