ECORYS-COORDINATED PROJECT ON PERSPECTIVES FOR ADVANCED BIOFUELS IN EUROPE

13TH CONCAWE SYMPOSIUM
SESSION 3: LOW CARBON PATHWAYS AND REFINING TECHNOLOGIES

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Based on final presentation of the study to DG R&I by ECORYS

- WIP Renewable Energies – Brief presentation
- Context and objectives of biofuels study
- Overview of the methodology and approach
- R&I potential for biomass feedstock – key results
- Advanced biofuels – key results
- Conclusions & recommendations

WIP RENEWABLE ENERGIES – BRIEF PRESENTATION

WIP RENEWABLE ENERGIES

FACILITATING THE TRANSITION TO A SUSTAINABLE ENERGY FUTURE

General Facts

Mission

Facilitate research, innovation and market integration of renewable energy systems through collaborative efforts across all sectors of society.

Renewable energy consultancy based in Munich, Germany:

- 50 years of existence
- 37 years involved in renewable energy projects
- 300+ projects completed
- Currently active in 25 European projects and tenders

Thematic Areas

- **Renewable Energy Technologies**

  • Solar energy • Bioenergy & bioeconomy • Wind energy •Hydropower

- **Energy System Integration**

  • Energy storage and grid integration • Energy efficiency • Smart cities and networks • Hybrid systems • Sector coupling

- **Market Uptake**

  Innovative financing • Policy development • Sustainability analysis • International cooperation • Training and capacity building

- **Event Organisation**

EU PVSEC European PV Solar Energy Conference and Exhibition

Services

1. **Project Management and Implementation**
   - Identification of project and funding opportunities
   - Assembly of strong project consortia
   - Preparation of effective grant applications
   - Coordination and management of international projects
2. **Research and Consultancy**
   - Economic assessments
   - Market research
   - Policy analysis
   - Life Cycle Assessments
3. **Dissemination and Exploitation**
   - Communication campaigns
   - Stakeholder workshops
   - exploitation strategies for R&I project results
4. **Organization of Scientific Events**

SOME PROJECTS

BIOFIT Bioenergy Retrofits for Europe's Industry

ENERGY MATCHING

Dem4BiPV

CROWDFUNDRES

BestRES

CoolHeating.eu

MEMBERSHIPS

PhotoVoltaic EUROPEAN TECHNOLOGY & INNOVATION PLATFORM

EUREC The Association of European Renewable Energy Research Centres

CABA Continental Automated Buildings Association

RHC Renewable Heating & Cooling European Technology and Innovation Platform

Wind EUROPE

SolarPower Europe

DHC+ TECHNOLOGY PLATFORM

EUBIA European Biomass Industry Association

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CONTEXT AND OBJECTIVES OF THE STUDY

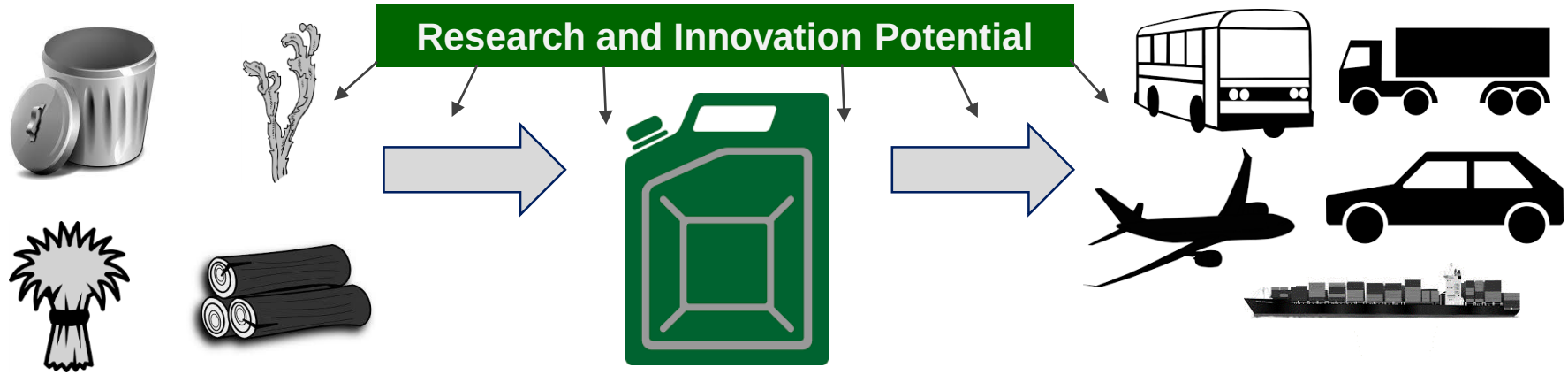
BIOFUELS STUDY TEAM – CONSORTIUM AND CO-AUTHORS

Authors: Paul Baker, Olivier Chartier, Robert Haffner, Laura Heidecke, Karel van Hussen, Lars Meindert, Barbara Pia Oberč, Karolina Ryszka (Ecorys), Pantelis Capros, Alessia De Vita, Kostas Fragkiadakis, Panagiotis Fragkos, Leonidas Paroussos, Apostolis Petropoulos, Georgios Zazias (E3MLab), Ingo Ball, Ilze Dzene, Rainer Janssen, Johannes Michel, Dominik Rutz (WIP Renewable Energies), Marcus Lindner, Alexander Moiseyev, Hans Verkerk (EFI), Peter Witzke (Eurocare), Magdalena Borzęcka (IUNG)

STUDY OBJECTIVES

Study Aim: examine the future potential role of R&I for advanced biofuels

- Task 1: assesses the potential for R&I to enable secure, low-cost, and low ILUC biomass feedstock for energy for the 2030 and 2050 time horizons
- Task 2: assesses the potential contribution of advanced biofuels to achieving the EU's ambitious climate change objectives
- Task 3: compares advanced biofuels with alternative fuel options for the road, maritime, and aviation transport sectors



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DEFINITION OF ADVANCED BIOFUELS

Advanced biofuels:

1. are produced from **lignocellulosic feedstocks** (i.e. agricultural and forestry residues), **non-food crops** (i.e. SRC, grasses, algae), or **industrial waste** and **residue streams**;

2. produce **low CO_2 emissions** or **high GHG reductions**; and

3. reach **zero or low ILUC impact**.

