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Joint Research Centre

Bioenergy potentials in the MRS EURLAP

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Air and Climate Unit

5th EUSALP Action Group 9 meeting
Agency for Energy South Tyrol CasaClima
21 March 2018

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Outline

- **Motivation and political context (EUSALP)**
- **Framework**
- **Bioenergy and its challenges**
- **The way out – hints from the working group**
- **Integrated assessment and its tools**
- **Key messages for policy makers**

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Motivation

Decarbonisation

- Bioenergy is a key component of the ongoing transition to decarbonisation in the European Union: **62** Mtoe (2005) → **108** Mtoe (2015) → **140** Mtoe (2020 planned).

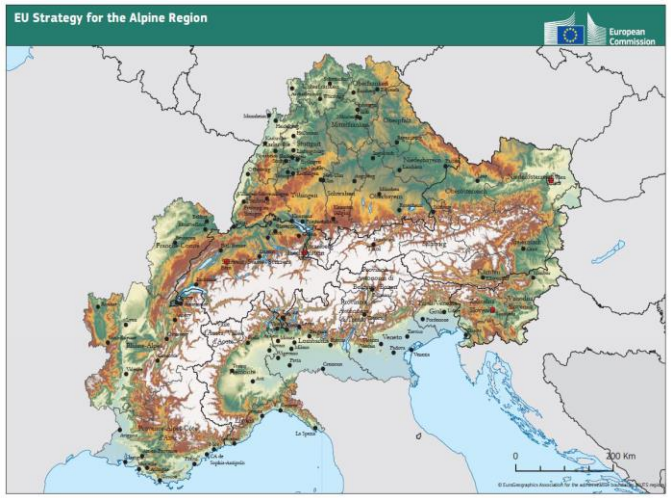
Trade-off, the bioenergy dilemma

- Increased use of biomass may result in **increased emissions of air pollutants**
- It is required to reduce **climate and environmental impacts at the same time**.

Measures

Bioenergy deployment, has to take place in **a proper context** and has to be balanced with **appropriate measures** aiming at minimizing the unintended negative impacts and enhancing environmental, climatic and societal benefits.

The political context - EUSALP



EUSALP

- Full countries: **Slovenia, Austria, Switzerland, Liechtenstein**
- Parts of
  - **Italy (north):** Liguria, Piemonte, Valle D'Aosta, Lombardia, Veneto, Trento, Bolzano and Friuli-Venezia Giulia
  - **Germany (south):** Freiburg, Tubingen, Schwaben, Oberbayern
  - **France (east):** Alsace, Franche-Comte, Rhone-Alpes and Provence-Alpes-Cote D'Azur

EURLAP

- the self-generation of energy is encouraged by promoting the development of renewable energy specific to this macro-region noticing the impact on air quality from using different types of combustion in the heating sector; public health concerns call for the urgent need to develop new strategies to combat air pollution (EURLAP, 2016)
- meeting the energy demand sustainable, securely and affordably is an important challenge while sustainability is highly considered.

Action group 9 objective "To support the expansion of local renewable energy sources in line with environmental and landscape protection standards".

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Framework

The JRC scientific support to the EU macro-regional strategies

MARREF project

- Project closing 2018

Macro-regions and regions of the future: mainstreaming sustainable regional and neighbourhood policy

The three macro-regional strategies targeted by the MARREF project are:

- EUSDR
- EUSAIR
- EUSALP

They share common pillars that look at relevant aspects of environmental protection.

Structure:

CONNECTIVITY WPK

Clean growth in transport and bioenergy

- Working groups: sharing knowledge between policy makers and researchers
- JRC report (in preparation)

ENVIRONMENT WPK

Air Quality

Relevant publications available at https://ec.europa.eu/jrc/en/publications-list

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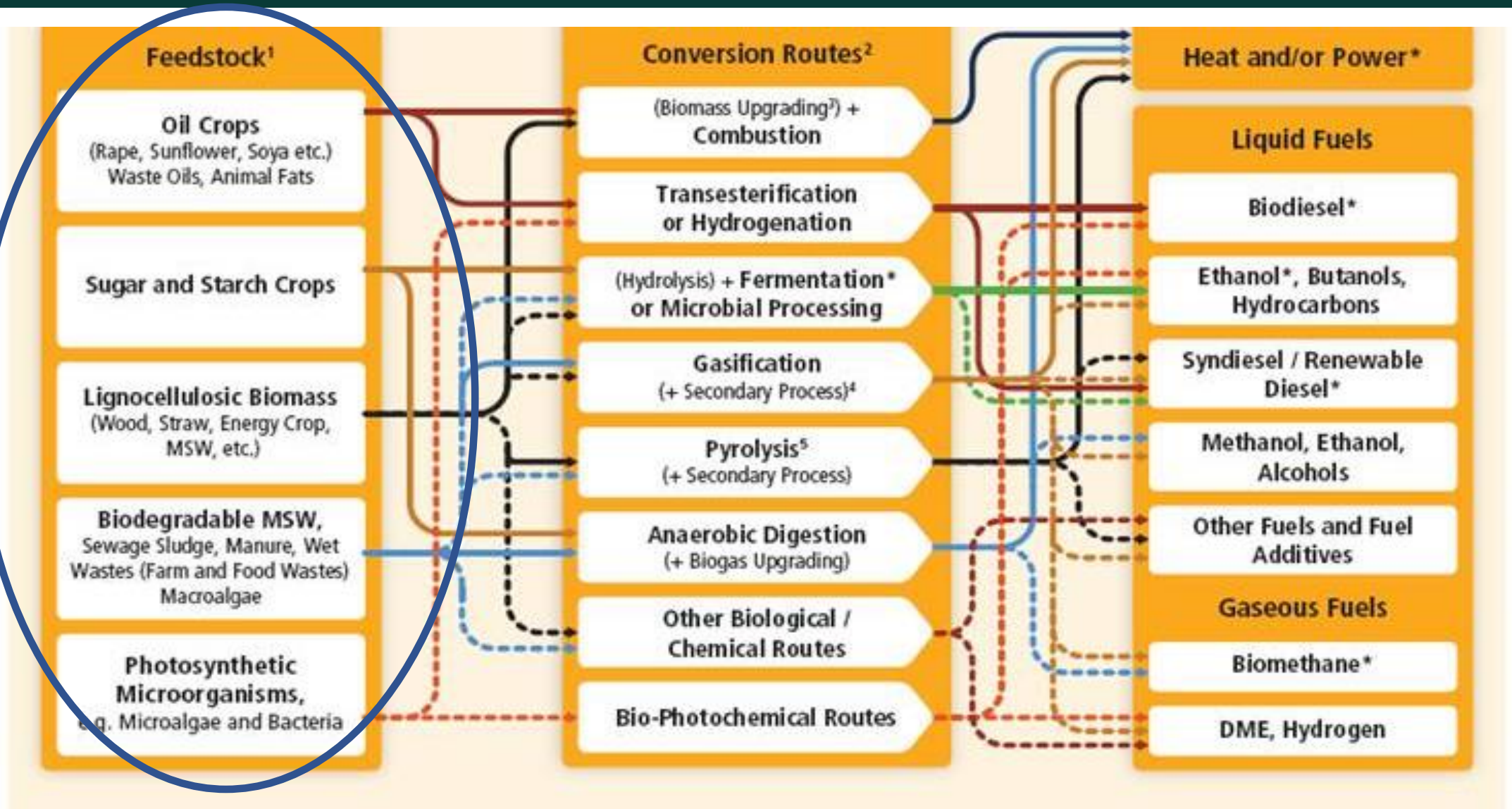
Bioenergy - a challenging Energy Source

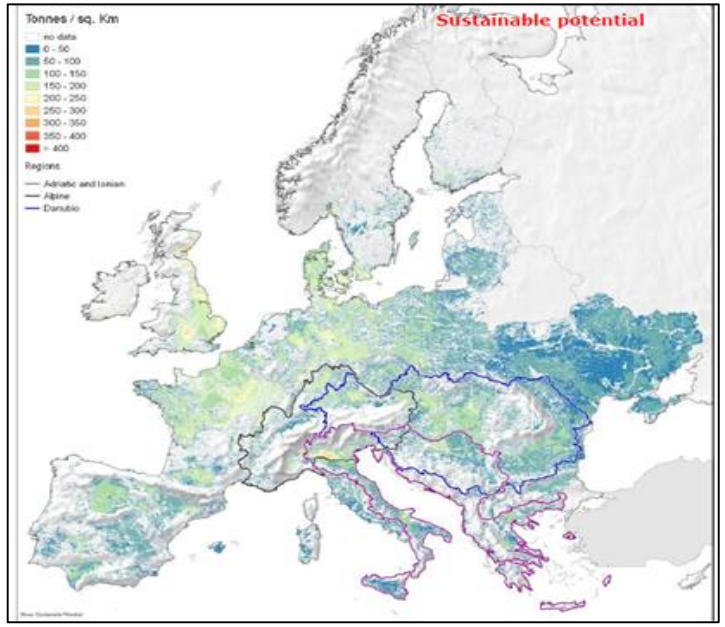
What is bioenergy? - the conversion of material of biological origin (biomass) into energy.



