Research and Innovation Perspective for Bioenergy, Advanced Biofuels and Renewable Fuels

Thomas SCHLEKER, PhD
Renewable Energy Sources
DG Research & Innovation
EUROPEAN COMMISSION

Research and Innovation

Advanced Biofuels/Bioenergy– Strategy in Horizon 2020

Overall strategy is to target the following sector challenges:

- Technology and cost competitiveness
  - Technology improvement, resource efficiency and diversification
- Feedstock availability
  - Feedstock diversification, energy intermediates
- Commercialization
  - Focus on particular transport sectorial needs
  - Aligned market up-take measures

MANDATE ON THE PROVISION OF DATA AND ANALYSIS ON BIOMASS SUPPLY AND DEMAND BY THE JRC ON A LONG-TERM BASIS

JRC is requested by Commission services to periodically provide data, processed information, models and analysis on EU and global biomass supply and demand and its sustainability

More information:

- *https://biobs.jrc.ec.europa.eu/analysis/jrc-biomass-mandate*

European Commission

S2Biom

WAGENINGEN

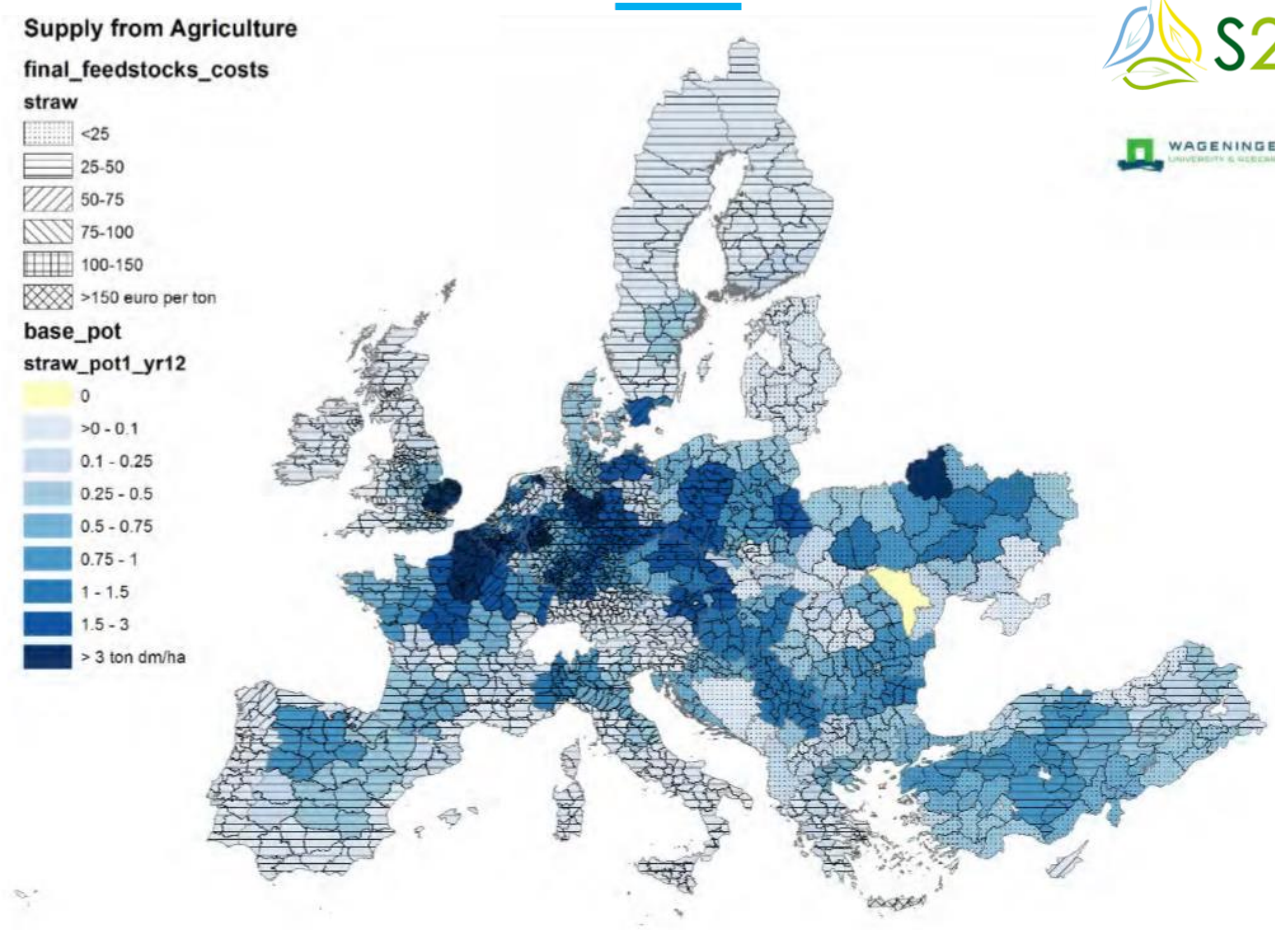


Figure 12 Cost and supply levels- for straw & stubbles

Drees et al. (2017): http://www.s2biom.eu/images/Publications/D1.8_S2Biom_Atlas_of_regional_cost_supply_biomass_potential_Final.pdf