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OVERVIEW OF THE METHODOLOGY AND APPROACH

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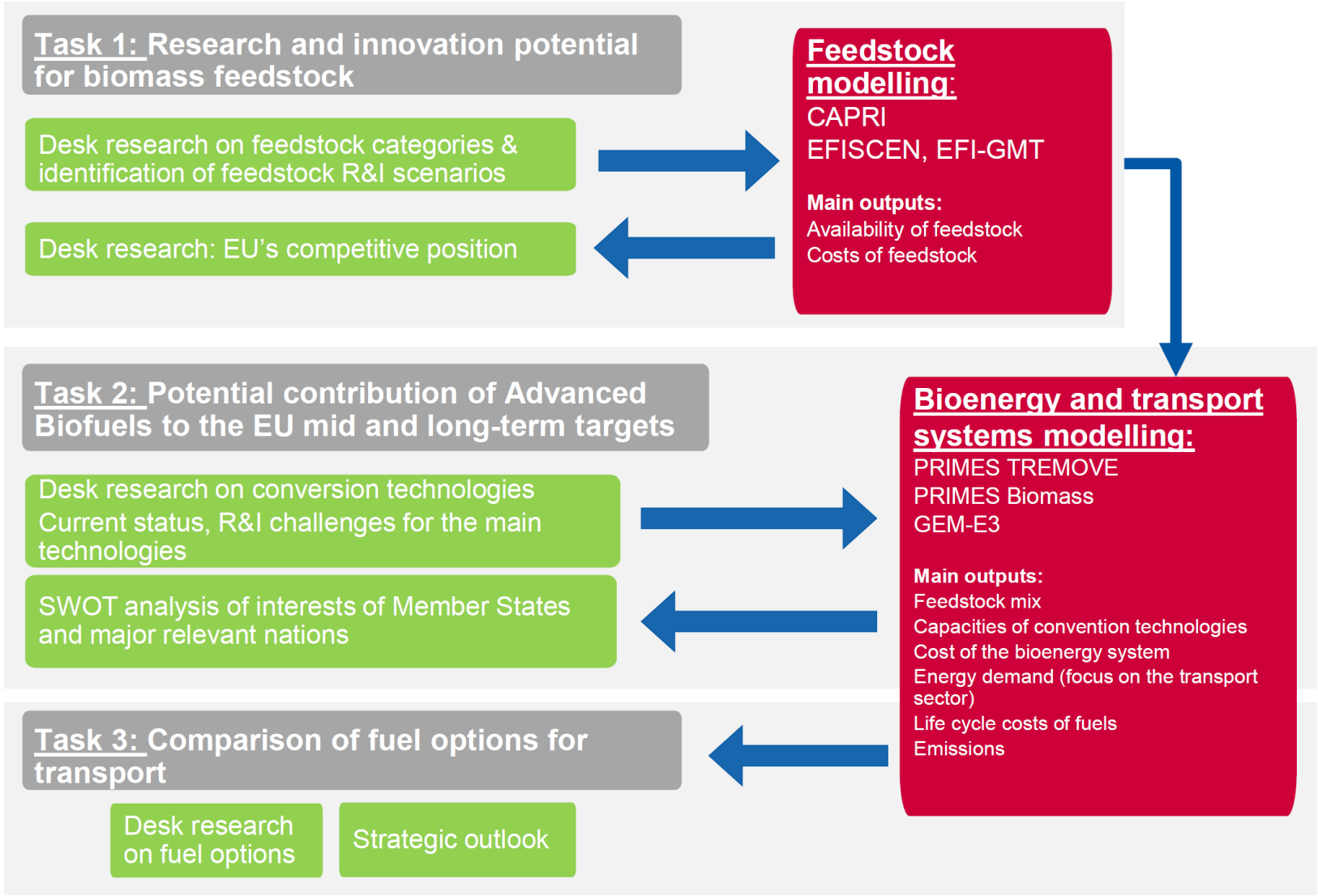
INTEGRATED QUALITATIVE AND QUANTITATIVE APPROACH



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OVERVIEW OF SCENARIOS

Scenario	Biomass feedstock	Conversion technologies	Demand for biofuels
BASE scenario	Option A0 – Baseline case	Option B0 – Low learning rates for conversion technologies at low TRL	Option C0 – Baseline: Low demand for biofuels
MEDIUM scenario	Option A2 – High R&I case	Option B1 – High learning learnings for all technologies	Options C1 – Moderate biofuels demand
HIGH scenario	Option A2 – High R&I case	Option B1 – High learning learnings for all technologies	Option C2 – High biofuels demand

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R&I POTENTIAL FOR BIOMASS FEEDSTOCK

