Market barriers, feedstock availability & suitability for advanced biofuels

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EU lignocellulosic feedstock availability and potential for advanced biofuels and connected challenges

[Ric Hoefnagels]
[Utrecht University]
ADVANCEFUEL Stakeholder Workshop
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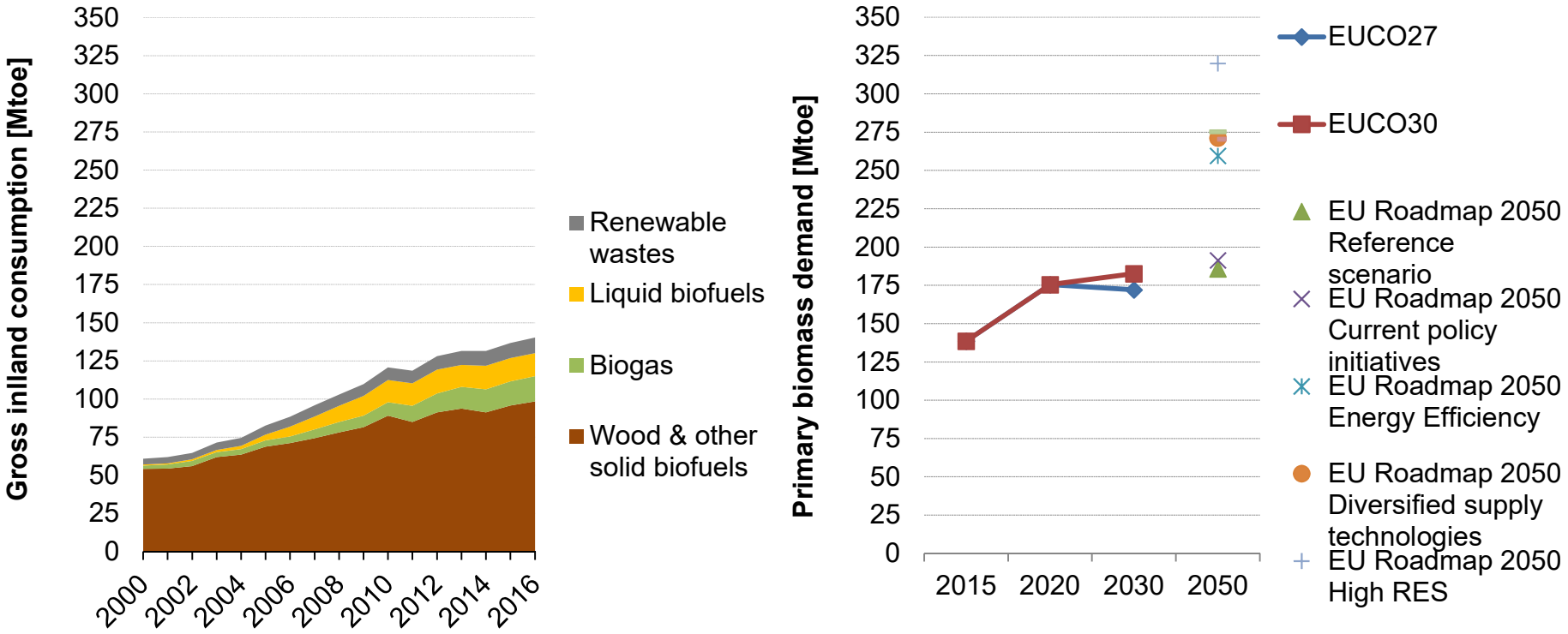
Overview

- **Current status of the EU bio-based economy and bioenergy.**
- **Future biomass availability**
- **Suitability and readiness of biomass for advanced biofuel production**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N.° 764799.

Historic trend and future projections of primary biomass demand in the European Union



To meet the 2050 objective (-80% GHG), biomass demand might grow substantially post-2030, in particular in advanced biofuels.

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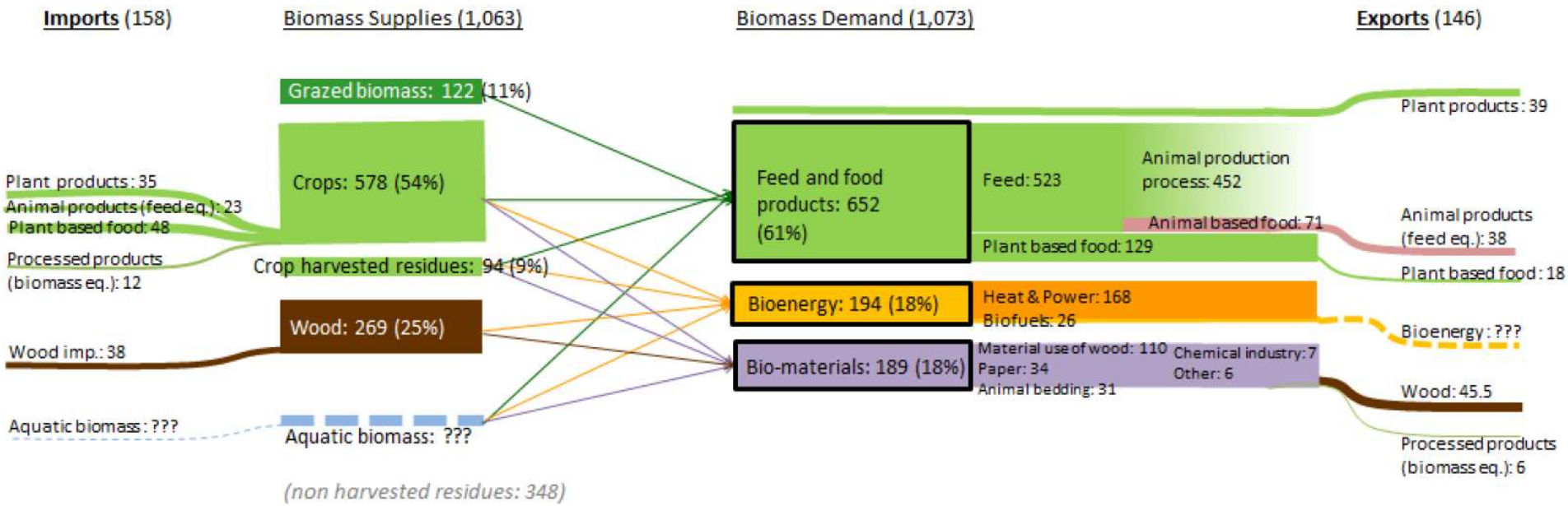
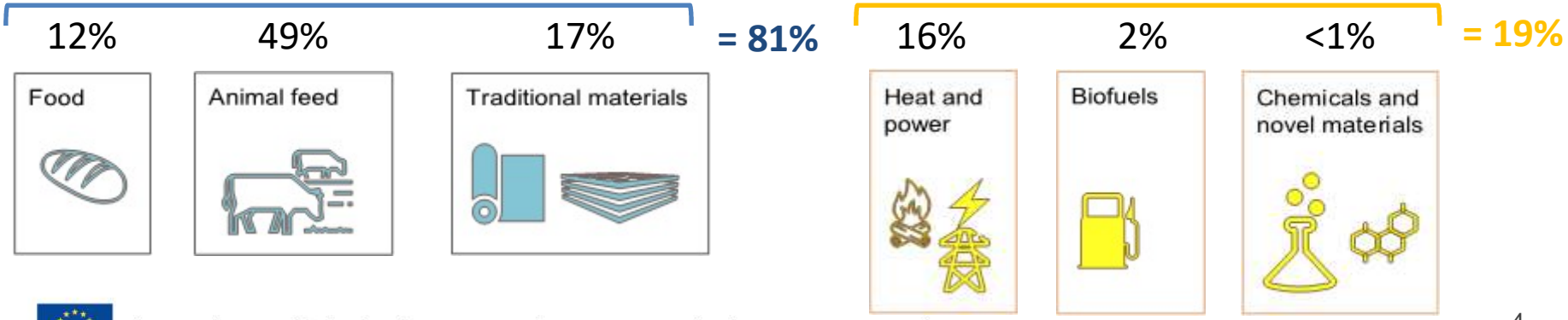
Source: EUROSTAT 2018, Impact Assessment Sustainable Bioenergy, EU SWD(2016) 418 final, Energy roadmap 2050' (COM(2011) 885 final of 15 December 2011