NOT LEGALLY BINDING

Research and Innovation

S2Biom has received funding from the European Union's 7th Framework Programme for research, technological development and demonstration under grant agreement No FP7-608622

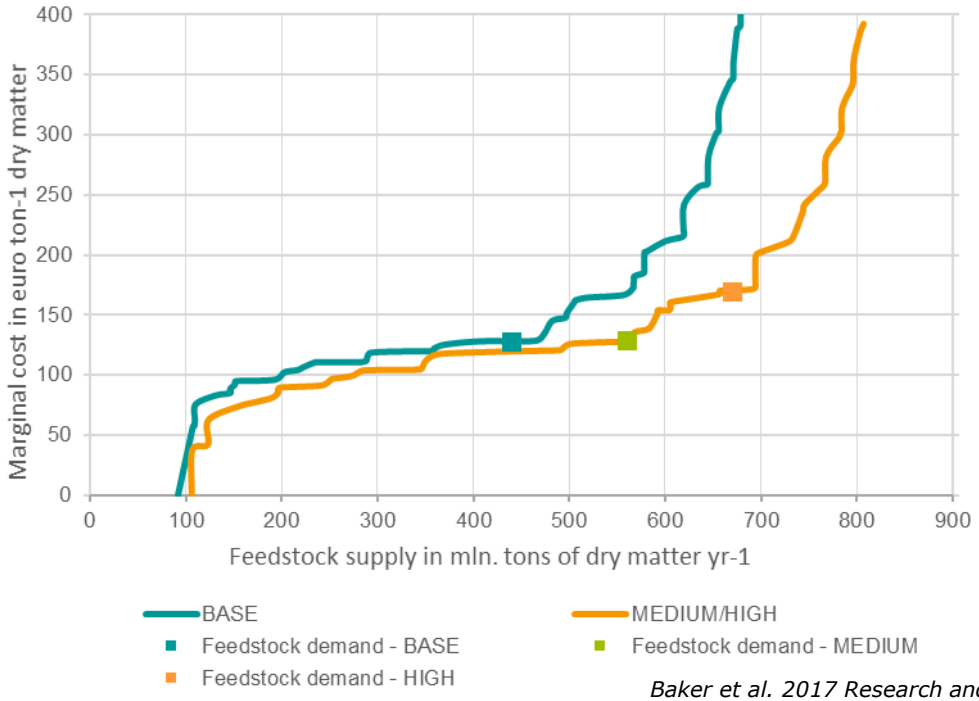
Task 1: Assesses the potential for R&I to enable secure, low-cost, and low ILUC biomass feedstock for energy for the 2030 and 2050 time horizons

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

For every level of feedstock demand, R&I significantly decreases the cost of biomass

Aggregated cost-supply curve for feedstock that can be used in the production of advanced biofuels (excluding algae)



Baker et al. 2017 Research and Innovation perspective of the mid-and long-term Potential for Advanced Biofuels in Europe.

R&I outlook from the study results

- **R&I on several fronts can lead to successful development of advanced biofuels**
  Improved biomass feedstock supply, reduced conversion costs

- **Successful Advanced Biofuel value chains need to be created**
  Biomass logistics, flagships

- ***Substantial share of advanced biofuels in overall transport is possible by 2050***
  Substantial market volume, GDP-neutral decarbonisation, energy security, jobs

Study on Research and Innovation Perspective of the mid-and-long-term Potential for Advanced Biofuels in Europe

ETIP Bioenergy, 12 April 2018

Karel van Hussen

Outline

1. Introduction to the study
2. Overview of the methodology & approach
3. R&I Potential for Biomass Feedstock
4. Potential Contribution of Advanced Biofuels
5. Comparison of Fuel Options for Transport
6. Conclusions