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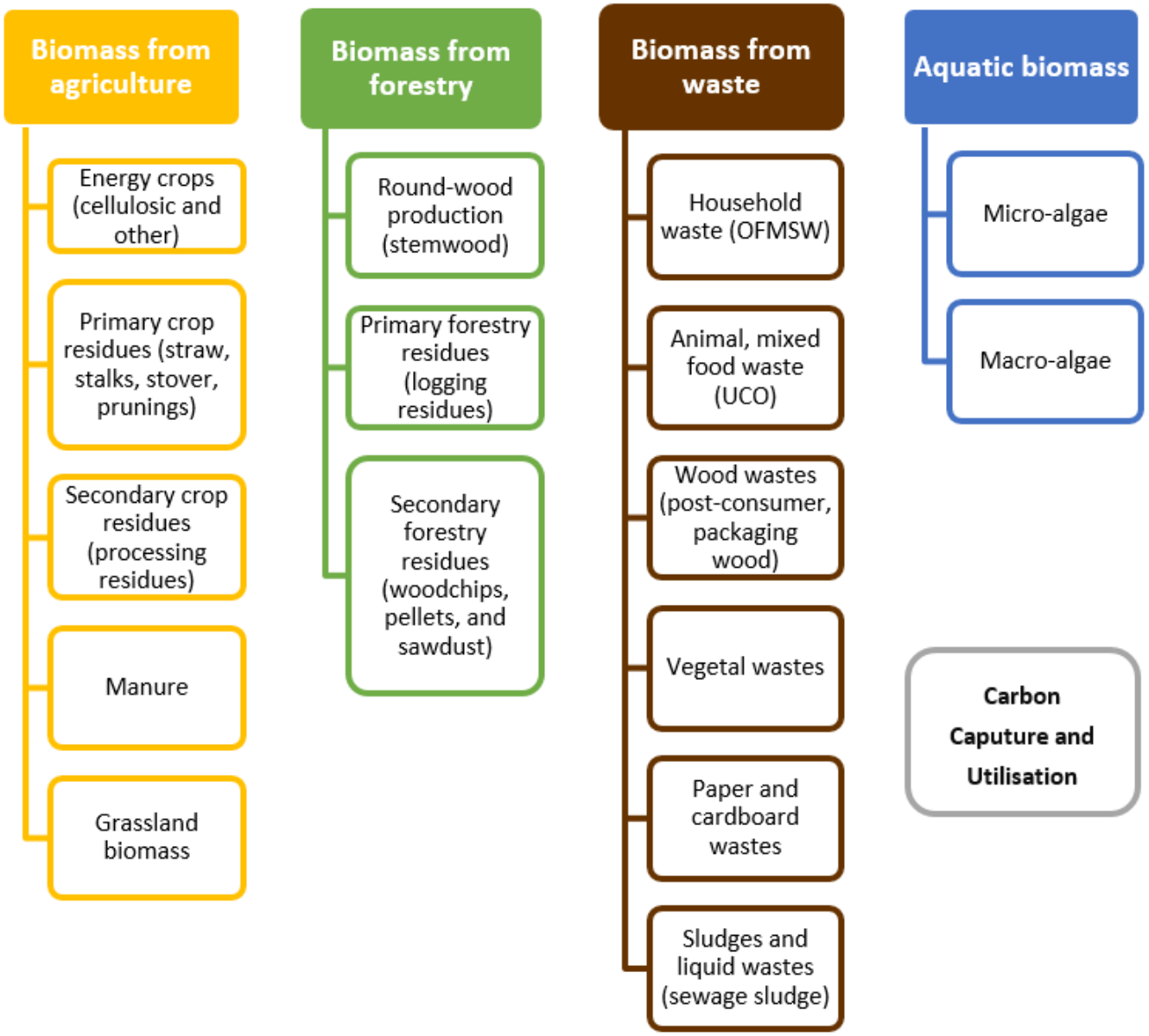
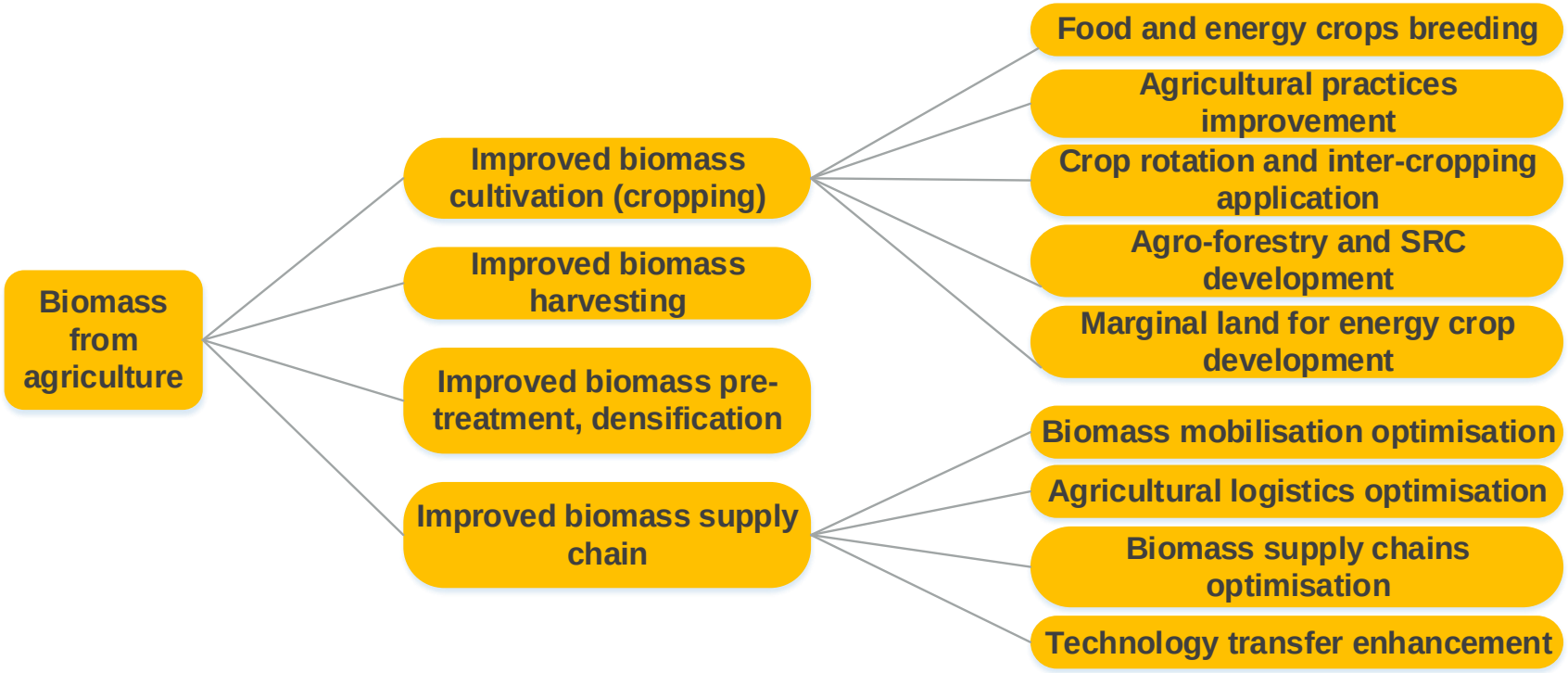
MAIN FEEDSTOCK CATEGORIES ADDRESSED