Biomass flows in the EU bio-based economy 2013, million tonnes dry





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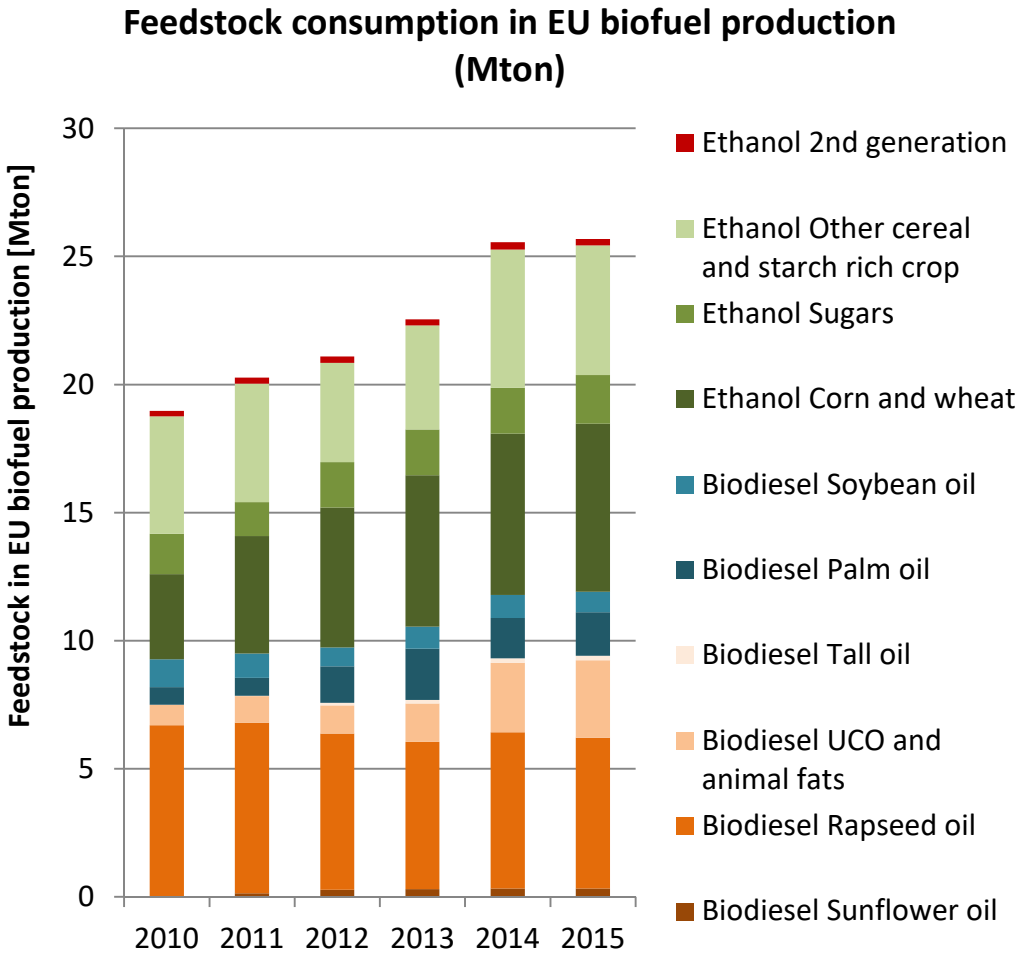
Source: Ronzon, T., Santini, F. and M'Barek, R. (2015) The Bioeconomy in the European Union in numbers. Facts and figures on biomass, turnover and employment. JRC IPTS

Feedstock consumption in EU biofuel production

Feedstock advanced ethanol: 240 kton (1%)

Esimated land use for EU biofuel production (2012):

- **Inside EU: 4.4 Mha**
- **Outside EU: 3.5 Mha**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N.° 764799.

Source: AEBIOM 2017, Hamelinck et al. (2014) Renewable energy progress and biofuels sustainability.

The need for biomass supply

- Is there sufficient sustainable biomass available to meet energy, climate targets in the European Union?
- Are biomass feedstocks actually (readily) available in specific locations for conversion to bioenergy (heat, electricity, biofuels)?
- And in particular for the production of advanced biofuels

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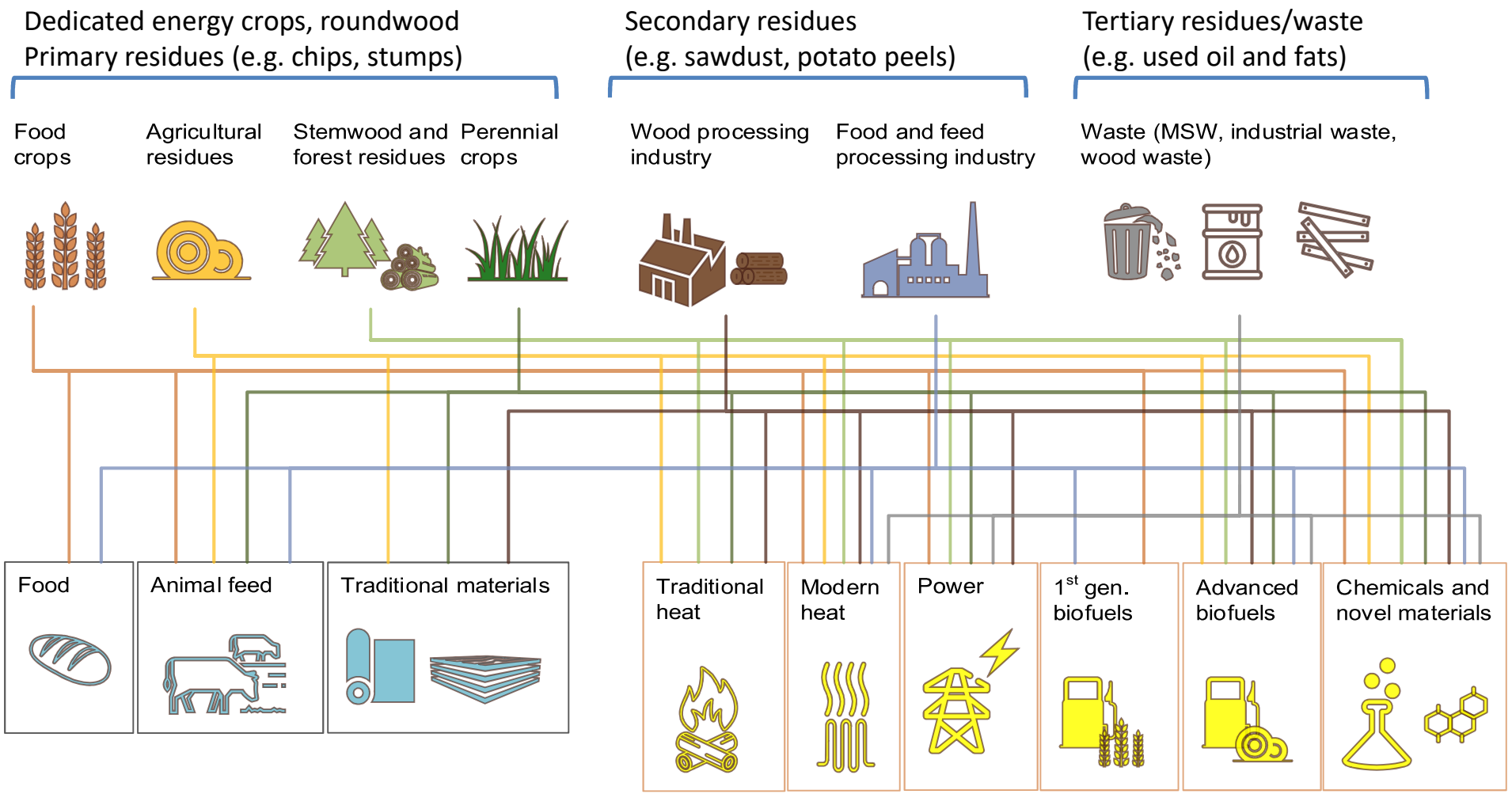
Biomass categories and markets