ECORYS

Context and Objectives of the Study

ECORYS

ECORYS

Presentation of the consortium

ECORYS

E³M - Lab

WIP

EFI

iung

EuroCARE
AGRICULTURAL POLICY RESEARCH

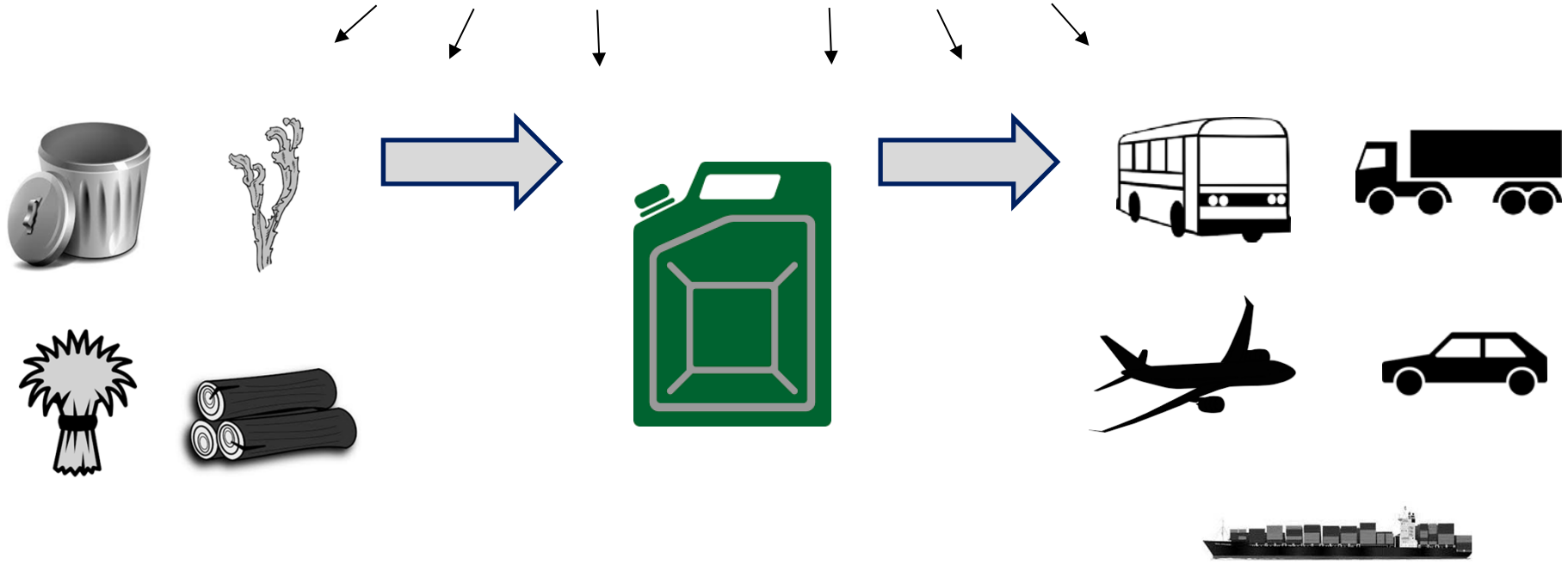
Study Objectives

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

ECORYS

Research and Innovation Potential



Definition of Advanced Biofuels

Advanced biofuels:

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

2. Produce **low CO2 emissions** or **high GHG reductions**

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

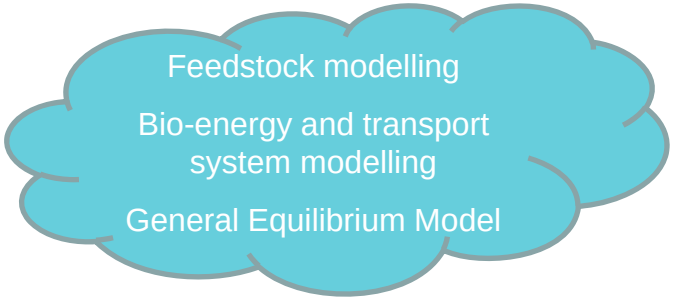
Overview of the Methodology and Approach

ECORYS

Approach:

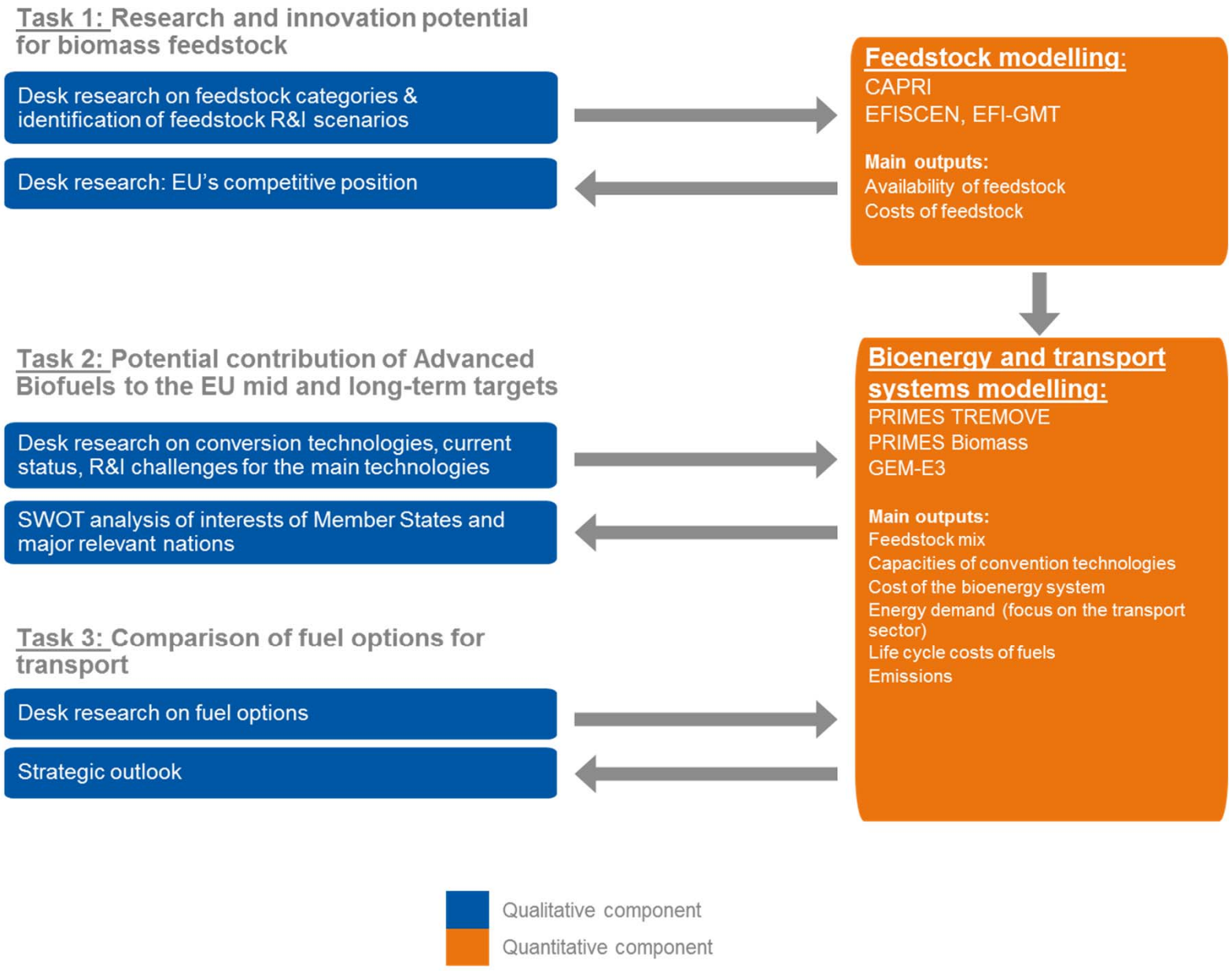
1) Extensive qualitative research on R&I potential and competitiveness

2) Quantitative modelling with three 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

Integrated Qualitative and Quantitative approach



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 

Main Findings of the Study

ECORYS

Task 1:

R&I Potential for Biomass Feedstock

ECORYS

Task 1: Objective & Methodology

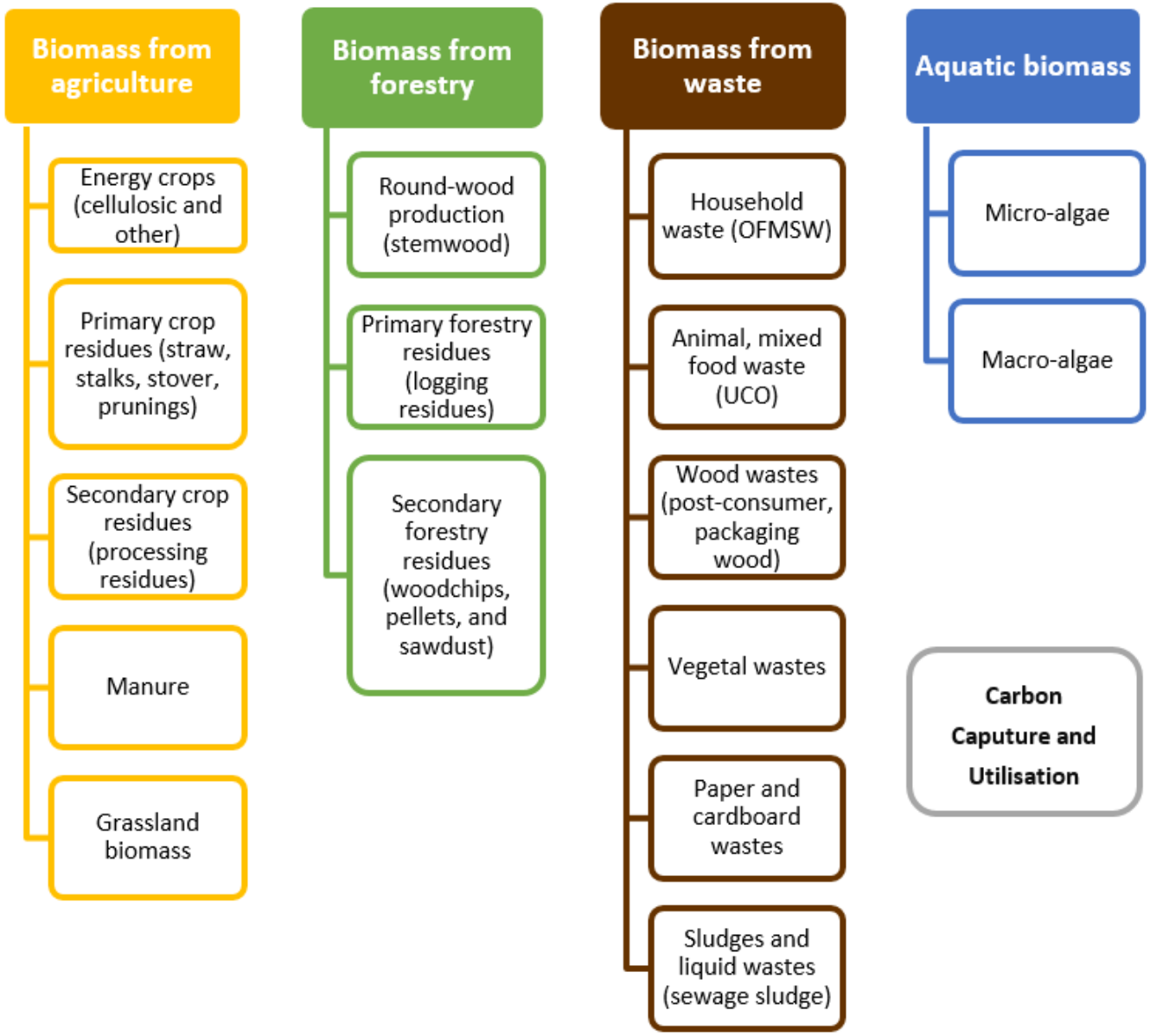
Objective: Assess the potential of research and innovation for secure, lower-cost and low ILUC biomass feedstock for energy in the 2030 and 2050 horizon.