RESEARCH & INNOVATION FIELDS - AGRICULTURE



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MEASURES CONSIDERED IN FEEDSTOCK SCENARIOS - AGRICULTURE

Scenario	Agriculture
Reference	• Yield data and regional distribution is based on aggregated data of S2BIOM • Yield increase of energy crops in the reference scenario is assumed at equal rate as projections for yield increase of cereals in CAPRI
Enhanced production	• Yield increase of energy crops exceeds yield by 50% the one for cereals in 2050 • Availability of straw and pruning residues is assumed to increase by 40% until 2050 in a typical situation where current management only permits to remove 50% of residues. This rests on improved agricultural management practices alleviating pressure on the carbon balance
Improved supply	• The use of improved harvesting technologies and practices leads to 20% decline in labour and capital costs by 2050 • Besides advances in harvesting machinery and methods, the cost reduction is affected as well by optimized supply chain logistics and increased awareness of actors involved in the biomass supply
Combined R&I	• Combination of measures from enhanced production and improved supply scenarios

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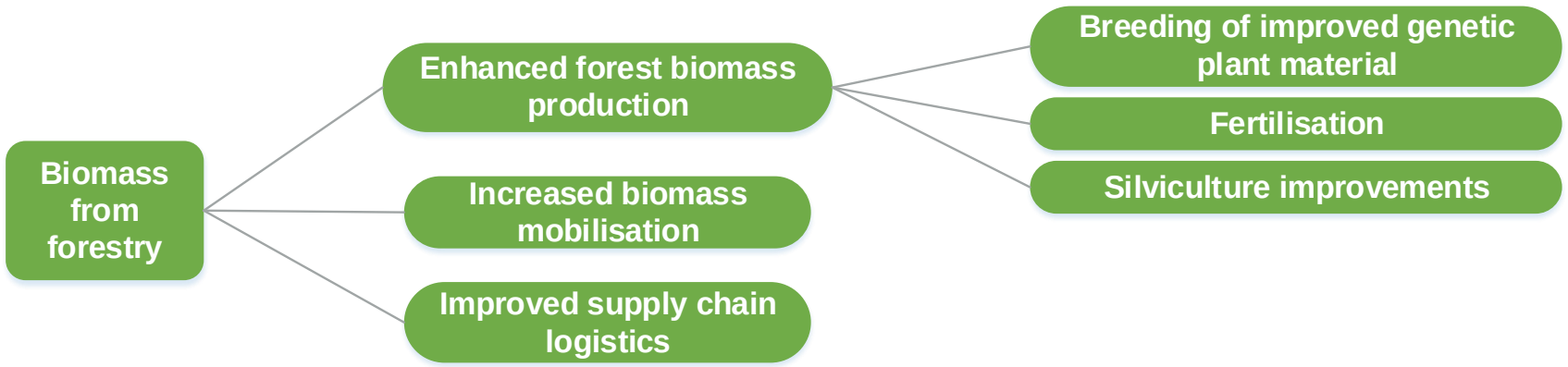
RESEARCH & INNOVATION FIELDS - FORESTRY



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MEASURES CONSIDERED IN FEEDSTOCK SCENARIOS - FORESTRY

Scenario	Forestry
Reference	• Theoretical biomass potentials are estimated based on current growth rates, tree species composition and management guidelines • Demand for forest products takes into account recent trends of declining graphic paper consumption and slow recovery of the wood products consumption

Enhanced production	• Modified practices to increase productivity:
	  • Upon final felling, regenerate 50% of forests dominated by species for which breeding programmes exits that grow 25% faster
	  • Regenerate 25% of the Norway spruce forests upon final felling with Douglas fir
	  • Fertilisation of forests growing on poor soils

Improved supply	• Modified practices to harvest, mobilise and transport forest biomass:
	  • Fellings are carried out more efficiently and the ratio between removals and fellings is increased by 5% (less harvest losses)
	  • Mobilisation of wood from private forest owners is raised by 5% compared to the reference scenario
	  • Reduced harvesting, forwarding and transport costs (30% by 2040)

Combined R&I	• Combination of measures from enhanced production and improved supply scenarios

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MEASURES CONSIDERED IN FEEDSTOCK SCENARIOS - WASTE

Scenario	Waste
Reference	• No major changes in the use of organic fraction of Municipal Solid Waste (OFMSW) • At actual separation rate in EU-28, in 2020 the availability of OFMSW for bioenergy production is assumed to be 44 million tonnes (EUROSTAT data) • Using most actual data for UCO collection in Europe (Greenea study) a potential of 0.7 million tonnes of UCO is assumed in 2020 • For wood waste 12 million tonnes are assumed for 2020 (S2BIOM data)
Enhanced production	Not estimated
Improved supply	• With major efforts in (source and mechanical) separation a potential of 94 million tonnes OFMSW is expected for bioenergy production in 2050 • All MS have installed functioning collection systems and manage to collect 70% of available UCO. In 2050 for UCO (household and professional collection) 1.4 million tonnes are available (conservative assumption) for biofuels • For wood waste, in 2050 more cascading use is assumed. Thus, with expected 10.5 million tonnes available for bioenergy production, this potential is lower than in the Reference scenario
Combined R&I	Not estimated

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MEASURES CONSIDERED IN FEEDSTOCK SCENARIOS – AQUATIC BIOMASS

Scenario	Aquatic biomass
Reference	**Microalgae:** • Only those Member States where microalgae R&I activities are taking place at present are considered to produce microalgae in future • Data for 2030 are based on calculations by Skarka (2015) and assume that the high technical production potential can be realized with R&I activities increasing technical maturity and viability of microalgae production • Costs of producing microalgal biomass in 2030 assumed at 1.330 €/t (Skarka, 2015). • Maximum supply constant between 2030 and 2050 , but price levels decrease by 20% **Macroalgae:** • Harvested and further processed only in countries located by the sea • Production volumes stated by West et al. (2016) double until 2030 and remain constant until 2050
Enhanced production	**Microalgae:** • Maximum supply triples every decade from 2030 onwards • Production costs are assumed to decrease by 30% per decade after 2030 **Macroalgae:** • Production volumes estimated for 2030 triple every decade between 2030 and 2050 • Price decreases to 40 € per tonne (wet) by 2030 • Price decreases by 30% per decade while production volumes triple
Improved supply	Not estimated
Combined R&I	Not estimated

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R&I POTENTIAL FOR BIOMASS FEEDSTOCK KEY RESULTS

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KEY FINDINGS – R&I POTENTIAL OF BIOMASS FEEDSTOCK

Agriculture:

- **Primary crop residues and cellulosic energy crops** - the most relevant agricultural feedstock categories for biofuels in future;
- Selection of **better adopted crop varieties and improved agricultural management practices** – important short term (until 2020) activities to close existing yield gaps among European countries;
- **Precision farming, breeding** to achieve greater robustness of plants - the most influential R&I fields in mid- and long-term (until 2030 and 2050).