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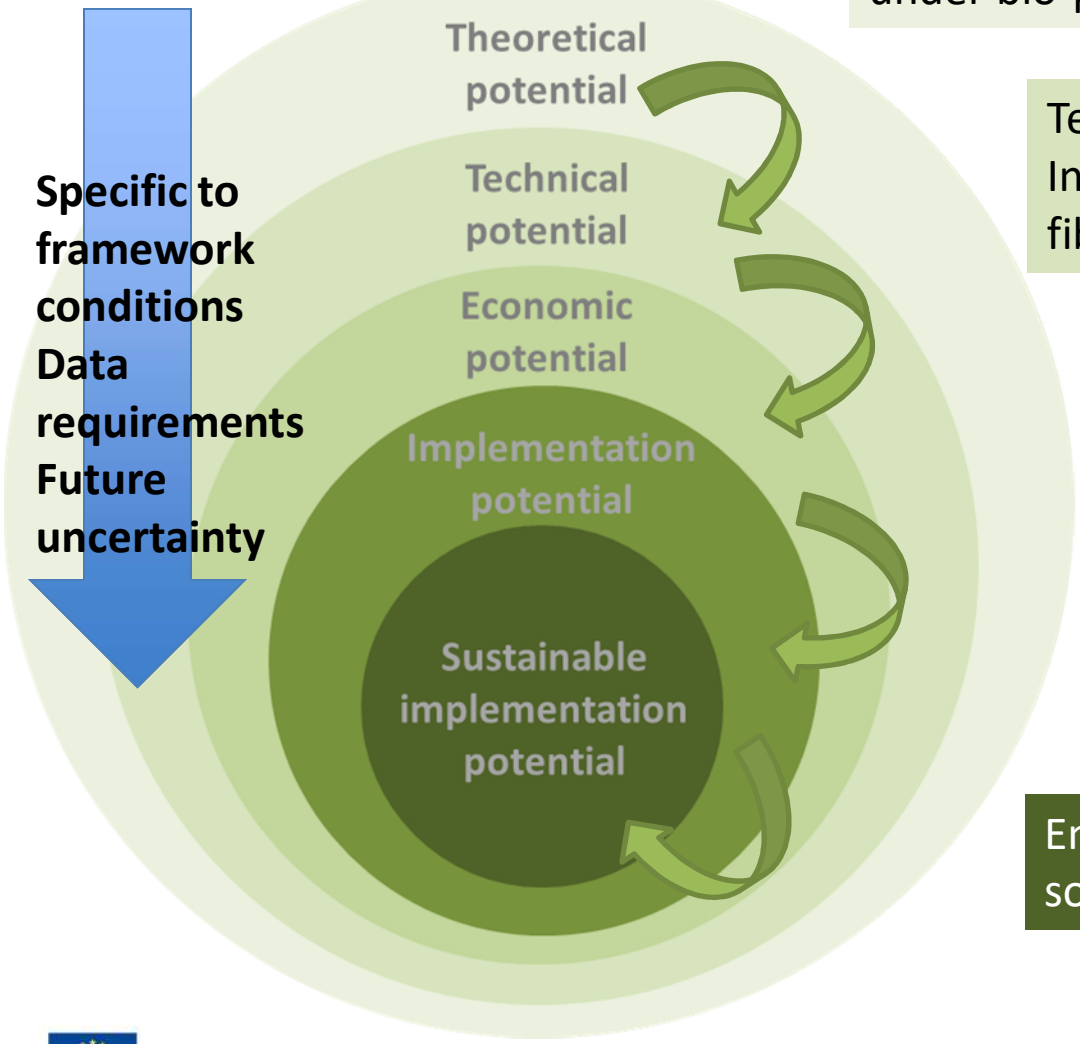
Types of biomass potentials



+ **Specific to framework conditions**
+ **Data requirements**
+ **Future uncertainty**

Maximum production under bio-physical limits

Technical and environmental constraints Including other land uses for food, feed fibre and ecological (e.g. nature)

Economic constraints and Sustainability criteria

Socio-political constraints

Environmental, economic and social sustainability criteria

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Source: van den Berg D, Vis MW (2010) Volume I Best Practices and Methods Handbook. Biomass Energy Europe (BEE).

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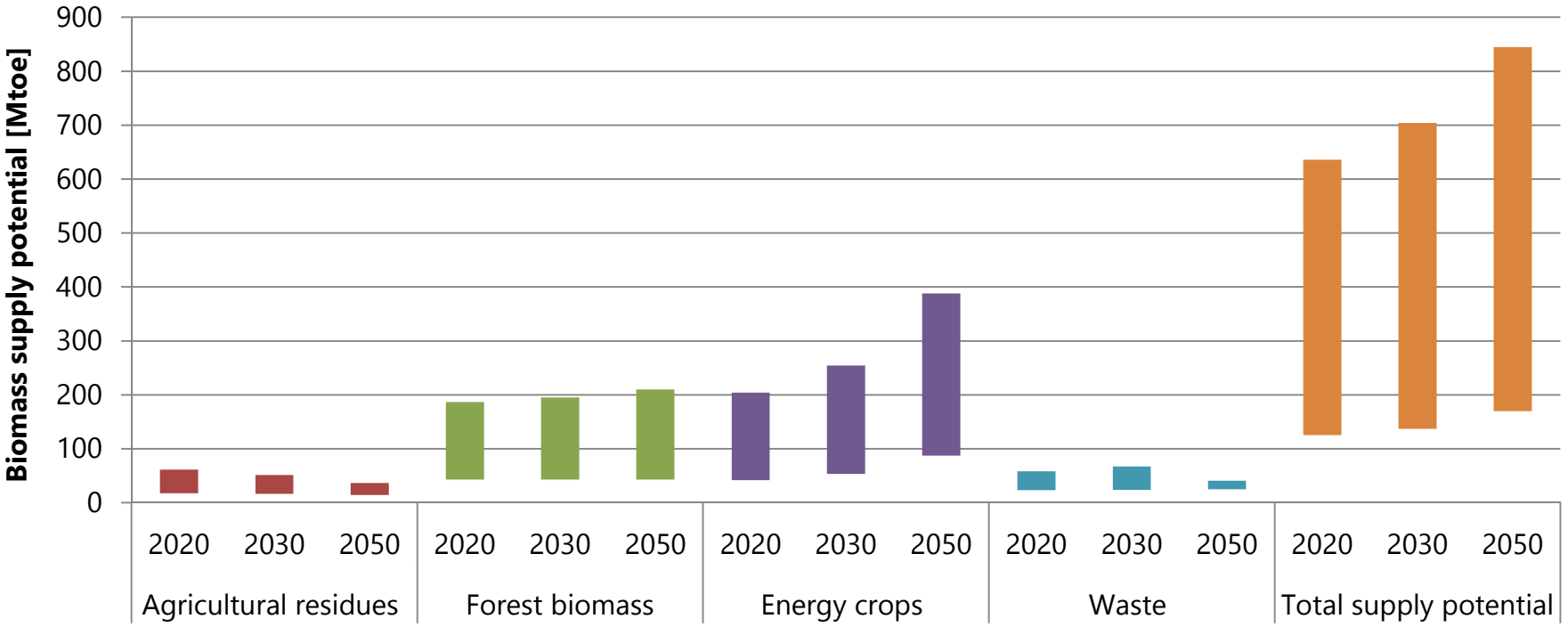
Biomass potentials

EU biomass potential available for bioenergy by main feedstock category from available EU biomass resource assessments (2006 - 2017)

Forest biomass (stemwood and residues) and energy crops (food based and perennial crops) are the largest sources of biomass, but also most uncertain.



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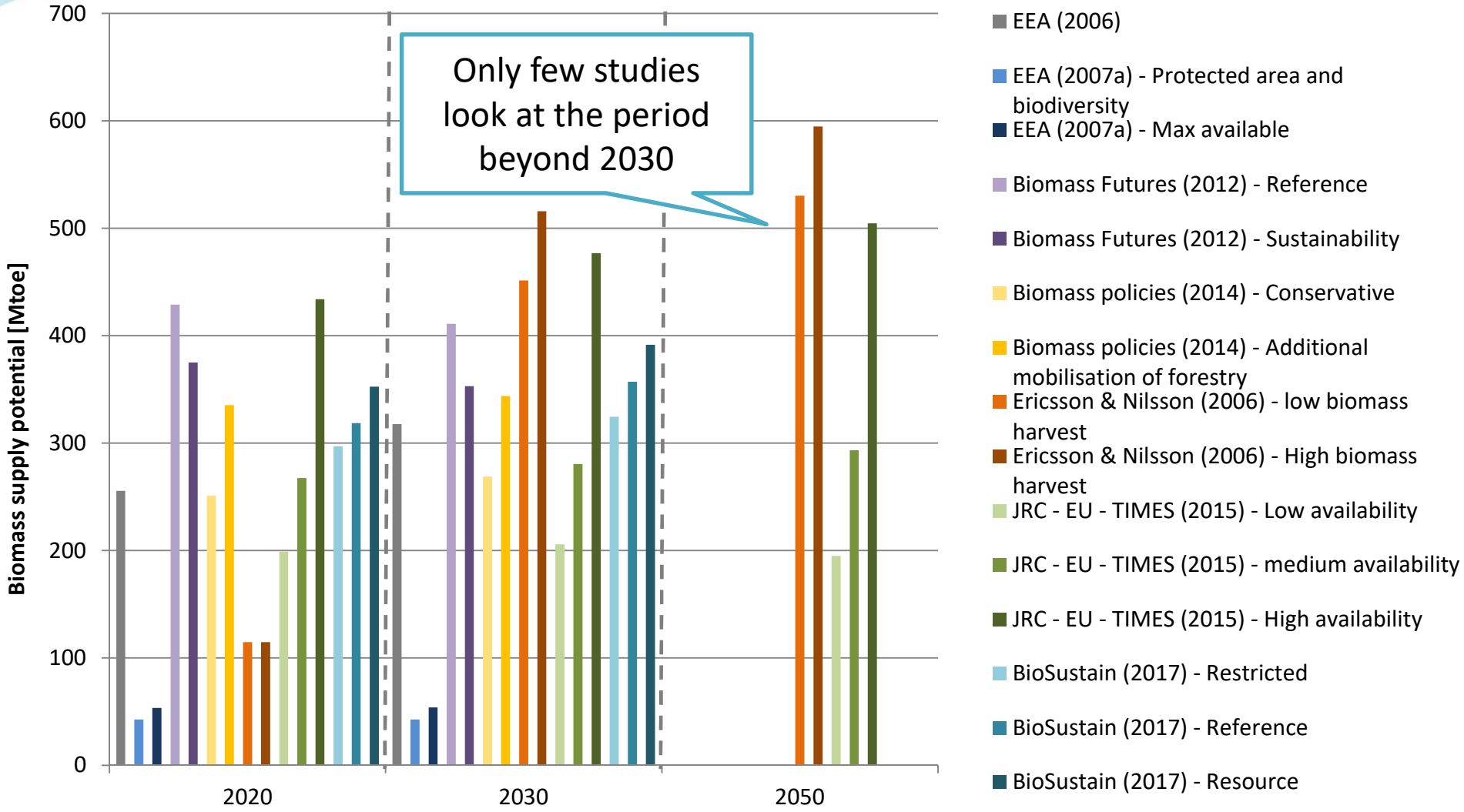
EU biomass potentials for bioenergy per study and scenario (2020 – 2030)