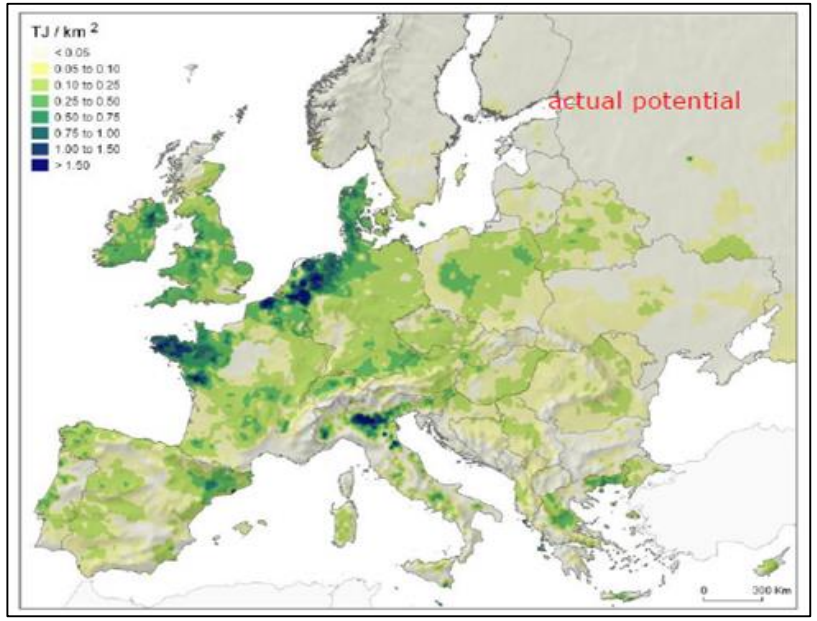
Source:
IPCC (2011)

Feedstock availability and mobilization (e.g.)

Crop residues technical potential in Europe



Biogas technical potential in Europe



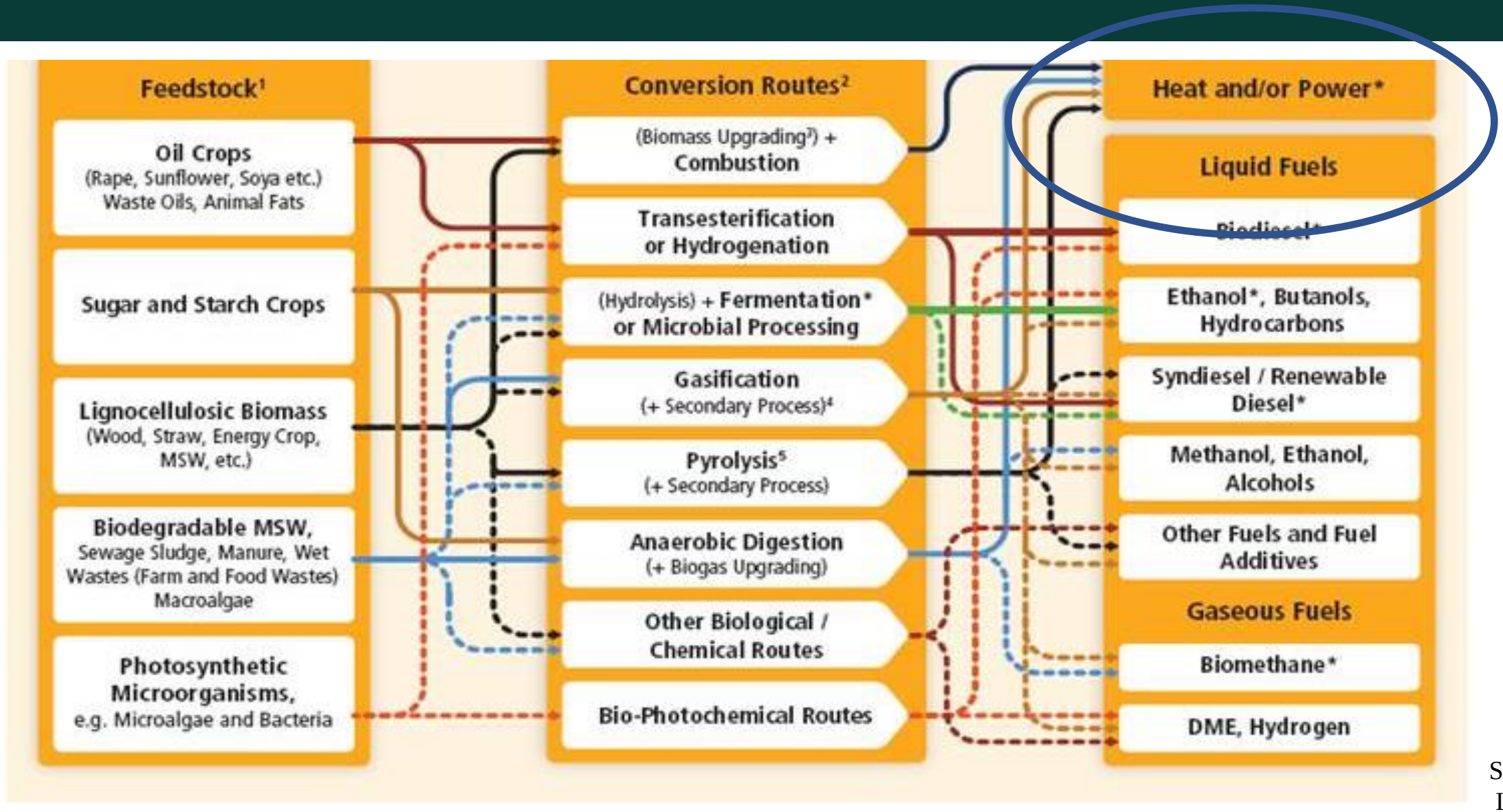
Source: JRC, Energy Efficiency and Renewables Unit.

Biomass needs to be:

- collected
- pre-processed
- transported to transformation sites

The assessment of technical (i.e., collectable) potential with an analysis of the feedstock mobilization and the related costs is of utmost importance.

CHP: choose an efficient conversion route

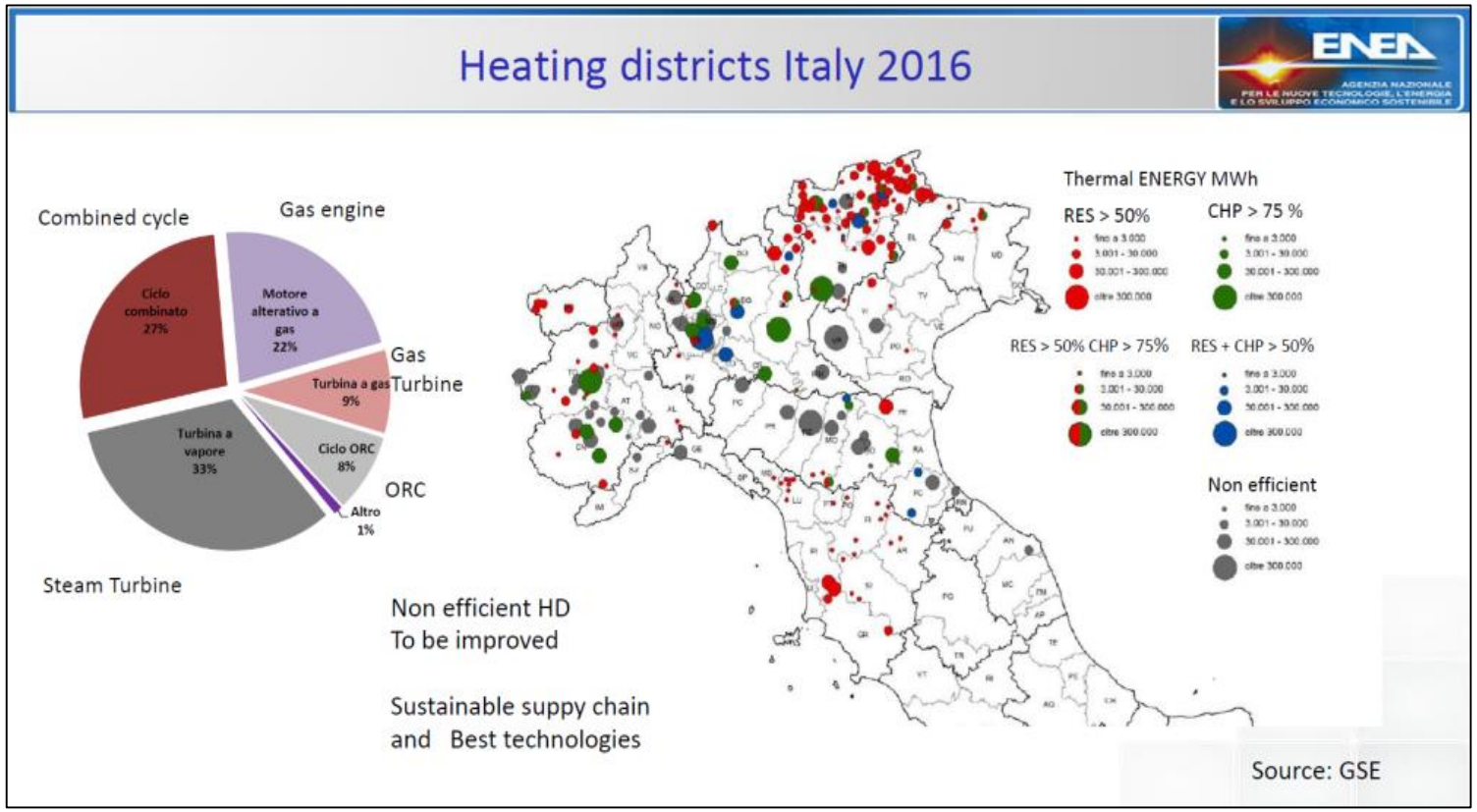


Source:
IPCC (2011)

CHP in Italy (V. Motola)