Methodology:

- Desk research
- Qualitative definition of scenario elements (R&I options)
- Definition of feedstock scenarios and validation workshop on 17.11.2016 with experts from main feedstock sectors
- Quantitative analysis via modelling
- Assessment of the EU's competitive position worldwide in terms of availability and cost-competitiveness of sustainable feedstock

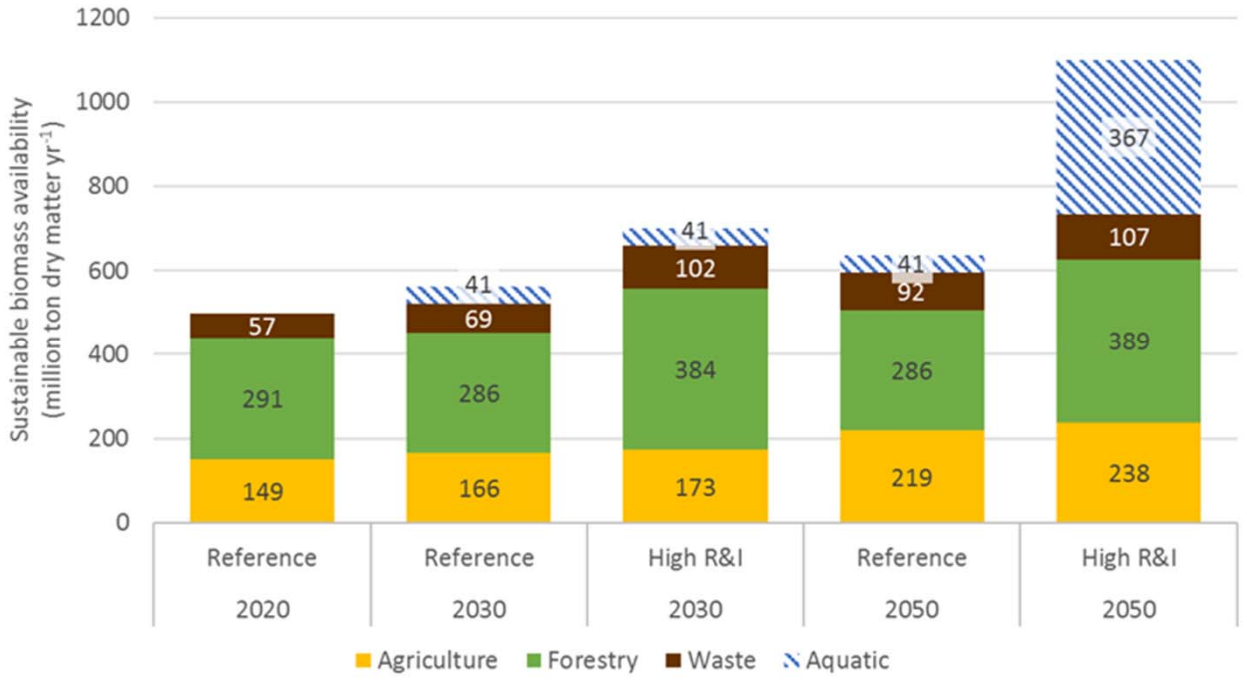
ECORYS

Main feedstock categories addressed in modelling



R&I measures can significantly increase the availability of biomass by 2050 – by up to 120% as compared to the reference scenario in 2020