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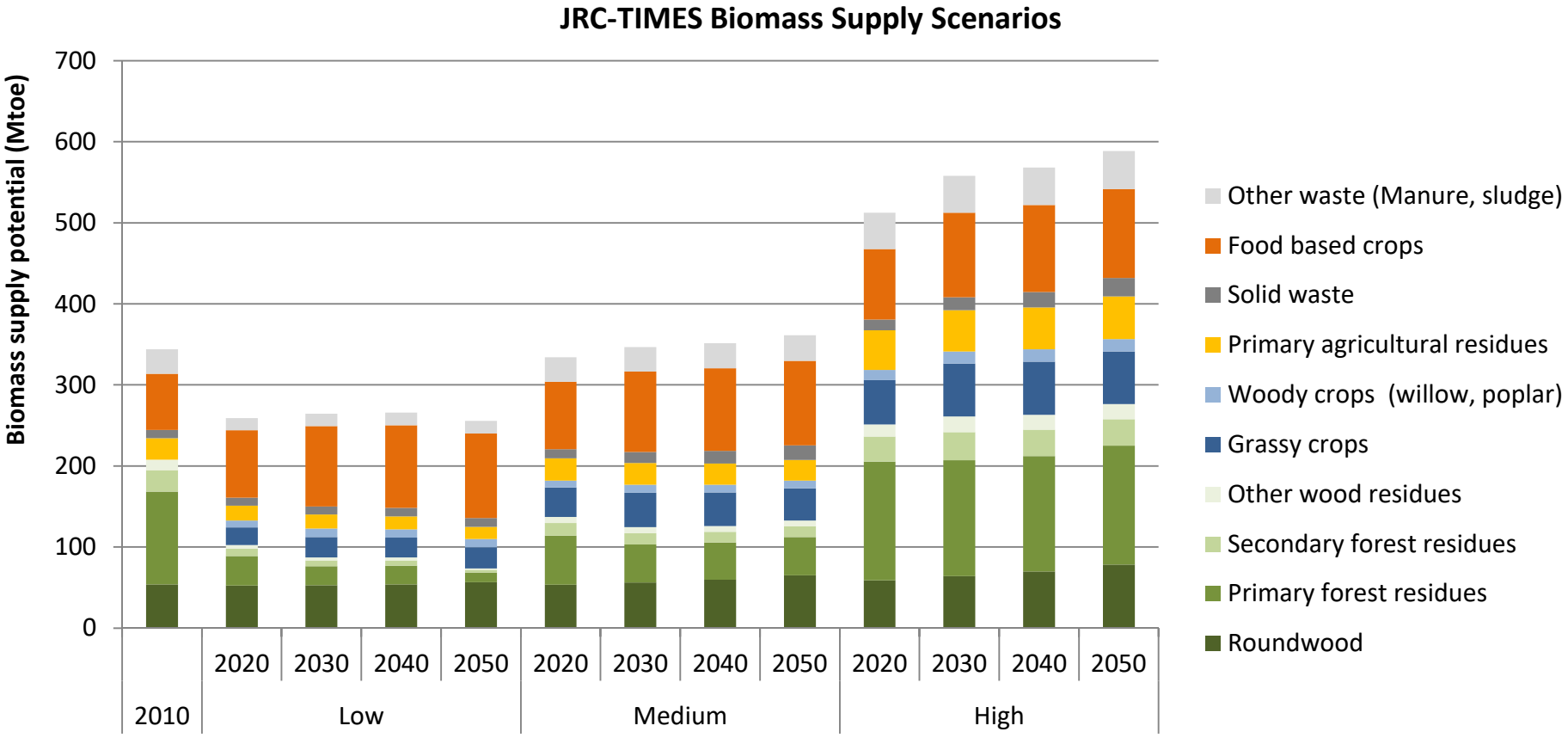
Source: as collected by Mandley et al. (forthcoming publication)

EU biomass supply scenarios JRC – EU-TIMES (2015)



Potential availability and actual availability are not the same. Upscaling of perennial crops and other feedstocks that are currently not mobilized might be too optimistic.

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Source: Ruiz, Pablo, et al. *The JRC-EU-TIMES model. Bioenergy potentials for EU and neighbouring countries*. Publications Office of the European Union, 2015.

Method to determine lignocellulosic feedstock readiness and suitability

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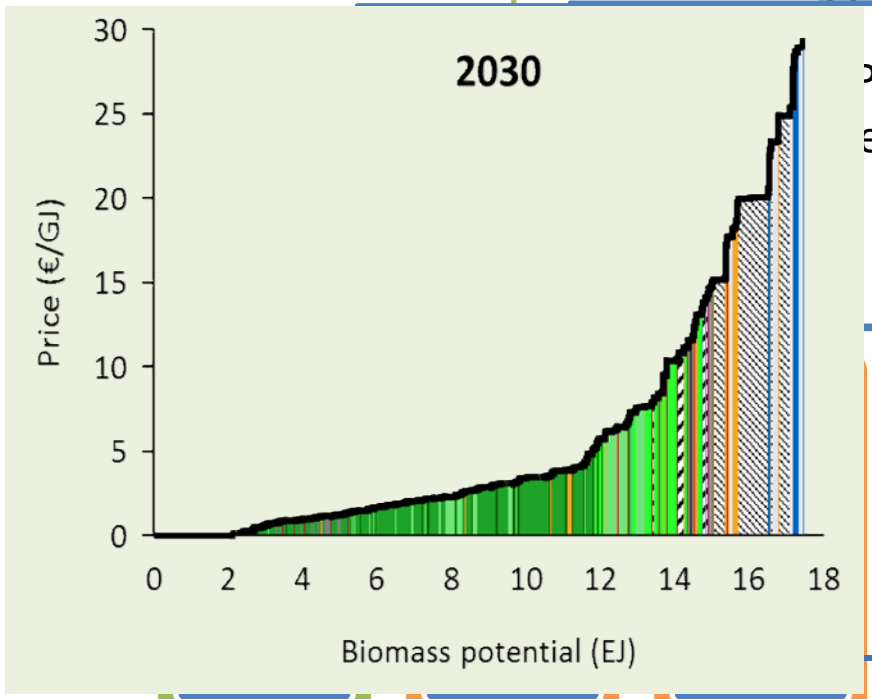
Building on existing work:

- **Feedstock potential: Cost-supply assessment of biomass (S2Biom, Biomass**



Promotion o
eedstock pr
regolatory

Matching feedstock with a specific conversion process

TRL)

Policy

Suitability

Conversion

Support schemes, regolatory compliances

Chemical and physical characteristics

(Bio-)chemical conversion

Thermal conversion

Sources: S2Biom D4.5: 1. Lammens T, Vis M, Berg D van den, et al (2016) Bio2Match: a Tool for Matching Biomass and Conversion Technologies - S2Biom Deliverable D4.5. Enschede and Wageningen (the Netherlands), Steiner JJ, Lewis KC, Baumes HS, Brown NL (2012) A Feedstock Readiness Level Tool to Complement the Aviation Industry Fuel Readiness Level Tool. BioEnergy Res 5:492–503. doi: 10.1007/s12155-012-9187-1