Forestry:

- Forest sector is estimated to be and remain the **largest potential supplier** of biomass;
- Measures related to **improving supply** have the strongest impact on availability and costs of woody biomass until 2050;
- Measures to **enhance production** appear to be less effective concerning availability and costs of woody biomass until 2050 due to long rotation cycles.

Waste:

- **Organic solid municipal waste and non-hazardous post-consumer wood** represent sizeable feedstock available at no or very low costs;
- Used cooking oil represents a rather small potential.

Aquatic biomass:

- Biomass from microalgae is currently negligible but its **theoretical potential is large**;
- Yet, aquatic biomass from microalgae can only be supplied at **very high costs**, thus low competitiveness for bioenergy production is expected (low economic potential);

All:

- **R&I measures are able to significantly increase availability of biomass by 2050**; Full potentials can only be realized at very high cost.

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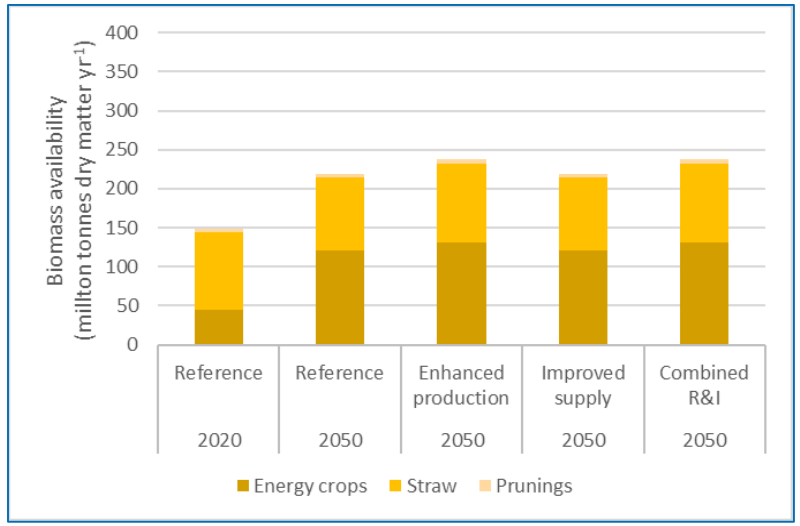
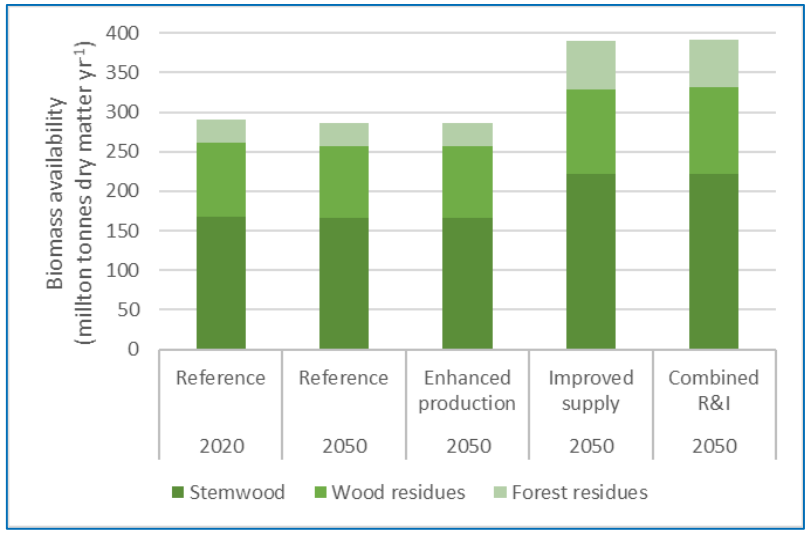
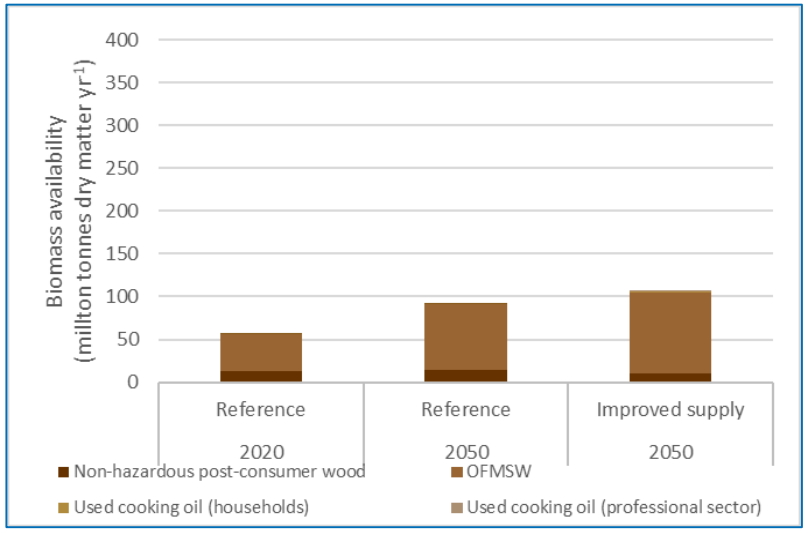
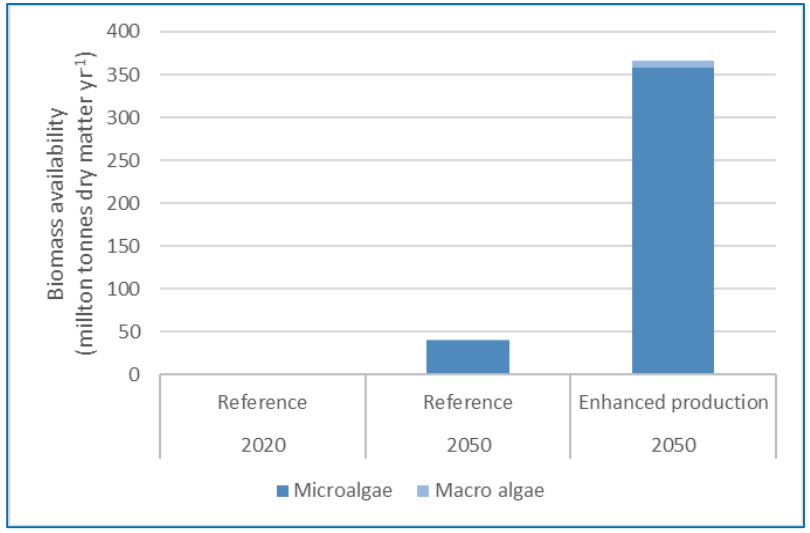
RESULTS: R&I POTENTIAL FOR INCREASED BIOMASS AVAILABILITY