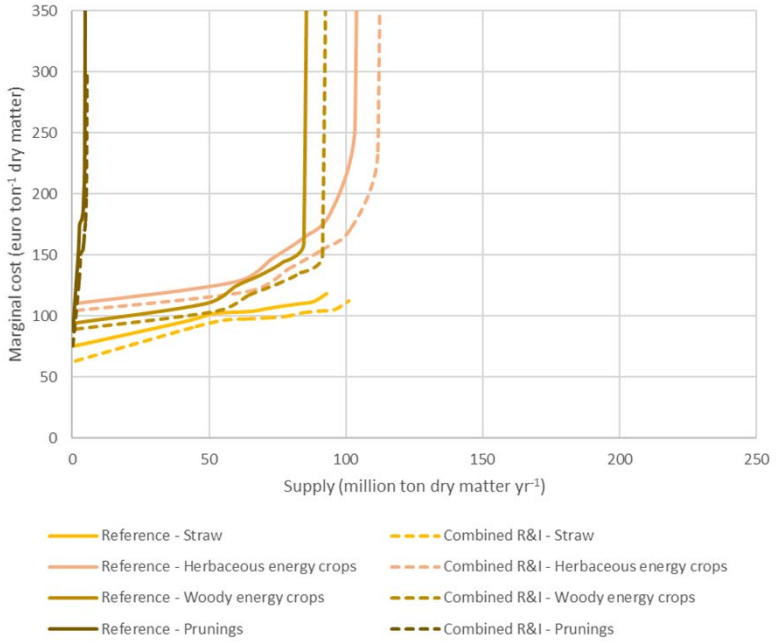
Maximum estimated potential availability of biomass for energy use in the EU

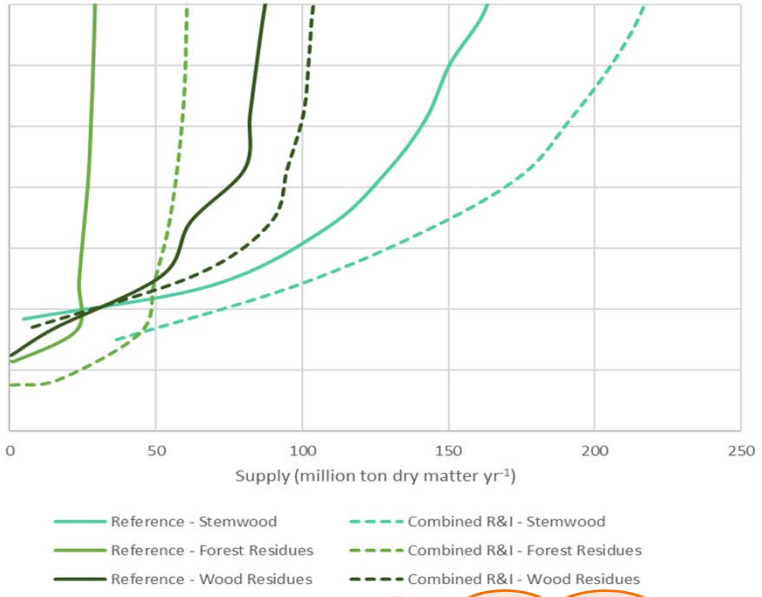


ECORYS

R&I measures are estimated to lead to more biomass being available from agricultural and forestry sectors at lower costs

Biomass cost-supply curves in the Reference and the Combined R&I scenarios in 2050 – for agriculture (left) and forestry (right)





= cost reduction

= volume increase

Aggregated:
+ 100 – 120 Mt
dry matter / year

R&I increases the future competitiveness of EU sustainable feedstocks, but many other factors are also at play

- Trade in feedstock for the production of advanced biofuels is limited.
- Due to disadvantageous share of calorific value and volume, only forest sector biomass and (possibly) energy crops may be traded on a substantial scale.
- Competition is likely to emerge downstream at the level of (intermediary) advanced biofuels.
- The competitiveness of EU biomass from forests and energy crops relative to non-EU imports will be determined by:
  - The development of domestic demand (in the EU, US, and Canada);
  - The exchange rate;
  - The development of transportation costs to and within Europe; and
  - Changes in EU policies supporting bioenergy could have an impact on imports.