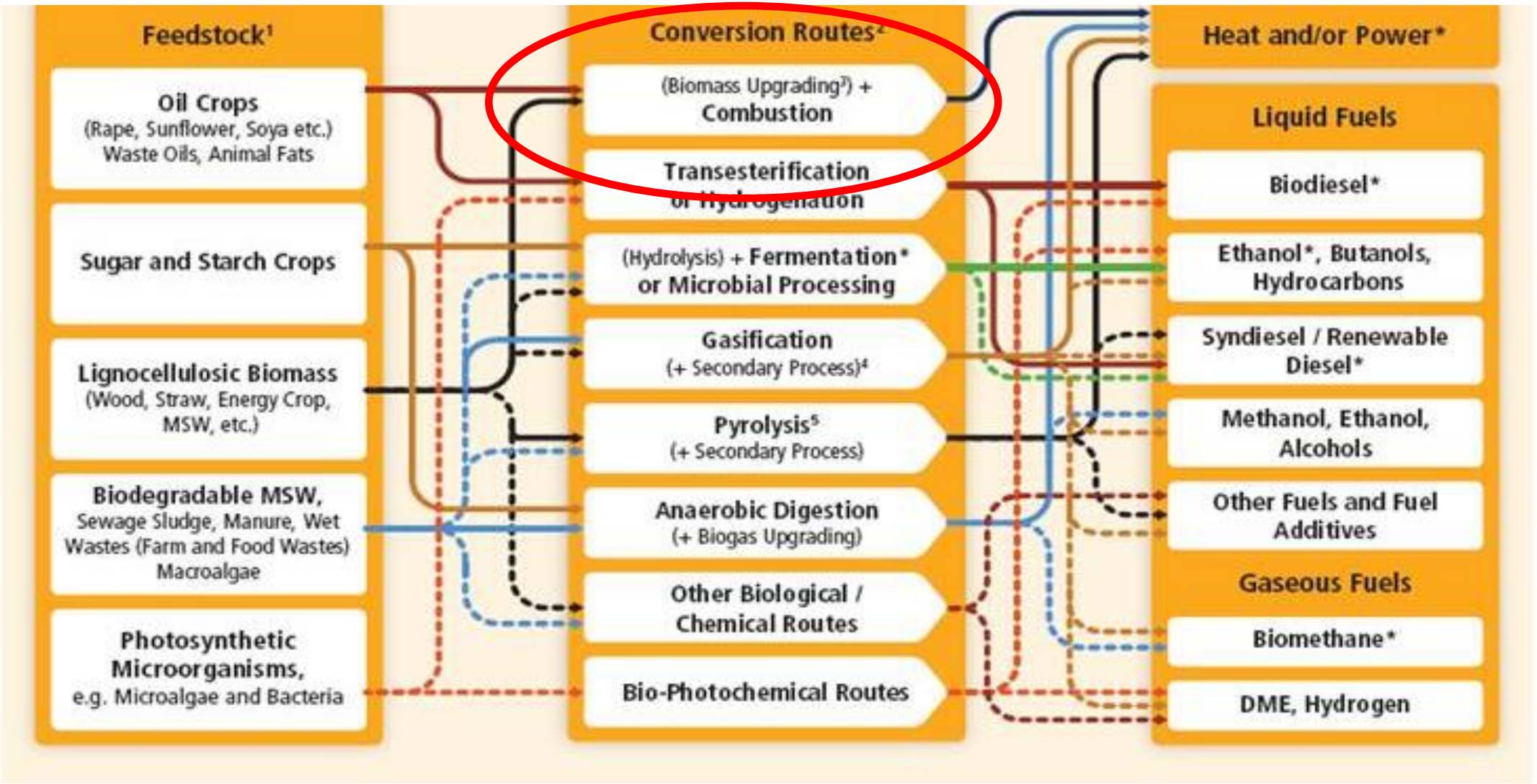
Combustion

Combined Heat and Power (CHP): the overall efficiency of biomass-based CHP plants for industry or district heating ranges from **70%-90%**



CHP and Heating Districts are largely installed in **Northern East Italy** because of average lower temperature and local fiscal incentives. Source: GSE, 2017

Combustion – room for technological improvement?



Source:
IPCC (2011)

Combustion – room for technological improvement? (for solid fuel, A. Weissinger)

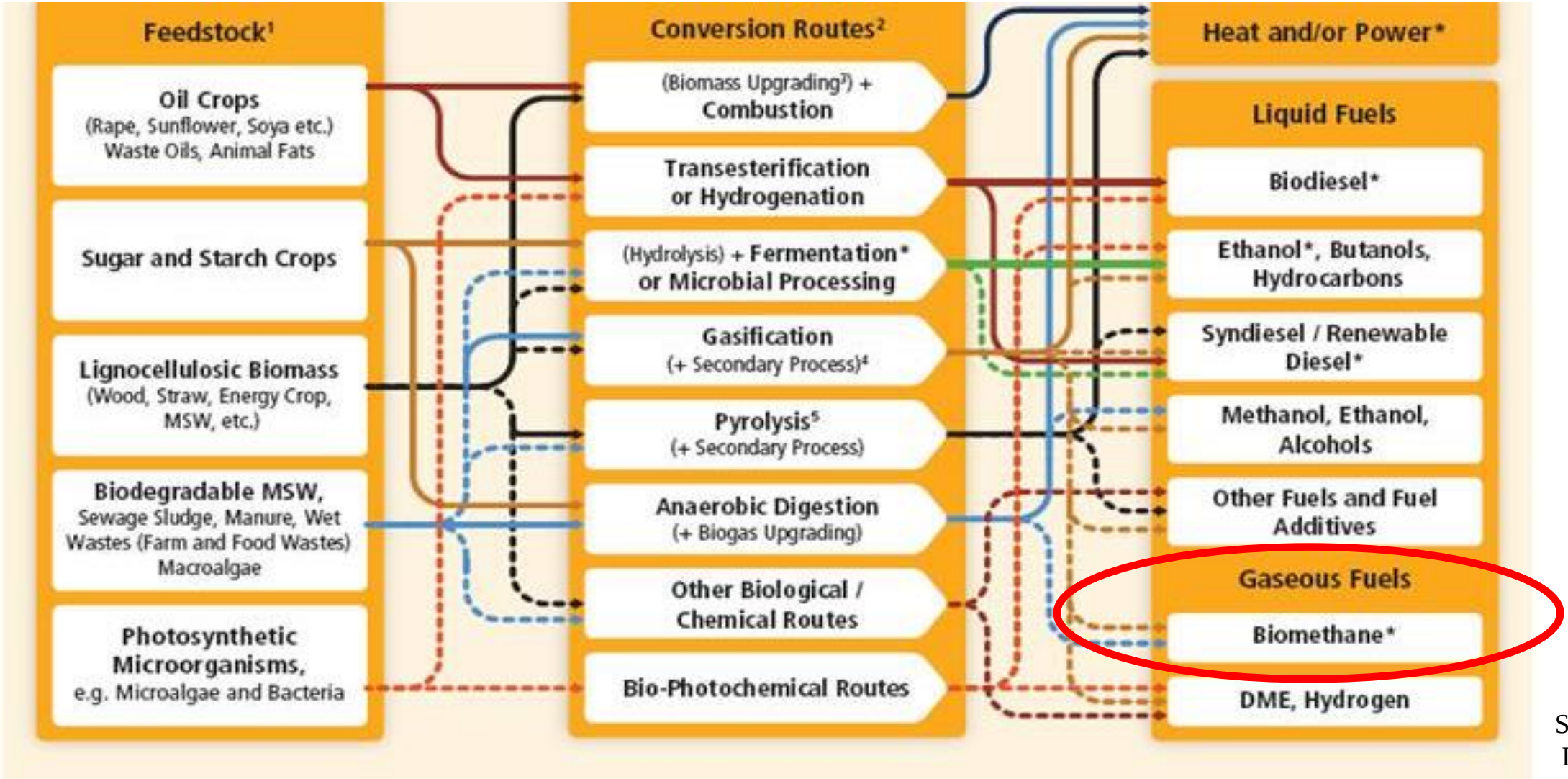
- **Integration of secondary abatement systems (e.g. Electrostatic precipitators)**
- **Fine particle reduction by extreme staged combustion**
- **New approach stoves - Candle burner**
- **Intelligent Control Algorithms**
  - Emission reduction in real life operation
  - Modelbased predictive systemcontrol and heat demand prognosis
- **Real life optimsation and testing methods**
- **CHP and integration into microgrids**

Source Source: Windhager Zentralheizung Technik GmbH

New technologies with a significant emission reduction potential are commercially available (partially). However, a broad market acceptance is needed for a significant market penetration.

Source: bioenergy2020+, Austria

Biogas– a flexible product



Source:
IPCC (2011)

Biogas

Anaerobic digestion: waste as feedstock

Anaerobic digestion: is a key technology to overcome various challenges namely waste recycling, sustainable waste treatment and renewable energy production.

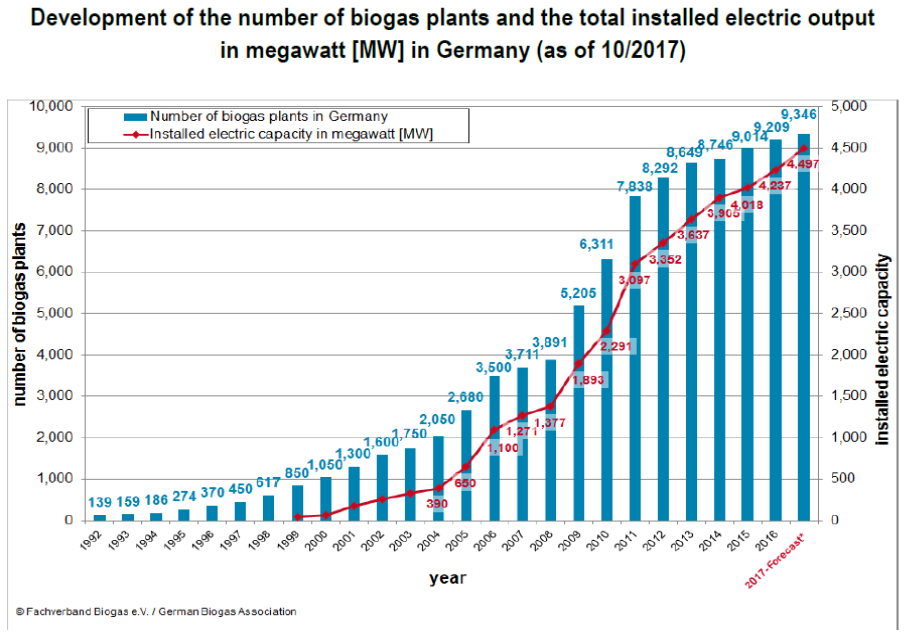
Promising combinations of feedstock and transformation technology: **anaerobic digestion of organic waste**.