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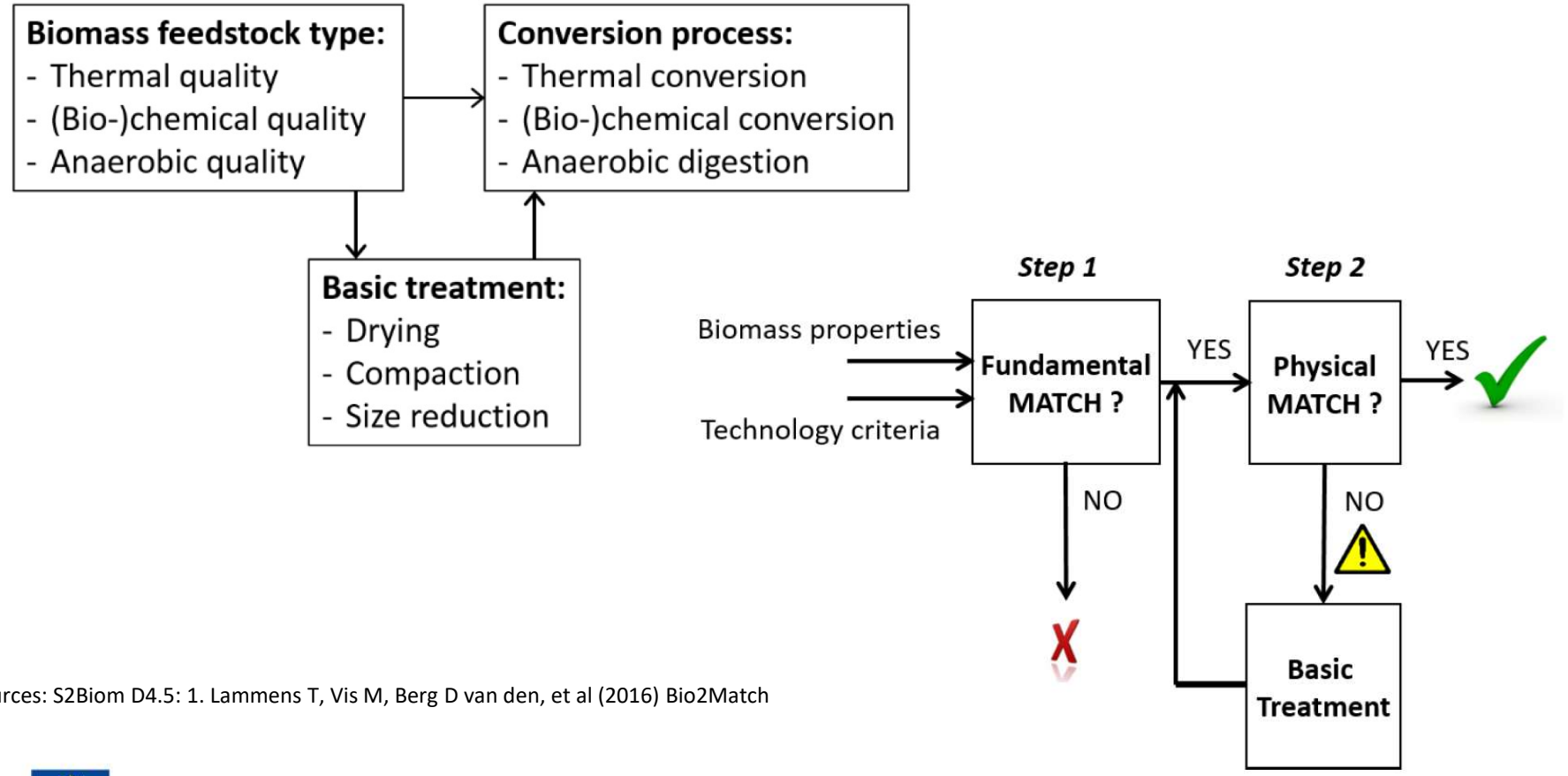
Suitability: Bio2Match tool (S2BIOM)



Sources: S2Biom D4.5: 1. Lammens T, Vis M, Berg D van den, et al (2016) Bio2Match

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Lignocellulosic biomass feedstock suitability for conversion with important indicators

Feedstock category	Range	Thermal conversion					(Bio)chemical conversion			
		Ash content	Ash melting temperature	Nitrogen content	Chlorine content	Total score	Ash content	Lignin content	Carbohydrate content	Total score
Stemwood	Min	4	4	3	3	**3.5**	4	2	4	**3.3**
	Max	4	4	4	4	**4.0**	4	3	4	**3.7**
Primary residues from forests	Min	2	3	3	4	**3.0**	2	2	4	**2.7**
	Max	2	3	4	4	**3.3**	2	3	4	**3.0**
Grassy crops	Min	2	1	2	1	**1.5**	2	3	3	**2.7**
	Max	3	4	3	2	**3.0**	3	4	4	**3.7**
woody crops (SRC)	Min	3	4	3	3	**3.3**	3	2	4	**3.0**
	Max	3	4	3	3	**3.3**	3	3	4	**3.3**
Agricultural residues	Min	1	2	2	1	**1.5**	1	2	3	**2.0**
	Max	3	4	3	3	**3.3**	3	3	4	**3.3**
Grassland	Max	2	2	2	1	**1.8**	2	3	2	**2.3**
Secondary residues from wood industries	Min	1	1	3	1	**1.5**	1	2	1	**1.3**
	Max	4	4	4	3	**3.8**	4	3	4	**3.7**
Secondary residues of industry utilising agricultural products	Min	1	1	2	1	**1.3**	1	1	2	**1.3**
	Max	3	4	3	2	**3.0**	3	3	3	**3.0**
Municipal waste	Min	1	2	2	1	**1.5**	1	3	1	**1.7**
	Max	1	3	2	2	**2.0**	1	3	1	**1.7**
Waste from wood	Min	2	3	2	2	**2.3**	2	2	3	**2.3**
	Max	3	3	3	3	**3.0**	3	2	3	**2.7**

Score: 4 = highest quality, 1 = lowest quality.

Some conversion technologies are more flexible than others.

Other important characteristics: energy/bulk density, particle size, moisture content, contaminations.

Only ranges are shown, detailed information is available within the Bio2Match tool.

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Perennial crops

Short rotation coppice (willow, poplar, eucalyptus) and herbaceous/grassy crops (miscanthus, switchgrass etc)

- 30 years of experience in Europe (with introduction of set-aside in CAP policy in 1988)
- Area of cultivation is however still limited (0.05% of the utilised agricultural area in the EU28)
  - SRC: 68 200 ha
  - Miscanthus: 21 800 ha
- Not competitive with food/feed when cultivated on productive lands (poor cashflow for farmers)
- Could give higher yields on low productive land compared to annual crops
- Not competitive with domestic and imported forest biomass (chips/pellets)
- Lack of skills and infrastructure (growers are often isolated and special machinery and infrastructure need economies of scale)
- Long term commitment is required
- Experience with bioenergy is limited to electricity (e.g. DRAX in the UK) and heat (e.g. district heating and CHP in Sweden)
- The current market is static, but the introduction of SRC as an Ecological Focus Area (EFA) in the CAP could stimulate production (adopted by Germany, Ireland, Poland and Sweden).

Sources: Lindegaard et al (2016) – Short rotation plantations policy history in Europe: lessons from the past and recommendations for the futrue, Food and Energy security 2016;5(3)125-152

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Feedstock readiness level of perennial crops in the EU28

The FSRL level of perennial crops is currently 5 – 6

Activity	Scale	Description	(1) Production	(2) Market	(3) Policy	(4) Suitability	Final score
Preliminary Feedstock Evaluation	1	Basic Principles					
	2	Concept Formulated					
Feedstock Experimental Testing	3	Proof of Concept					
	4	Preliminary Technical Evaluation					
Pre-commercial Feedstock Assessment	5	Production System Validation				X	X
	6	Full-Scale Production Initiation	X	X	X		
Feedstock Commercial Deployment	7	Feedstock Availability					
	8	Commercialization					
	9	Sustainable Feedstock Production Capacity Established					

Sources: Steiner JJ, Lewis KC, Baumes HS, Brown NL (2012) A Feedstock Readiness Level Tool to Complement the Aviation Industry Fuel Readiness Level Tool. BioEnergy Res 5:492–503. doi: 10.1007/s12155-012-9187-1