Task 2:

Potential Contribution of Advanced Biofuels to the EU Climate and Energy Targets

ECORYS

Task 2: Objective, Scope & Methodology

Objective: Assess the potential contribution of advanced biofuels for meeting the 2020, 2030 and 2050 targets

Scope: Conversion from feedstock to biomass, not only advanced biofuels but the total bioenergy system

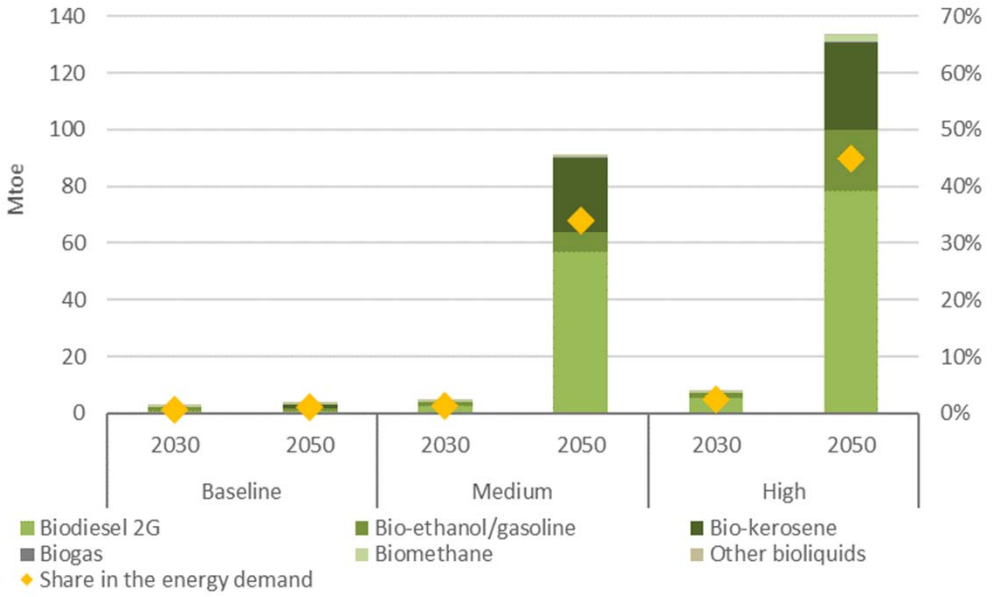
Methodology:

- Desk research
- Quantitative analysis via modelling
- SWOT analysis (analysis by cluster of Member States)

Advanced biofuels can help achieve the EU climate and energy goals

- Lower Well-To-Wheel emissions
- 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.

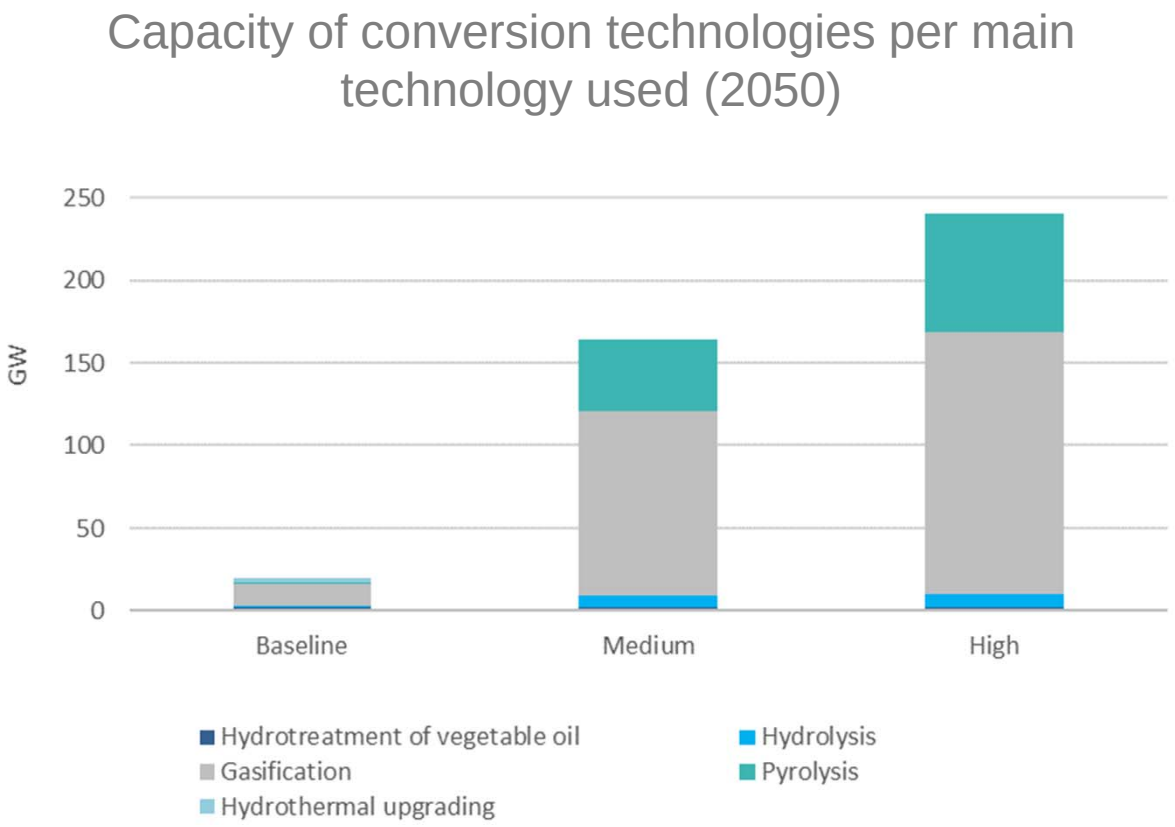
Bioenergy demand for EU-28 in the main Bioenergy scenarios