Modern and environmentally friendly waste management is still not introduced in many European cities and regions, including several countries of the Alpine Region.

Depending of the quality of the biowaste collection → further processing:1. Anaerobic digestion[1] (e.g. waste with high water content), 2. Composting, 3. Incineration and 4. Landfilling.

[1]From the environmental point of view, source separated collection should be introduced and the digestible fraction used for Anaerobic Digestion, in order to increase the share of bioenergy generation.

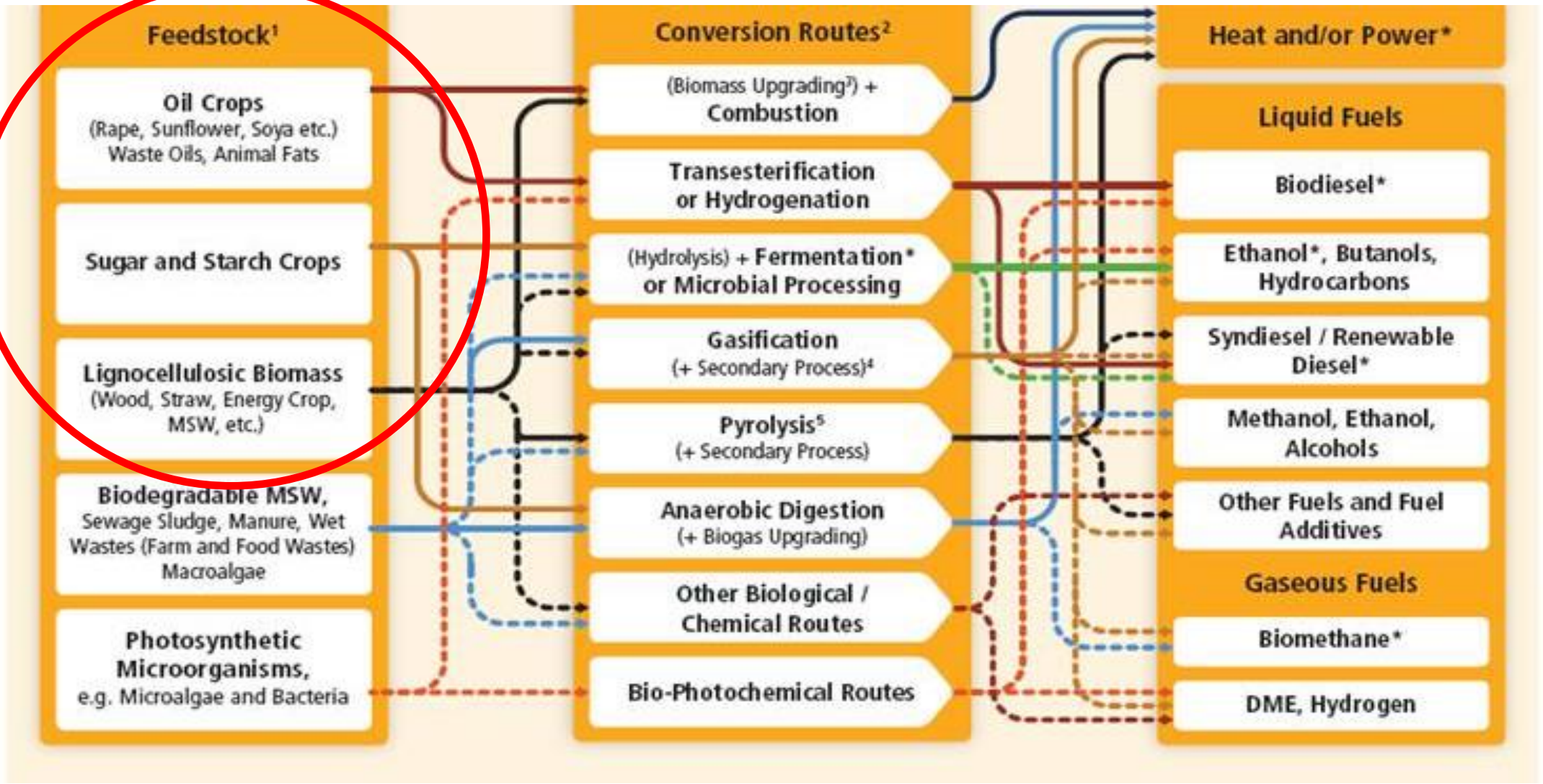
Achievements e.g. in Germany



Source: Fachverband Biogas (https://www.biogas.org/edcom/webfvb.nsf/id/DE_Branchenzahlen/$file/17-10-13_Biogasindustryfigures-2016-2017.pdf).

The climate change around the corner

Biomass productivity



Source:
IPCC (2011)

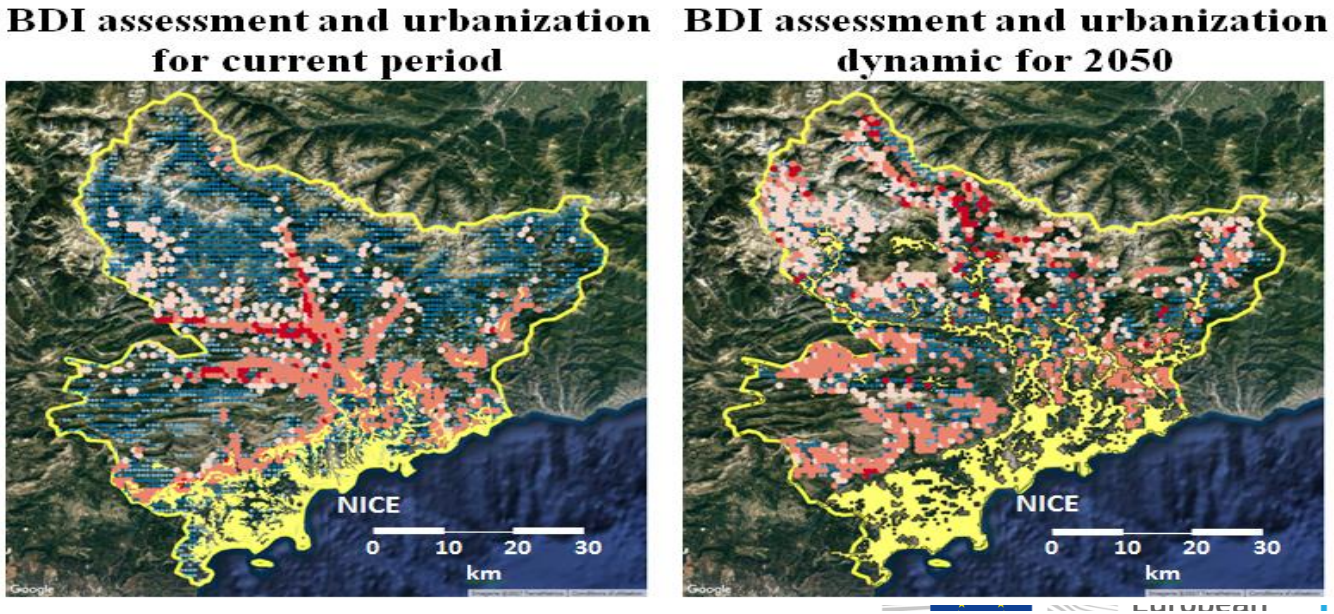
The climate change around the corner

(E. Garbolino)

Anticipating climate change effect on biomass productivity and vegetation structure of Mediterranean forests.