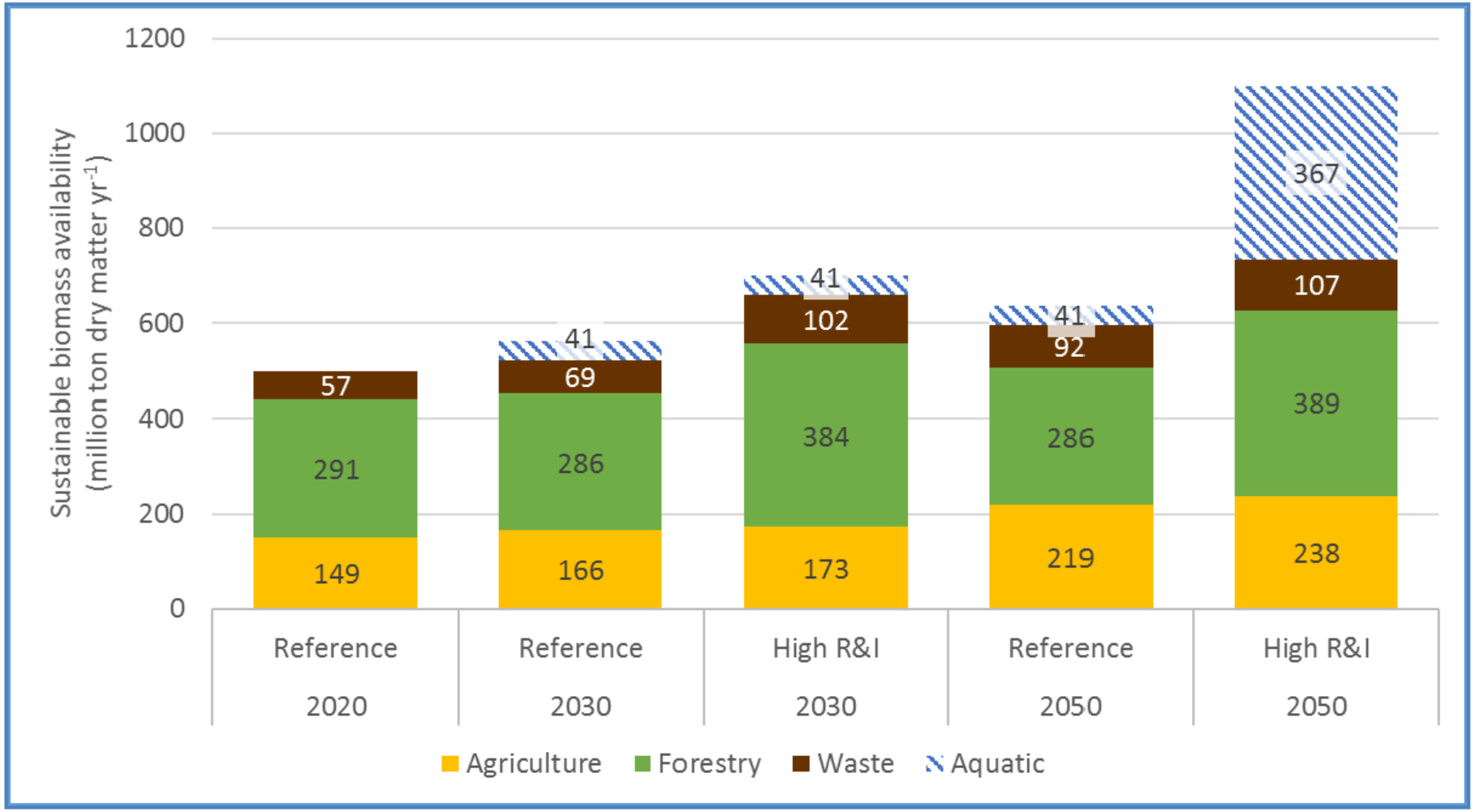








RESULTS: MAXIMUM ESTIMATED R&I AVAILABILITY



NB. The estimates for aquatic biomass availability (striped blue) are much more uncertain than for the other biomass sources. The full potential for aquatic biomass is not expected to be used because of its high cost compared to other feedstock sources. Furthermore, A sensitivity analysis for aquatic biomass has been performed and is reported in the findings" with cross reference to section where the findings are reported.

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ADVANCED BIOFUELS – KEY RESULTS

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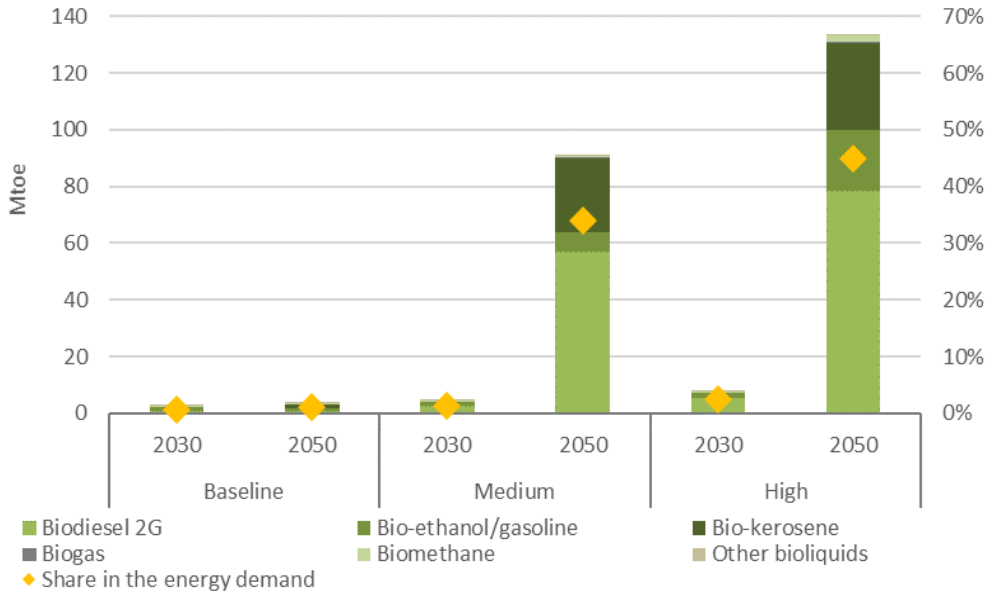
POTENTIAL CONTRIBUTION OF ADVANCED BIOFUELS TO MEET EU CLIMATE AND ENERGY GOALS