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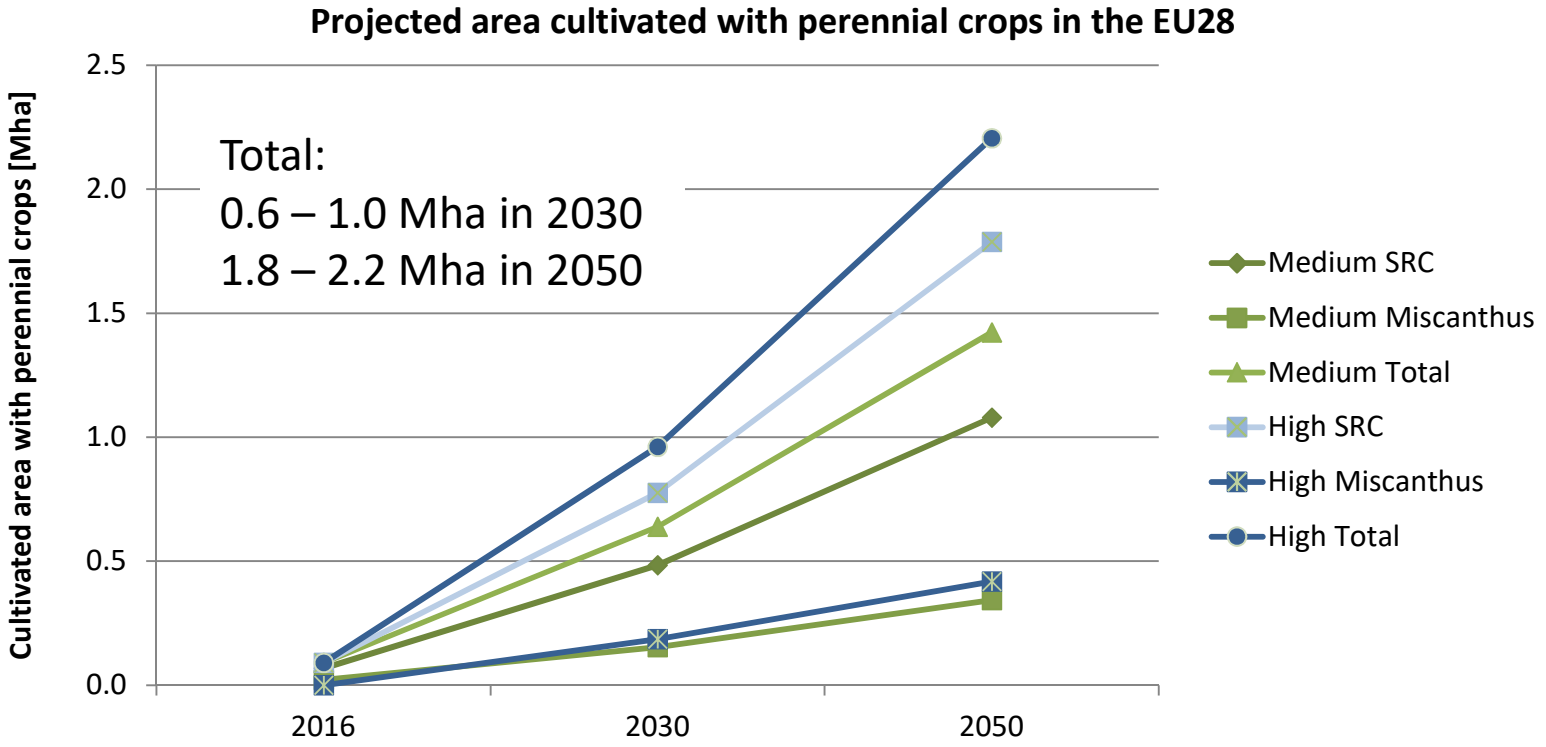
Projected area with perennial crops in the EU28 based on historic trends

Medium: using average rates of annual increases of the last decade in Austria, Belgium, Germany and Sweden.

High: using the average of peak increases of the last decade in Germany, UK and Ireland for SRC and the peak rate in Germany for miscanthus



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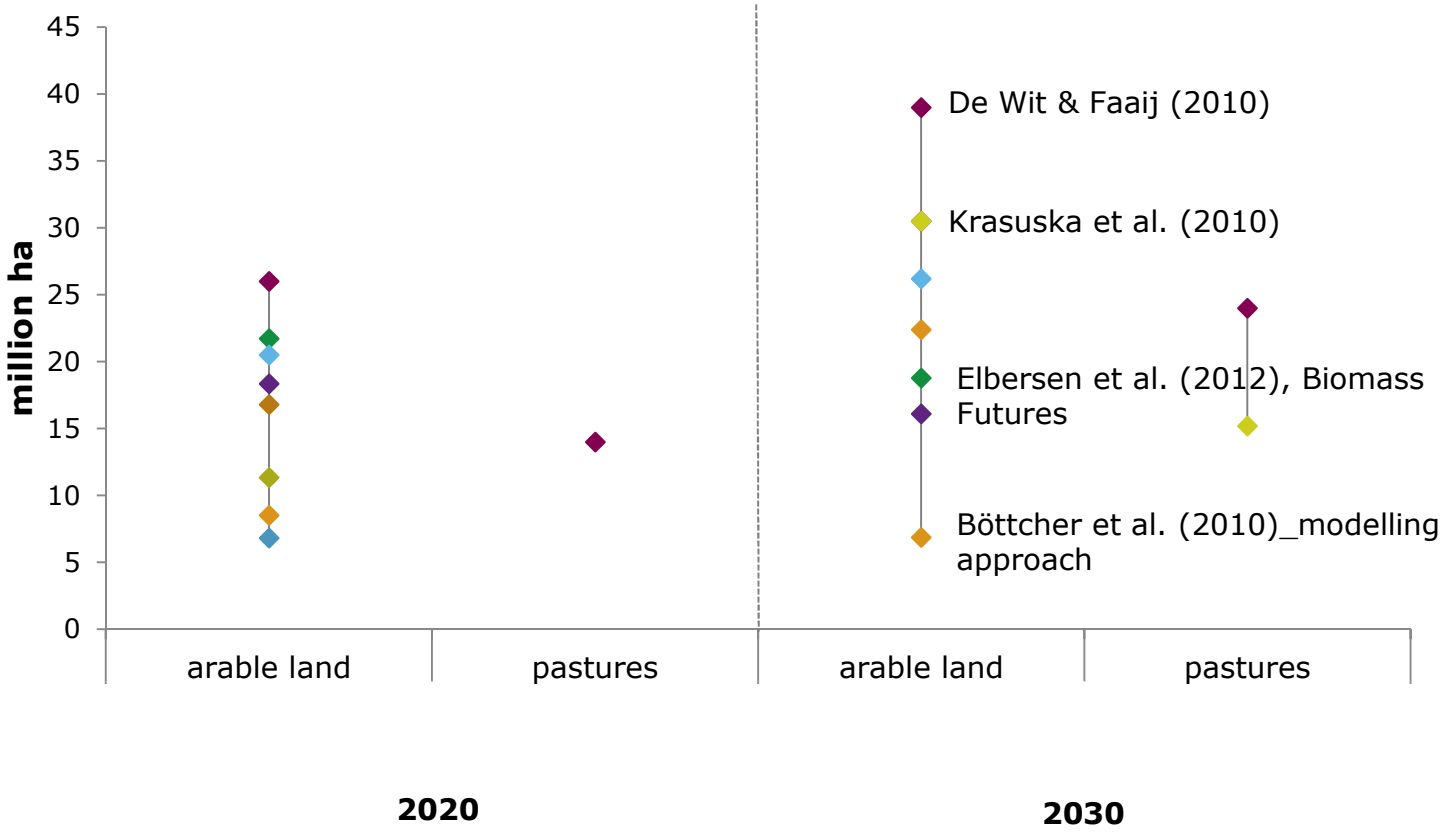
Future land availability for energy cropping is well above the estimated scale up



- 107 Mha of arable land and 59 Mha of pastures, 12 Mha of permanent crops in EU-28 in 2015

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Conclusions

- Solid biomass is almost entirely supplied from forest sources and used in electricity, heat and CHP sectors.
- Bioenergy demand in the EU could still grow substantially in the future, in particular solid biomass demand used for advanced biofuels in climate scenarios beyond 2030
- Many biomass sources are potentially available still, but require substantial efforts before they are readily available to produce advanced biofuels at commercial scale (infrastructure, farmers experience, regulatory compliance and support, suitable for conversion)

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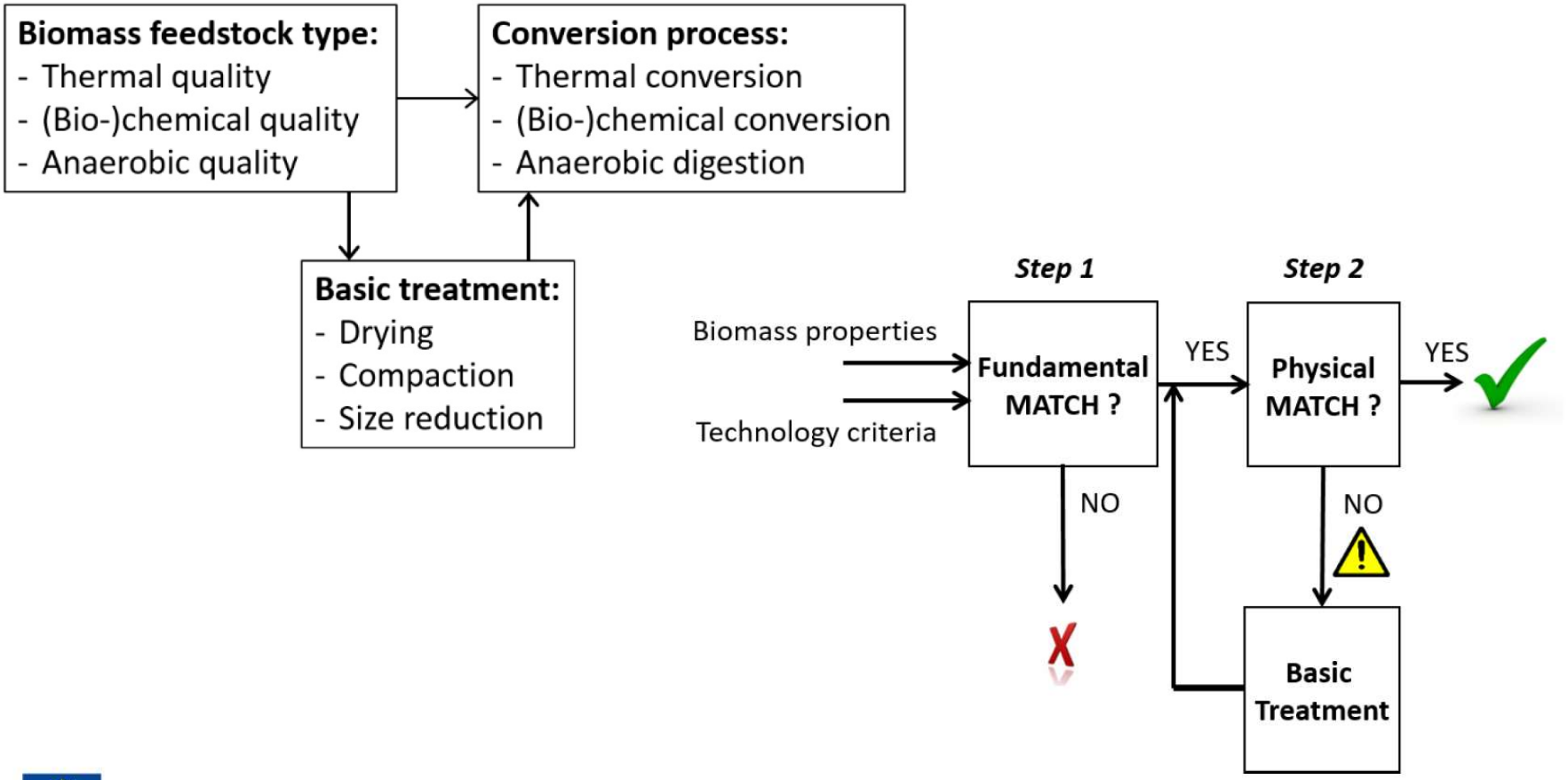
Thank you for your attention