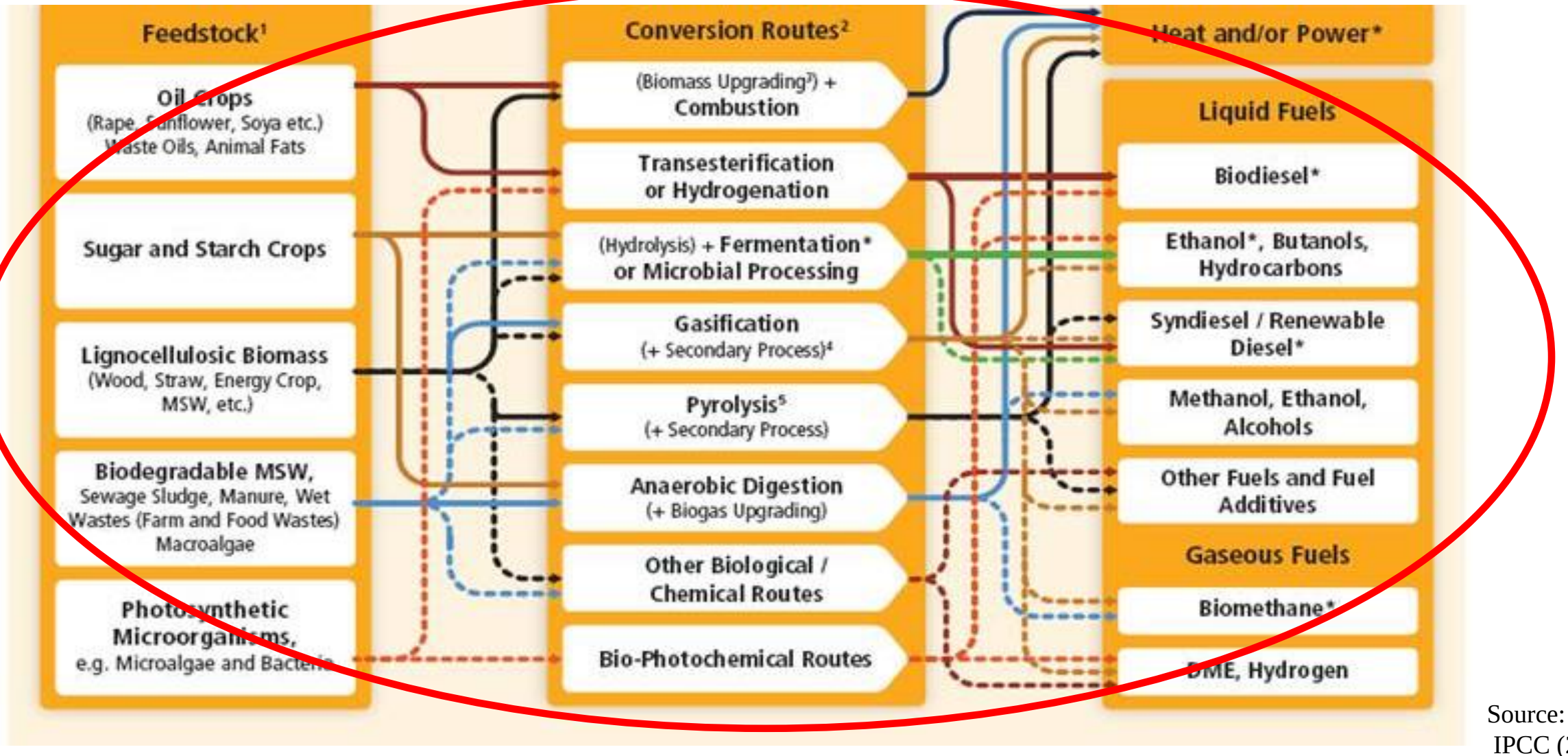
- Mediterranean forest may be more vulnerable due to the increase of temperatures that may affect the mortality of the trees and shrubs.
- In the mountain areas, the NPP will increase and the dynamic of trees would be suitable to the development of forests.

Geoprospective approach: the methodology takes into account the impact of the global warming on the Net Primary Productivity (NPP) and the vegetation structure towards 2050 (considering IPCC RCP 6.0 scenario), and the assessment of urban dynamic in order to identify the future areas of energy demand.



Source: Garbolino et al. (2017), Biomass Development Index (BDI) in Alpes-Maritimes in 2015 and 2050 and urbanization.

Bioeconomy – the full picture

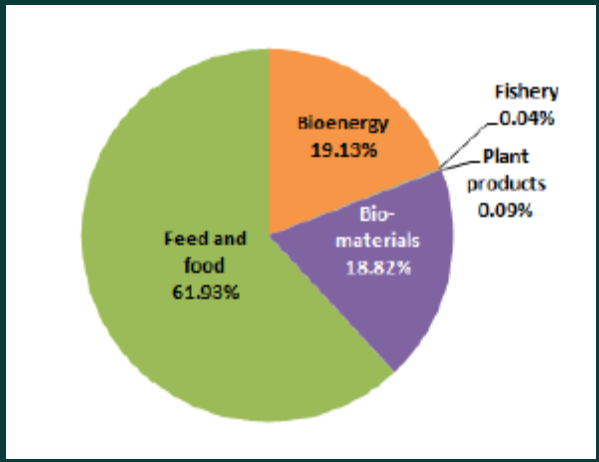


Source:
IPCC (2011)

Bioeconomy – the full picture

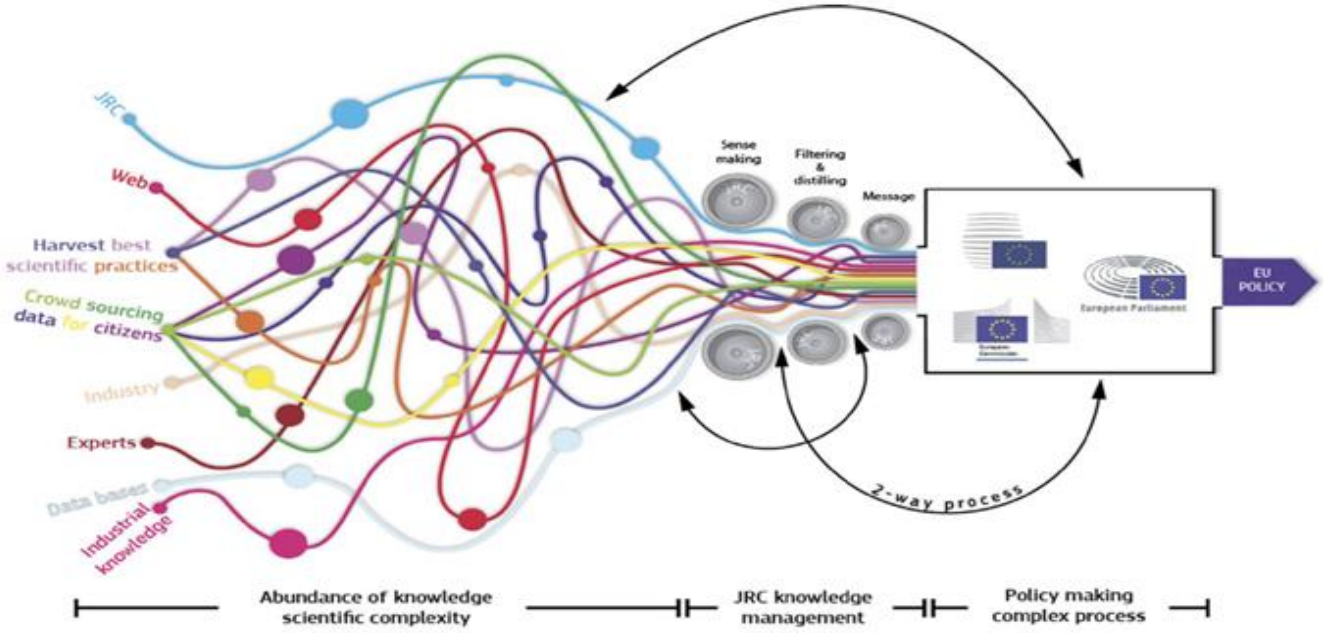
European Commission has put in place a **bioeconomy** strategy and a related Action Plan (COM (2012) 60) aiming to pave the way to a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes, while ensuring environmental protection.

Composition of the EU-28 biomass uses



Source: JRC, http://publications.jrc.ec.europa.eu/repository/bitstream/JRC106502/kjna28565enn.pdf

The concept of knowledge management to support policy making in the JRC Knowledge Centres



Source: JRC, Bio-Economy Unit.

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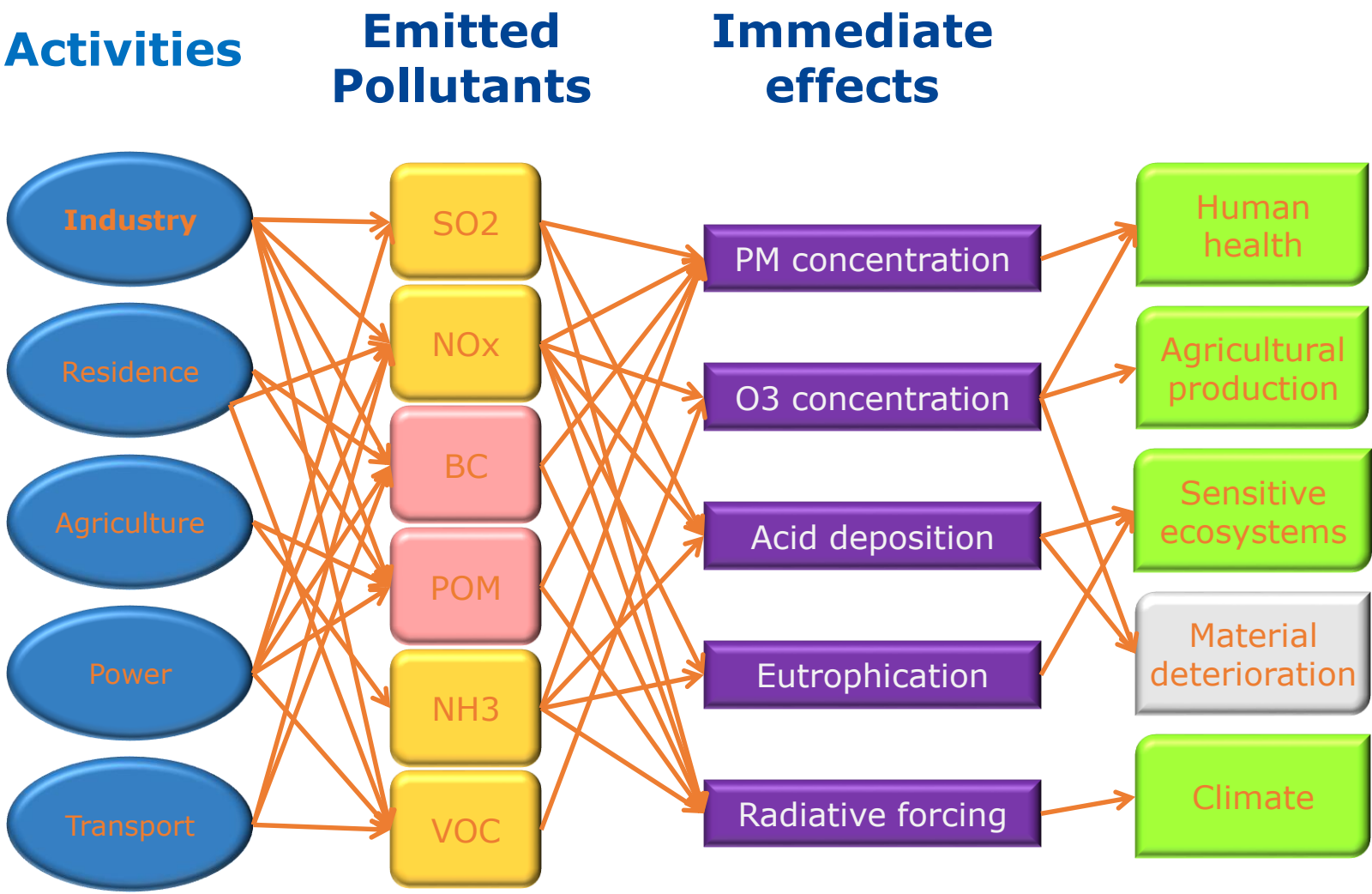
Quantitative policy assessment