- Advanced biofuels have much lower Well-To-Wheel emissions than conventional fuels
- Under targeted R&I policies for feedstock utilization and conversion technologies, advanced biofuels will be able to meet around 50% of the EU transport sector's energy demand.
- Wide penetration of advanced biofuels in energy mix will enhance energy security

Contribution of advanced biofuels in the transport sector



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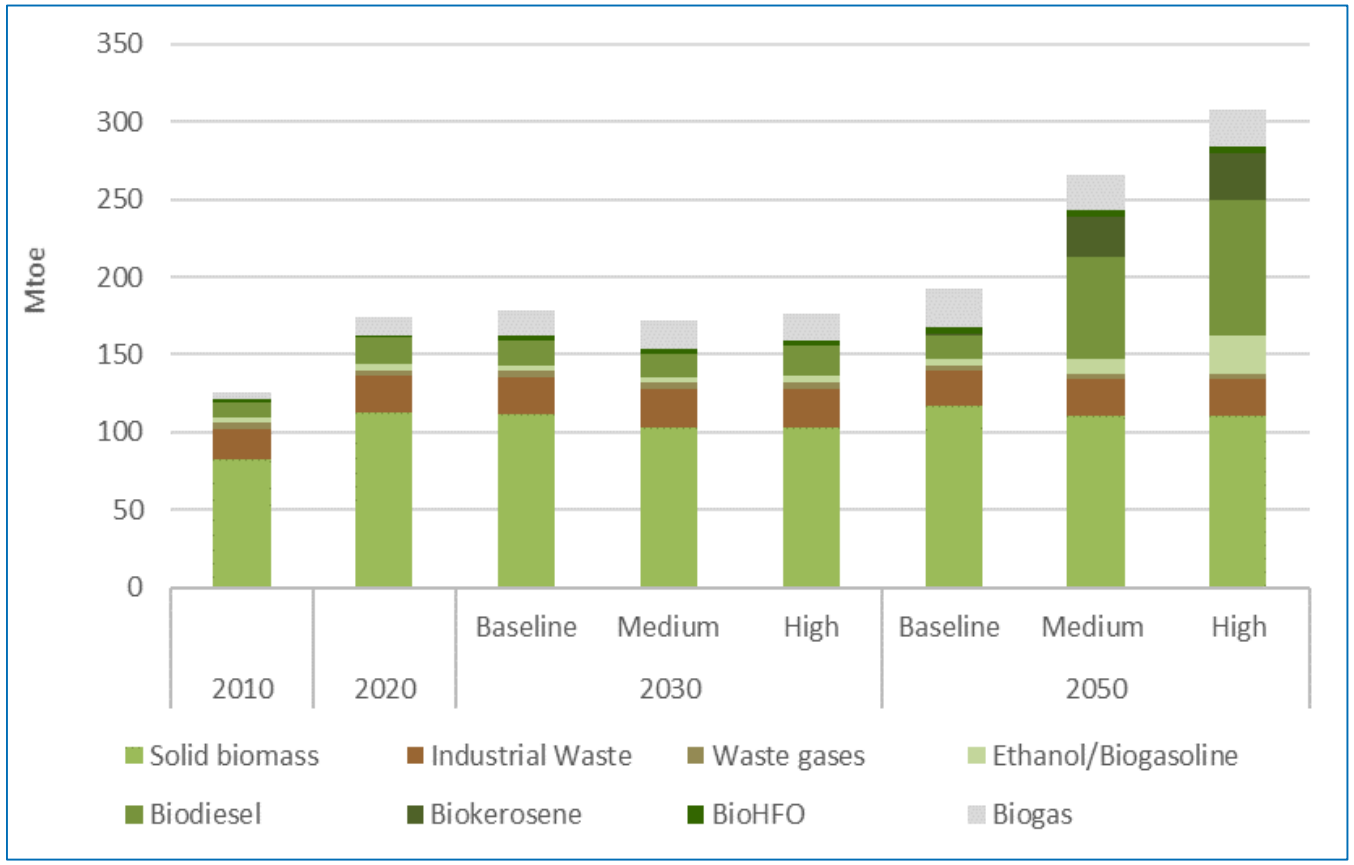
BIOENERGY DEMAND FOR EU-28



Demand does not increase significantly between 2020 and 2030 due to efficiency improvements. There is, however, a significant increase in biofuels uptake up to 2050, especially regarding demand for biodiesel and bio-kerosene, due to the increasing role of the bioenergy sector in reaching the EU's long-term energy objectives