[Ric Hoefnagels]
[Utrecht University]
[r.hoefnagels@uu.nl]
[Website]

Bio2Match tool (S2BIOM)



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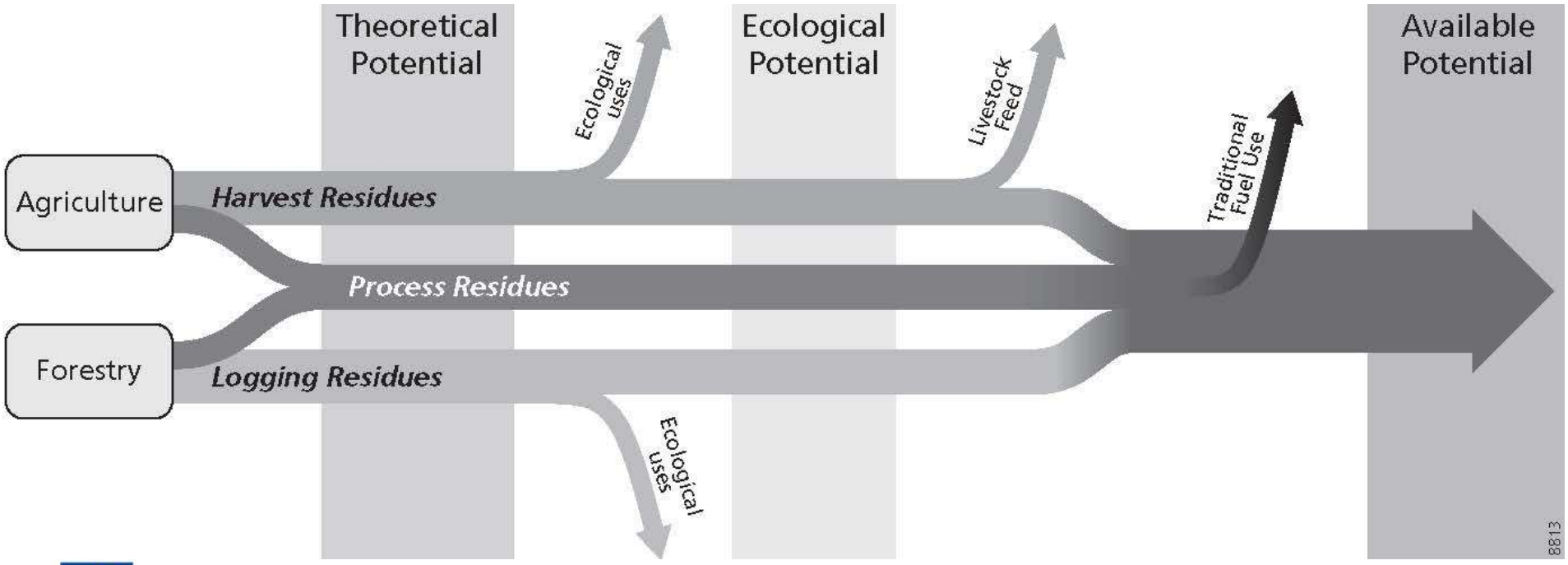
Method to determine the potential of forest and agriculture residues



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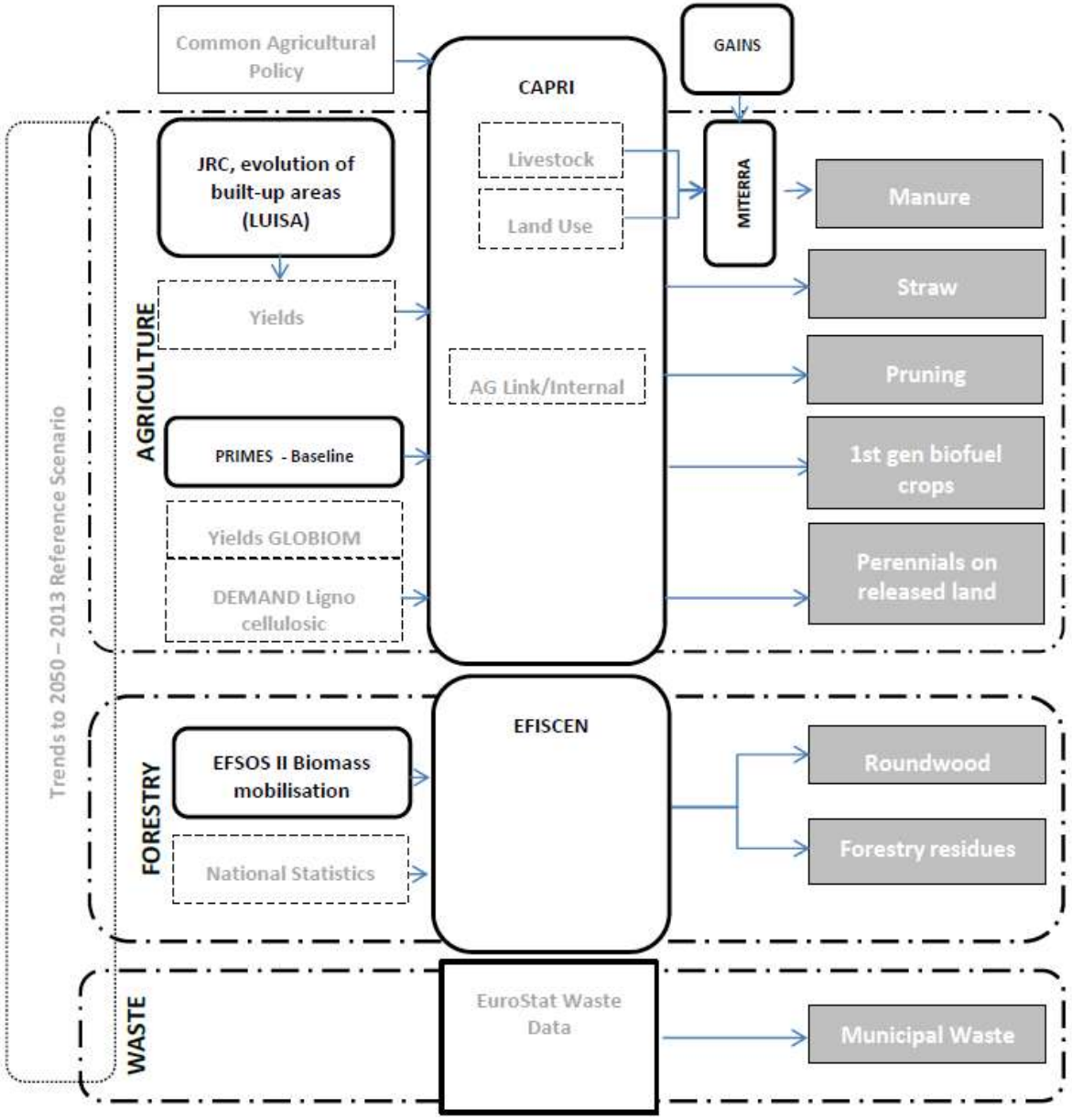
Source: Diaoglou et al.