all sources

JRC TM5-FASST

TM5-FASST model framework



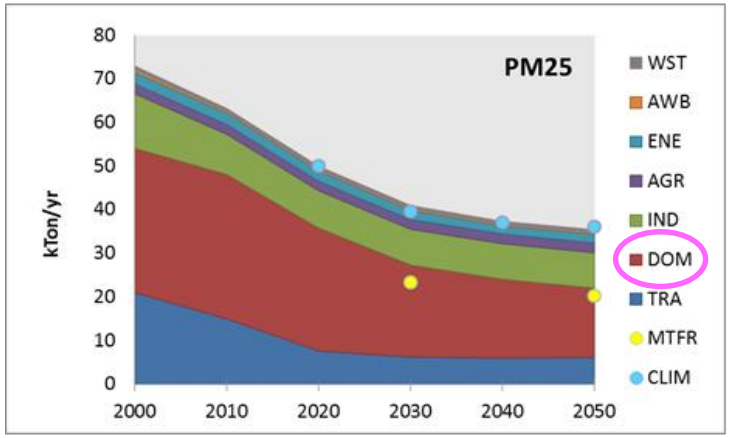
Source: JRC, Air and Climate Unit

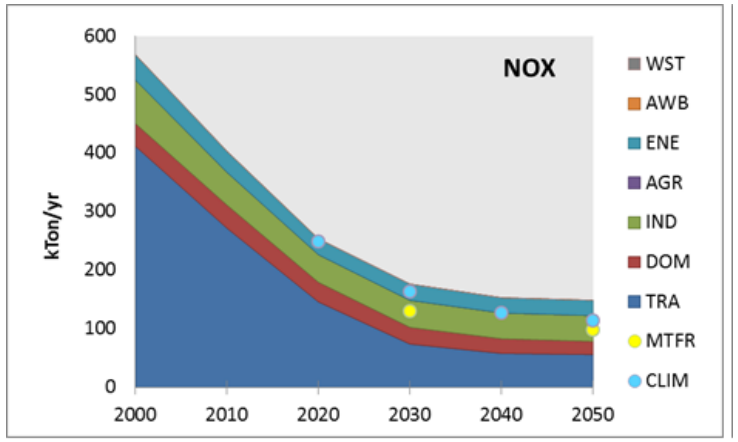
The FASST tool is available on-line at tm5-fasst.jrc.ec.europa.eu

Emissions and emissions scenarios: Alpine Region

Input for FASST

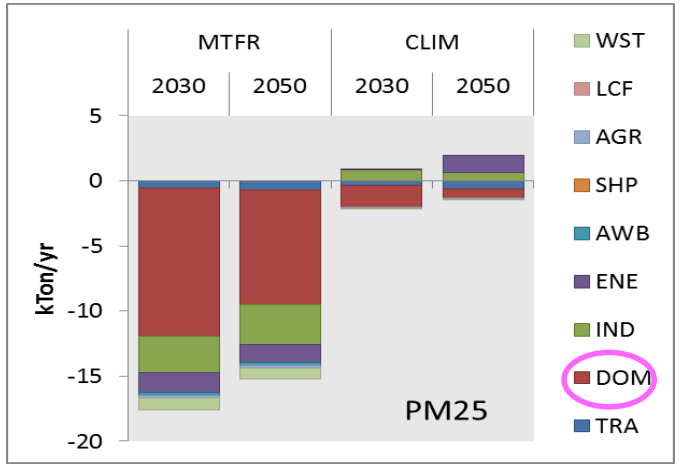
- current legislation (CLE)
- technology implementation (MRFT)
- climate measures (CLIM)

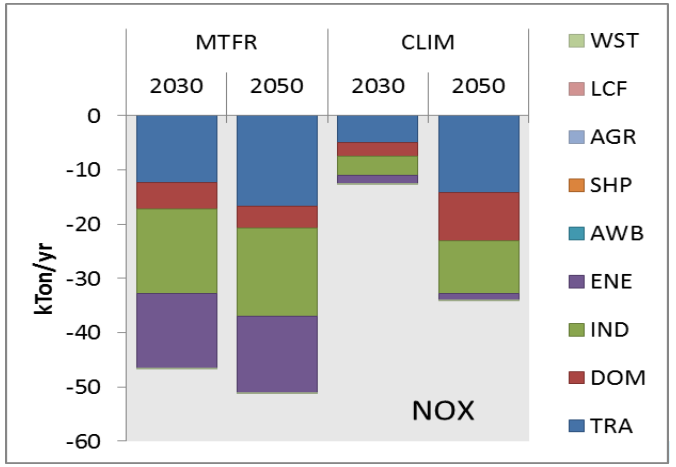




PM2.5 and NOx emission trends by sector **under CLE**; dots indicate the total of all sectors for the MTFR (yellow) and CLIM (blue)

Mitigation potential (as annual emission strength) by 2030 and 2050 under MTFR and CLIM scenarios, relative to CLE for the same year

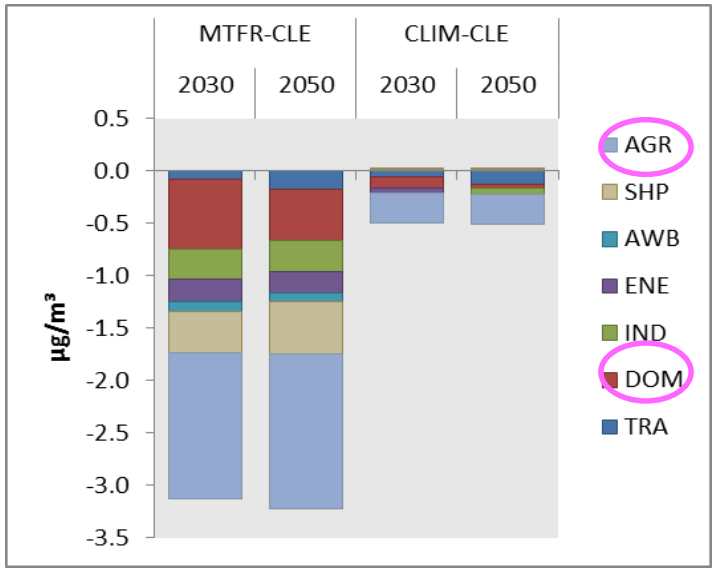




Source: JRC elaboration of ECLIPSE V5a gridded emission set (http://www.iiasa.ac.at/web/home/research/researchPrograms/air/ECLIPSEv5a.html).

A scenario analysis in the Alpine Region

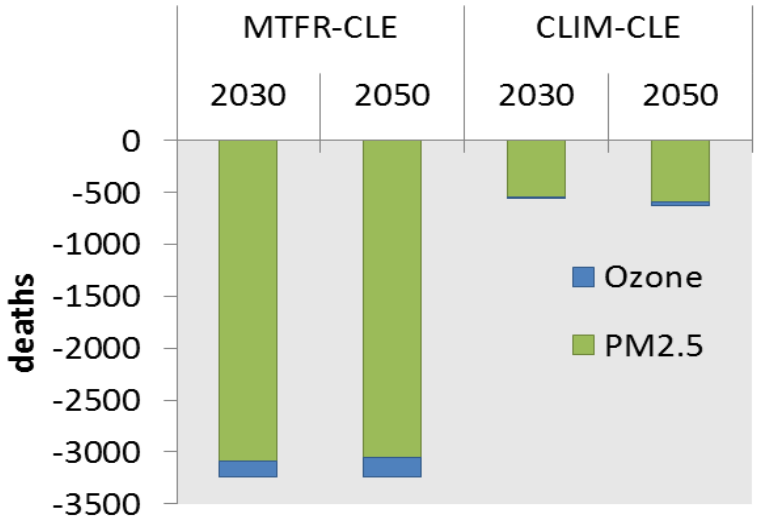
Reduction in population-weighted PM2.5 concentration in 2030 and 2050 compared to CLE for the same year.



Source: JRC elaboration of ECLIPSE V5a scenarios.

The contributions to PM2.5 by individual sectors, indicate a prominent role for the agricultural sector as a result of ammonia (NH_3) emissions leading to the formation of ammonium nitrate or sulphate in fine particulate matter.

Reduction in premature deaths attributable to air pollution in 2030 and 2050 (PM2.5 and ozone) under MTFR and Climate mitigation scenarios, relative to CLE for the same year.



Source: JRC analysis, Air and Climate Unit.

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Health impacts in the Alpine Region

Change in total annual premature mortalities from PM2.5 and ozone for MTFR and CLIM scenarios, relative to CLE from all sectors, and share of the change by sector. Numbers in red indicate a trade-off (i.e. an increase in mortalities from the associated sector).