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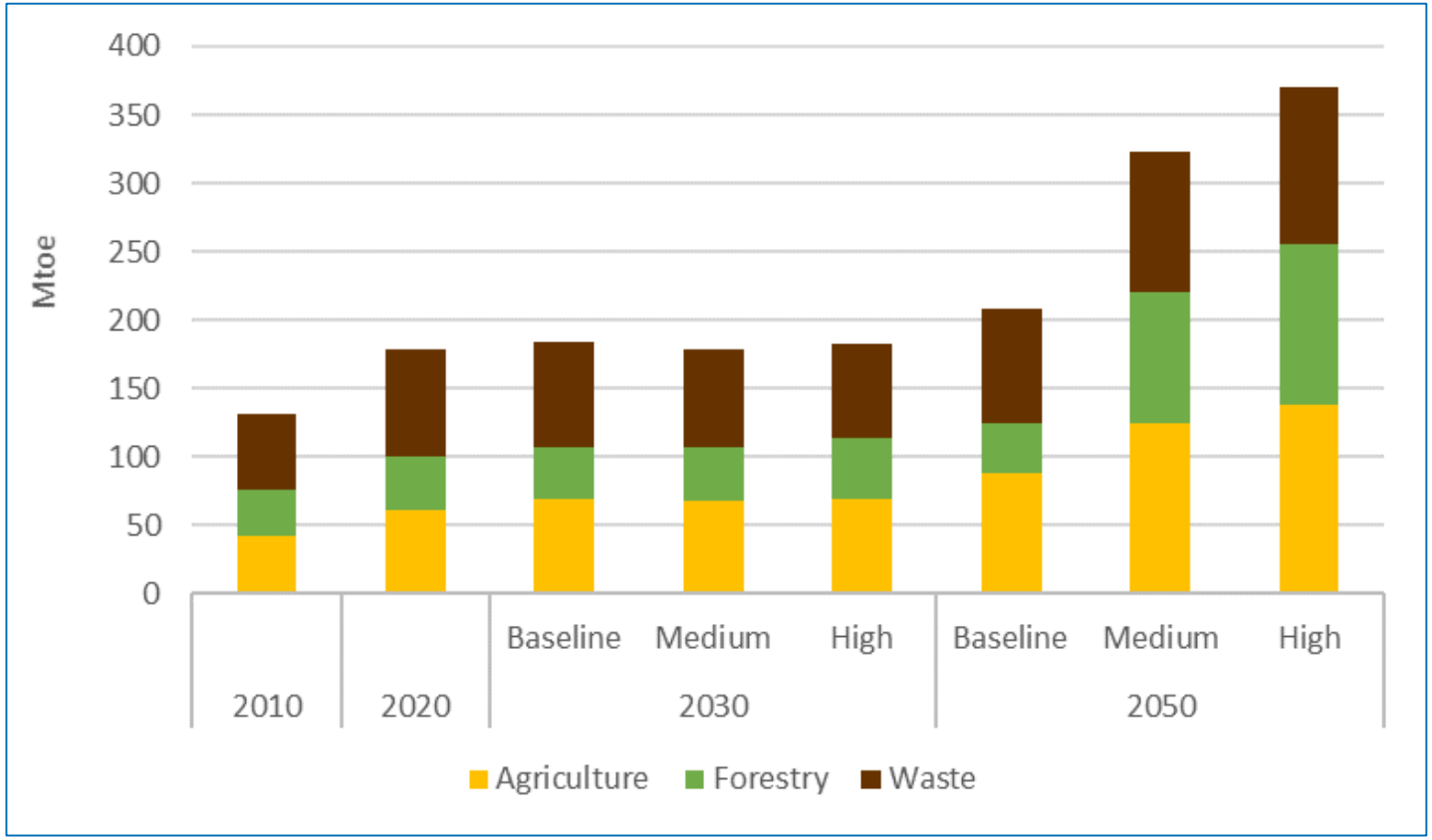
FEEDSTOCK USED BY THE ENERGY SECTOR



In the mid-term, the feedstock requirements are stable. In the long-term decarbonisation scenarios, the usage of feedstock from forestry increases substantially. Agriculture and waste feedstock usage also increases, but not as substantially as forestry

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CONCLUSIONS & RECOMMENDATIONS

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CONCLUSIONS

Development of advanced biofuels requires **R&I instruments on several fronts**:

- R&I can improve the **supply of biomass feedstock**
- R&I can improve advanced biofuels production processes to **reduce conversion costs**
- A **stable demand outlook** for advanced biofuels will be needed to establish a market and to spur development

If successfully developed:

- share of advanced biofuels in overall transport **sector energy mix can reach 50%** by 2050
- Substitutions of imported fossil fuels with domestically produced advanced biofuels, **improved energy security**
- Absolute market volume could reach €365 billion (1.6% of EU's GDP)
- Net GDP growth is negligible
- **Net increase of 108,000 extra jobs**

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RECOMMENDATIONS

Due to **feedstock limitations** R&I investments should steer towards:

- the long-term use of advanced biofuels, complementary with renewable alternative fuels
- transport sectors with limited alternatives→ heavy duty road transport, aviation and shipping

Successful diffusion of advanced biofuels depends on:

- the right market transformation
- coordination between stakeholders (farmers, forestry owners, innovators, industrial investors, consumers)

Scaling up the advanced biouels sector will **take time**

- transition period 15-20 years
- alternative “competing” technologies will also be evolving simultaneously

Full study results available at:

- https://publications.europa.eu/en/publication-detail/-/publication/448fdae2-00bc-11e8-b8f5-01aa75ed71a1/language-en

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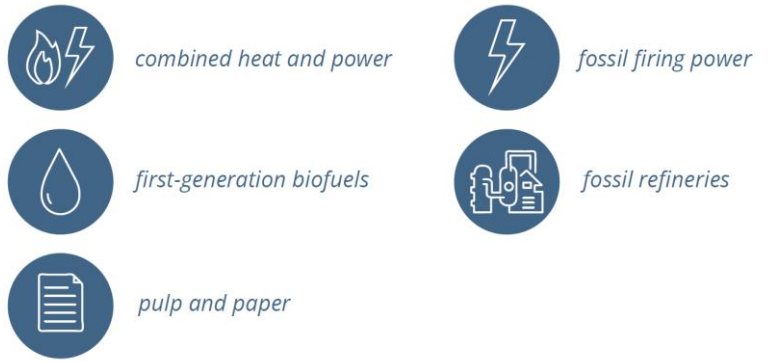
NEW HORIZON 2020 PROJECT BIOFIT

BIOFIT
Bioenergy Retrofits for Europe's Industry

- **BIOFIT - Bioenergy Retrofits for Europe‘s Industry**
- Coordination and Support Action (CSA)
- Project duration: October 2018 – September 2021
- Budget: 2.6 million EUR
- Co-financed by the European Commission (Horizon 2020)
- Coordinator: BTG Biomass Technology Group BV, The Netherlands
- **www.biofit-h2020.eu**



THANK YOU FOR YOUR ATTENTION

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