Modeling framework used in JRC-EU-TIMES



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JRC 2015 - The JRC-EU-TIMES model. Bioenergy potentials for EU and neighbouring countries.

Biomass properties and their classification in the Bio2Match tool

Property	Unit	1	2	3	4
Chlorine content	wt-% d.m.	<0.02	0.02-0.1	0.1-0.4	>0.4
Ash deformation temperature	°C	>1200	1000-1200	800-1000	<800
Ash content	wt-% d.m.	<1	2 to 4	3 to 10	>10
Nitrogen content	wt-% d.m.	<0.3	0.3-1	1-2.5	>2.5
Carbohydrates	wt-% d.m.	>65	50-65	30-50	<30
Lignin content	wt-% d.m.	<10	10 to 25	25 to 35	>35

S2Biom D4.5: 1. Lammens T, Vis M, Berg D van den, et al (2016) Bio2Match: a Tool for Matching Biomass and Conversion Technologies - S2Biom Deliverable D4.5. Enschede and Wageningen (the Netherlands)

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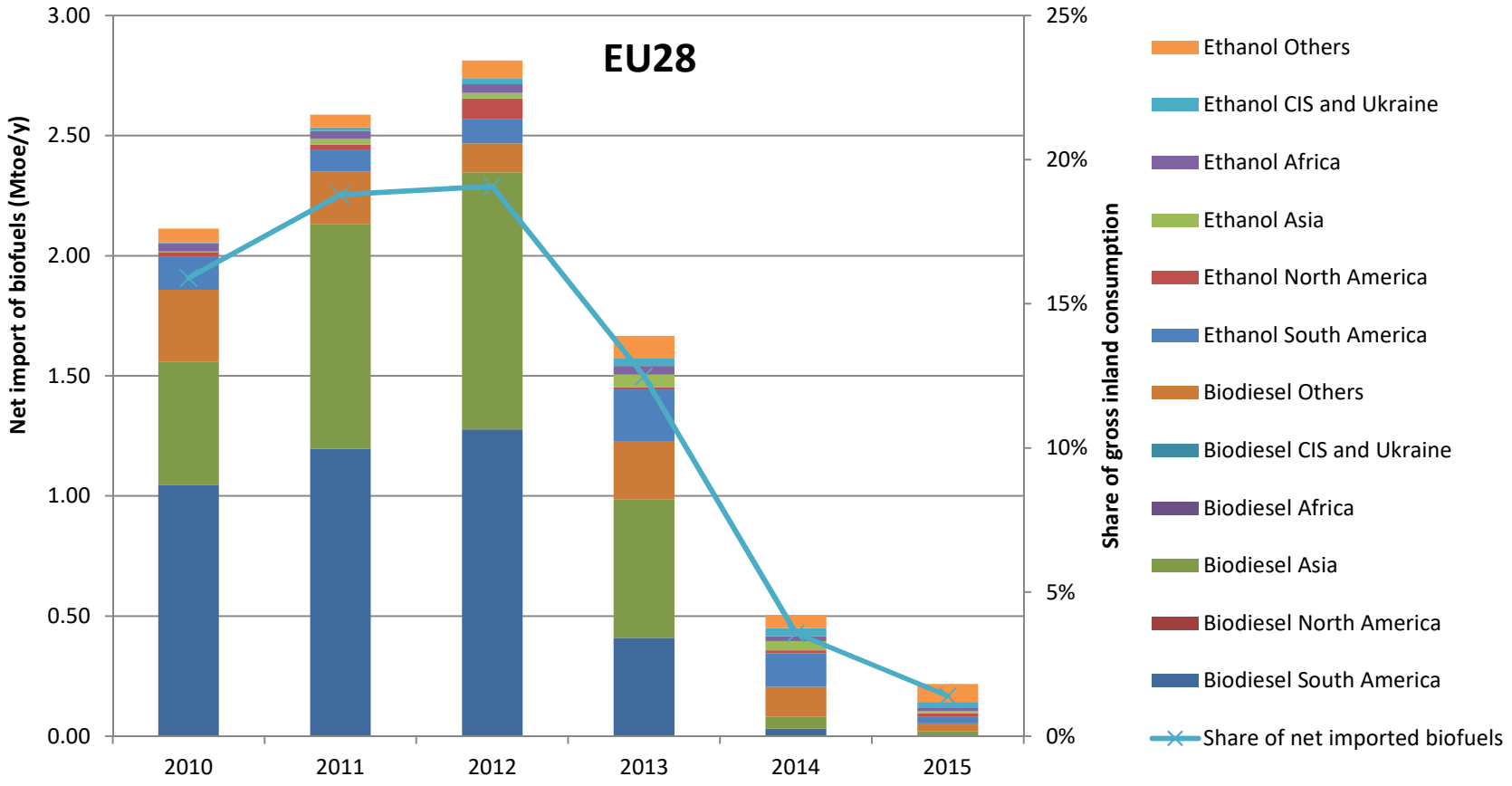
Developments of biofuel imports to the EU



Data: EUROSTAT (2017), F.O. Lichts World Ethanol & Biofuels Report (2016)

Excluding imports of vegetable oils

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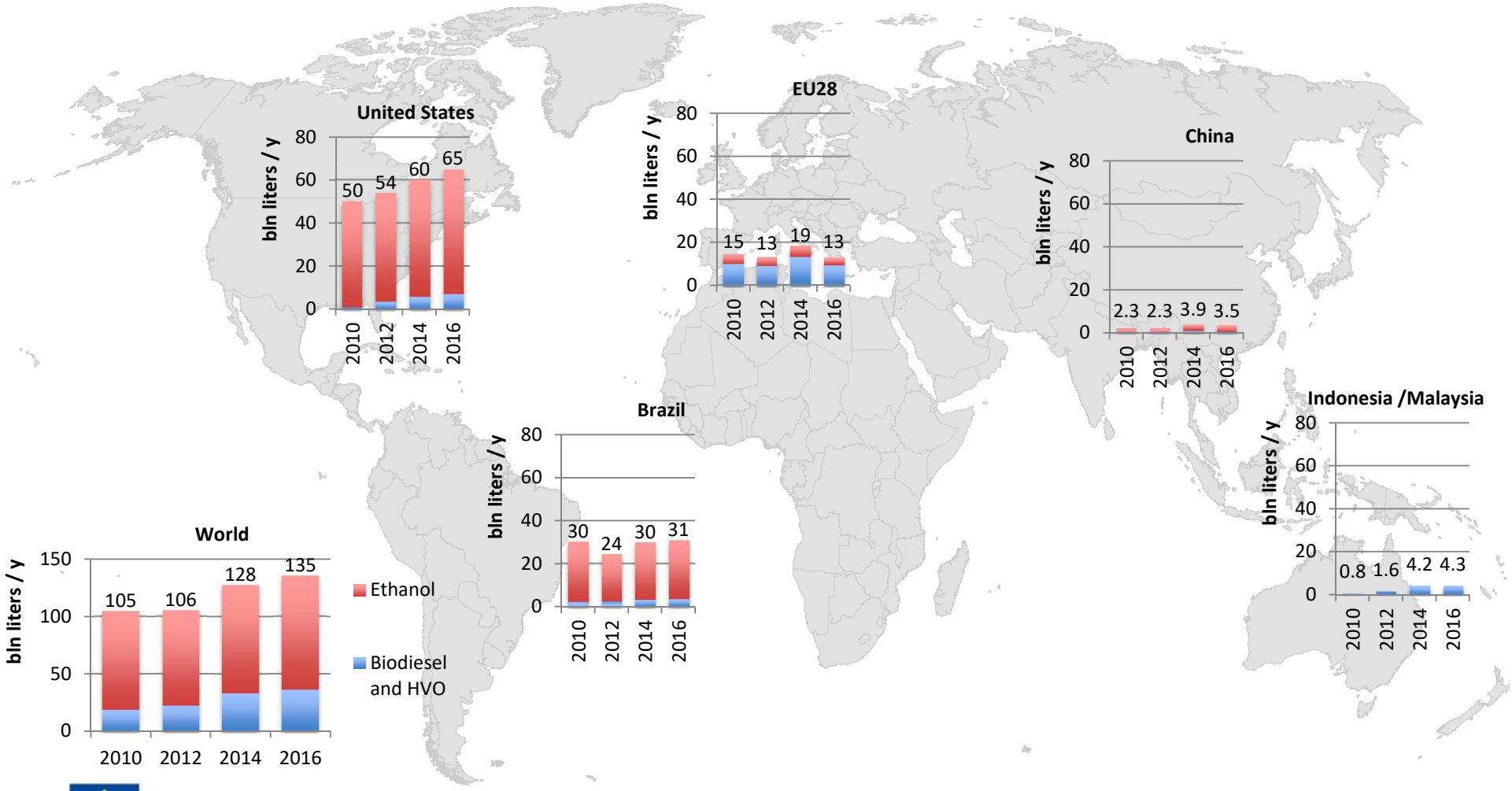
World biofuel production and key production regions



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Data: REN21 (2011 – 2017 reports)