ALPINE									
		ALL	TRA	DOM	IND	ENE	AWB	SHP	AGR
		# of deaths	Fraction by sector						
MTFR-CLE	2030	-3240	3%	21%	9%	7%	3%	14%	42%
	2050	-3240	6%	15%	10%	6%	3%	17%	43%
CLIM-CLE	2030	-556	13%	21%	0%	11%	-2%	0%	57%
	2050	-624	28%	7%	11%	-2%	0%	-2%	57%

Source: JRC analysis, Air and Climate Unit .

- The **MTFR scenario** leads to about 3,200 annual extra avoided premature mortalities (compared to CLE) by 2030 and 2050.
- Co-benefits from **climate mitigation** are relatively small i.e. 600 avoided premature deaths by 2050. We note in particular the trade-off and ENE sectors in 2050, due to the projected change in the fuel mix with a larger contribution from biomass leading to higher emissions of primary PM2.5.

Key messages for policy makers

- Bioenergy will remain a key component of the European **energy mix.**
- Bioenergy poses relevant challenges for **sustainability.**
- **Efficient resource utilisation** is highly recommended e.g. by applying biorefinery concept to the industry that produces residues; by biowaste collection and the use of waste with high water content in biowaste refinery (anaerobic digestion).
- **Carbon neutrality of biomass**: the GHG reductions depend on type of feedstock, forest management (past, present and forecasted), alternative uses of biomass, fossil source substituted, end-use efficiency etc.
- **Support research** on GHG emissions and capture due to forest management techniques in order to underline the best practices to ensure the lowest GHG emission.
- **Evaluate the climate change impacts** on the resource of biomass in order to assess the sustainability of the development of the supply chain.

Key messages for policy makers

- Appropriate measures for **reconciling** climate mitigation and environmental protection to be implemented all along the bioenergy production chain.
- Attention should be given to the **increasing biomass combustion**, which will increase pollutant emissions unless emissions are abated with technology; advanced technologies need a broad market acceptance to enable a strong market penetration.
- Some sustainability aspects e.g., **air quality and health** can be assessed quantitatively with models such as JRC TM5 FASST.
- Stakeholders are encouraged to think about **multiple aspects** when planning in the bioenergy field, food and bio-materials.

Many thanks to the contributors!

http://edgar.jrc.ec.europa.eu/working_group_bioenergy_2017.php

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JRC report (in preparation) "Identifying key priorities in support to the EU Macro-regional Strategies implementation: An ex-ante assessment for the Adriatic-Ionian and Alpine regions focusing on clean growth in transport and bioenergy"

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Any questions?

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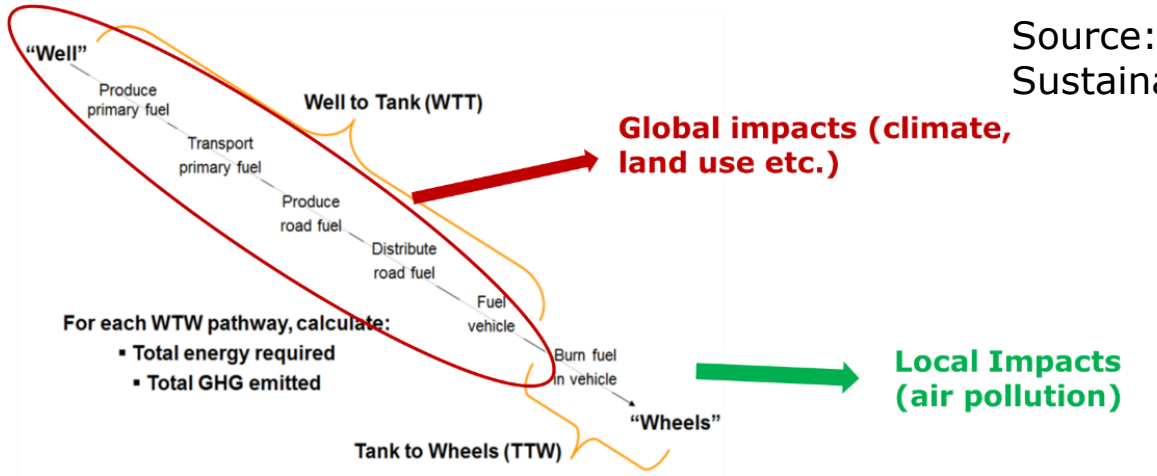
Biofuels in transport: trade-off

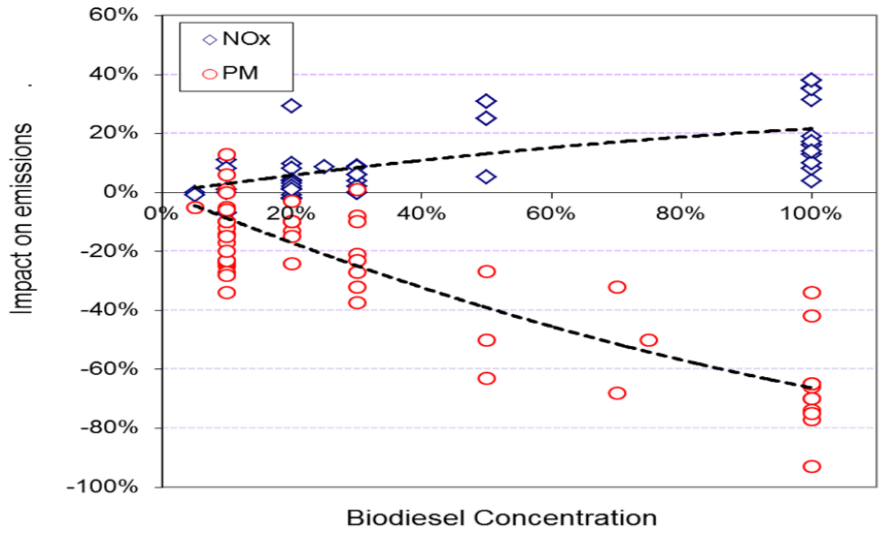
1) Life-cycle of the fuels in use with different regulatory frameworks for WTT and TTW
2) NOx and PM emissions related to biodiesel concentration

Biofuels represent one of the few options to reduce CO_2 emissions in transport.
1st generation biofuels vs advanced biofuels (mainly from waste and residues).



Source: JRC elaboration, 2017, Sustainable Transport Unit .

Environmental and climate impacts of biofuels must be assessed over the entire life-cycle of the fuels in use with different regulatory frameworks for WTT and TTW emissions.

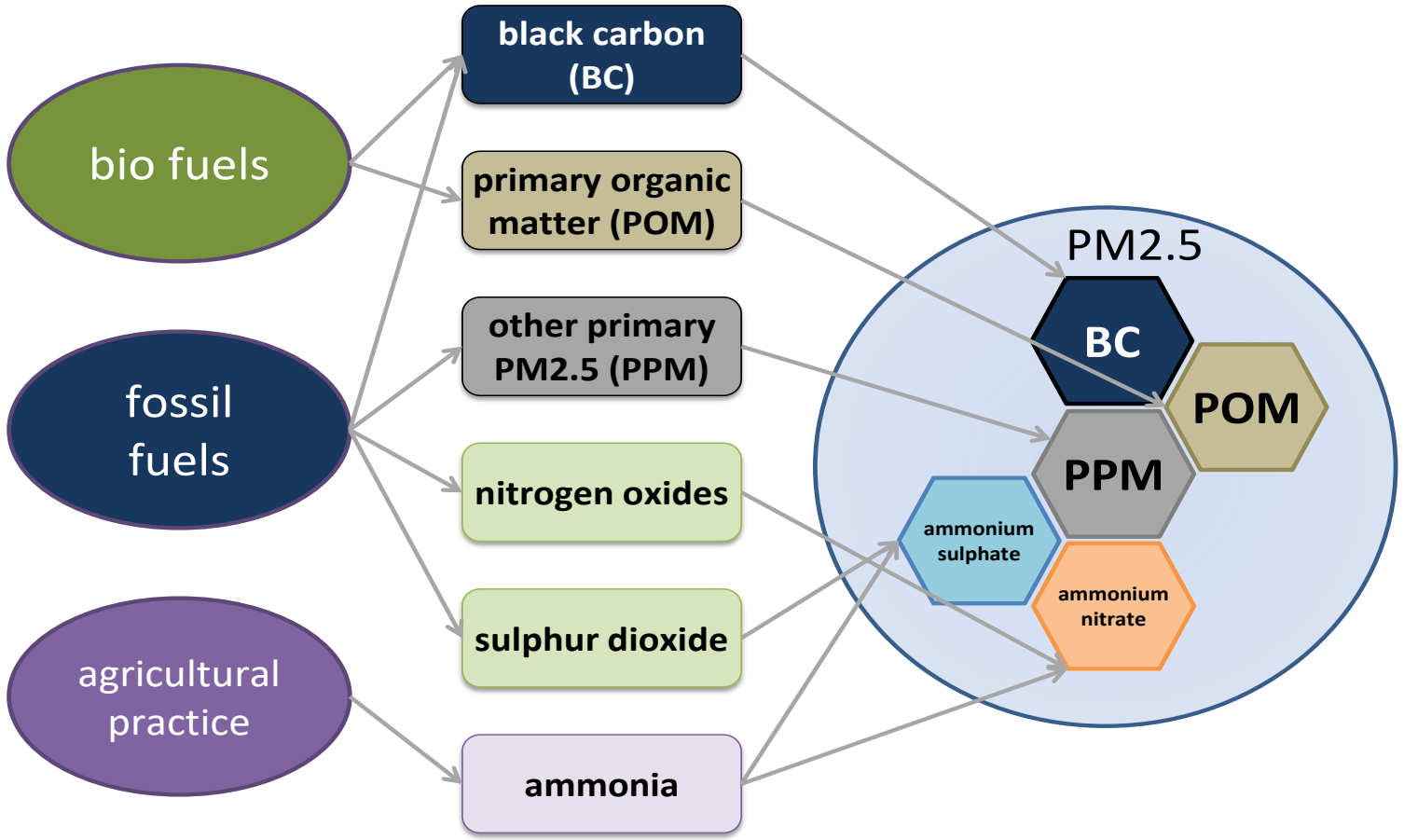


Source: Kousoulidou et al, 2012.

Emissions:
There are potentials for CO_2 reductions and climate benefits compared to the use of fossil fuels in the WTT part (supply-chain).
The tailpipe emissions reduction are important for urban air quality with trade-offs between some effects e.g. PM and NOx emissions.

Note on the agricultural contribution to PM2.5

The contributions to PM2.5 by individual sectors shown below indicate a prominent role for the agricultural sector as a result of ammonia (NH_3) emissions leading to the formation of ammonium nitrate or sulphate in fine particulate matter.



Source: JRC elaboration, Air and Climate Unit

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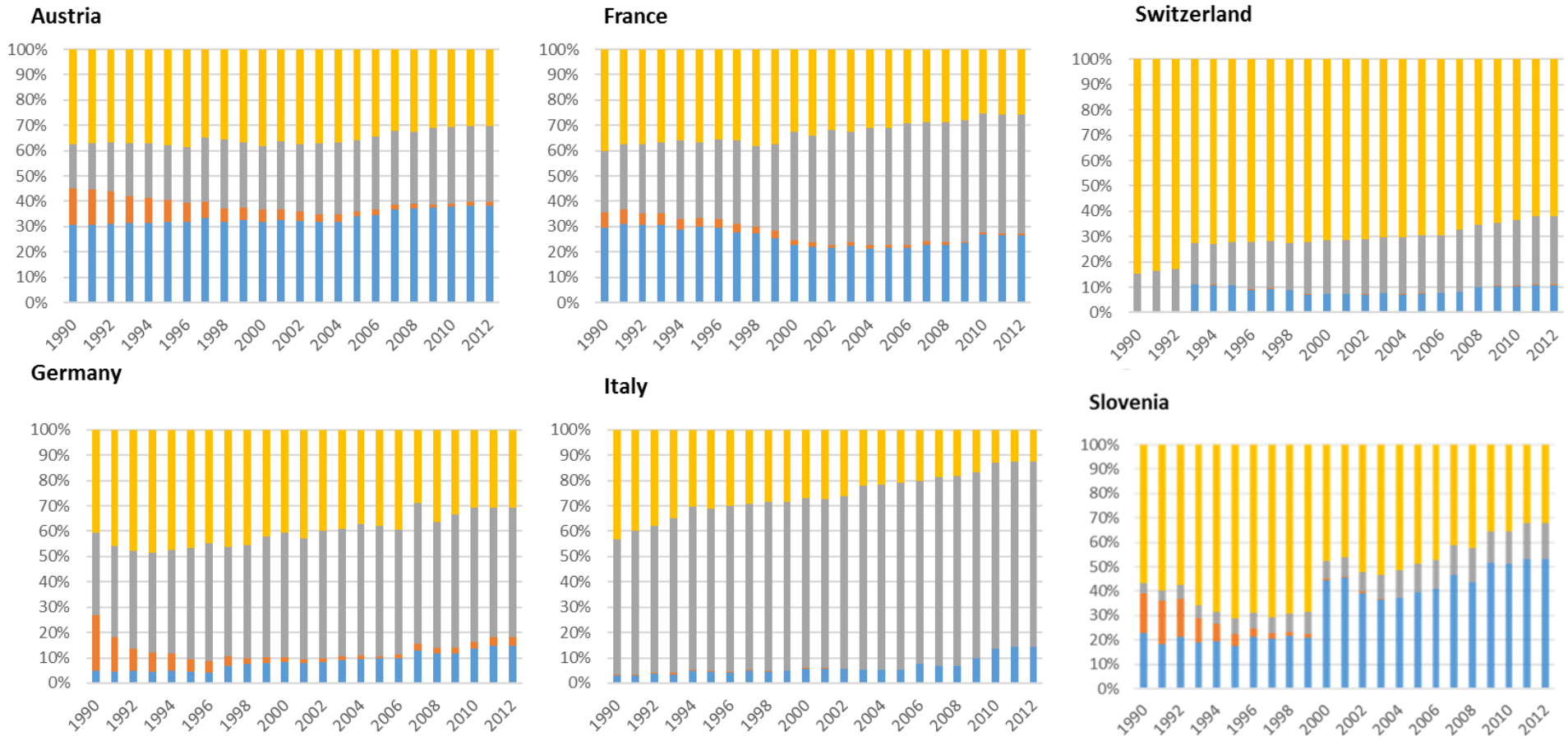
Fuel mix in EUSALP: residential sector



Source: EDGARv4.3.2 (IEA, 2014).

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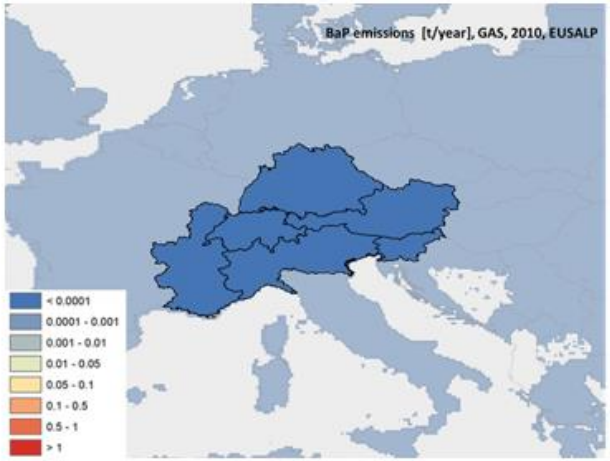
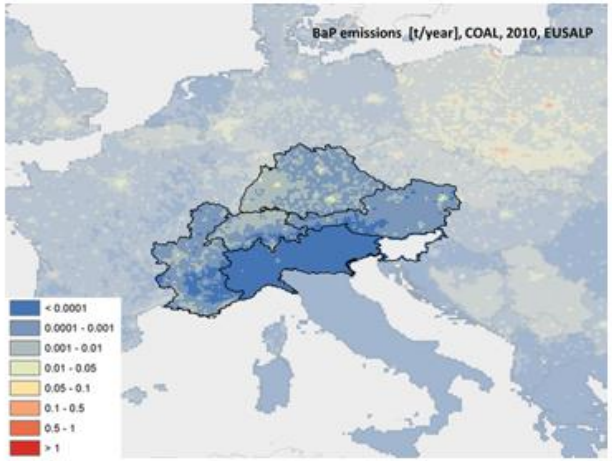
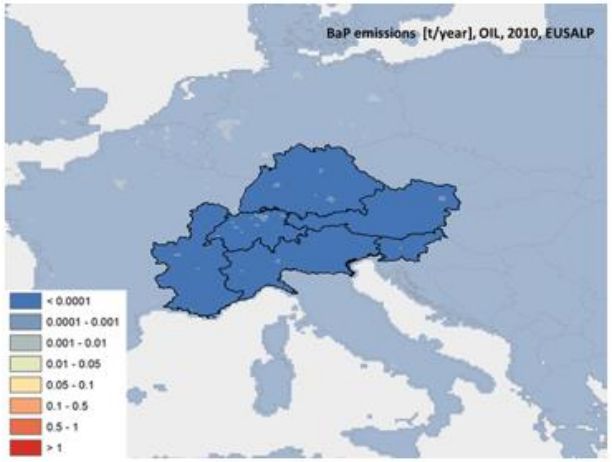
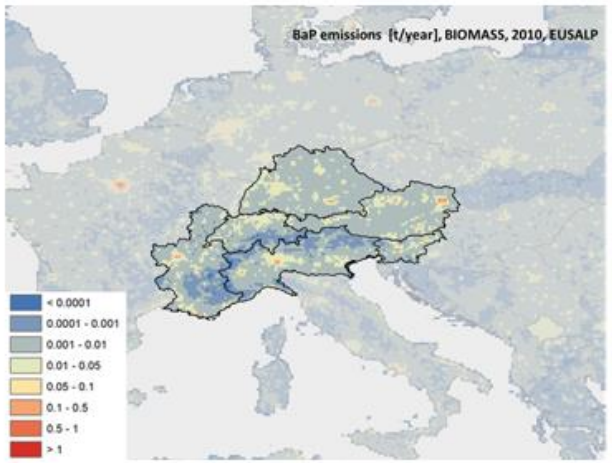
Effects e.g. emissions from fuel combustion in residential sector

benzo[a]pyrene (BaP)









Country/EUSALP	%shares 2010
Austria	24.2
Switzerland	9.4
Germany (part)	26.2
France (part)	19.6
Italy (part)	15.4
Liechtenstein	0.1
Slovenia	5.1

Emission Factors

Residential, BaP

a) Traditional stoves

b) Advanced technology

EFs BaP	Coal [mg/GJ]	Biomass [mg/GJ]	Liquid [µg/GJ]	Gas [µg/GJ]
a)	250	121	80	0.56

EFs BaP	Coal [mg/GJ]	Biomass/pellet [mg/GJ]
b)	**150** (40% lower)	**10** (92% lower)

Source: JRC, https://ec.europa.eu/jrc/en/publication/impact-evaluation-biomass-used-small-combustion-activities-sector-air-emissions-analyses-emissions

"Impact evaluation of biomass used in small combustion activities sector on air emissions: Analyses of emissions from Alpine, Adriatic-Ionian and Danube EU macro-regions by using the EDGAR emissions inventory"