Flexibility in feedstock utilization and conversion technology application is an advantage

- Currently not possible to predict which conversion technologies will prevail.
- **Flexible scalable** technologies are most promising, allowing
  - Treatment of **large volumes**
  - **Feedstock flexibility** for the conversion process
  - **Flexibility for processing intermediate** products into final fuel outputs
- Pyrolysis & gasification most flexible biofuels production technologies.
- R&I that improves the energy efficiency of biofuel production processes will reduce the quantity of feedstock needed per unit of output.
- R&I also can decrease investment costs by 20% on average, whereas the decrease for gasification/Fischer-Tropsch, pyrolysis and enzymatic hydrolysis amounts to 40-60%.

Flexibility in feedstock utilization and conversion technology application is an advantage



To achieve the climate goals, significant investments in advanced biofuels' capacity are needed

2020 targets:

- Current installed capacity must increase from 0.2 GW to 1.1 GW
- Estimated cost of 4.5-5 billion euros

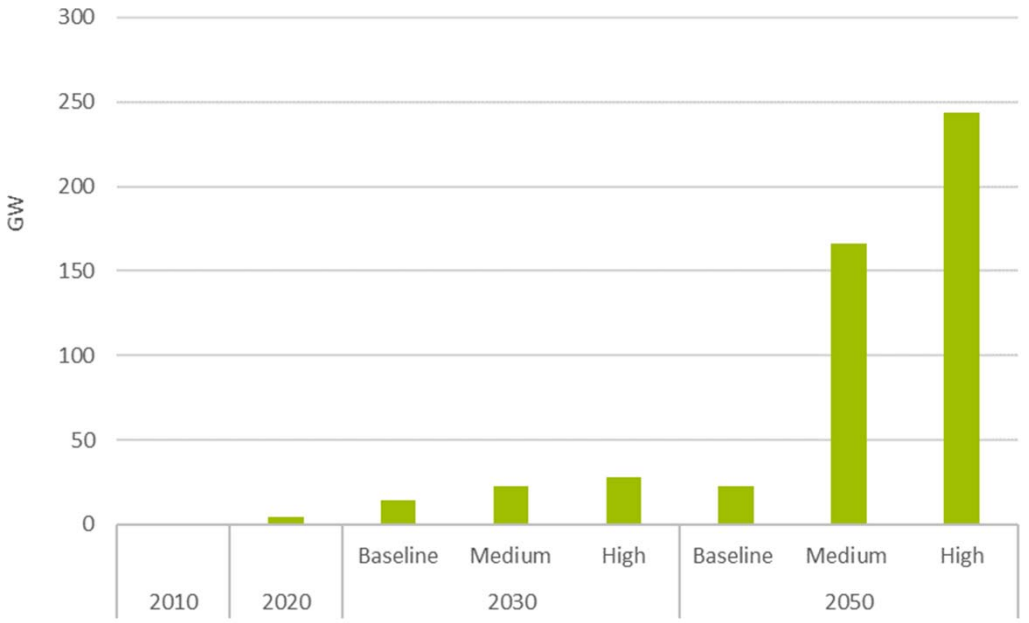
2030 targets:

- Capacity must increase to 30 GW

2050 targets:

- Capacity must increase to 250 GW

Production capacity needed to cover domestic production needs for advanced biofuels



→ Fuel and Feedstock Flexibility are key

ECORYS

R&I can drive down costs and substantially contribute to the EU decarbonisation goals

- The increase in demand for advanced biofuels and their prominent role in the energy mix could potentially increase the total costs of bioenergy.
- R&I has the potential to mitigate this cost increase.

Targeted R&I policies are key to address challenges related to the energy system transition, such as:

- Stakeholder coordination (farmers, forestry owners, innovators, industrial investors, consumers);
- Improvement/establishment of logistics chains from fields/woods etc. to bio-refinery, needed to achieve economies of scale; and
- The substantial investments needed for the market transition to large-scale advanced biofuels production.

Task 3:

Comparison of Fuel Options for Transport up to 2030 and 2050

ECORYS

Task 3: Objective, Scope & Methodology

Objective: Assessment of the advanced biofuels potential in the 2030 and 2050 transport fuel mix, taking into consideration the development of other 'competing' fuel options.

Scope:

Road transport- *passenger cars, light & heavy-duty vehicles*;

Maritime transport- *inland navigation, short-sea and deep-sea;*

Aviation;

Fuel options for the 2050 fuel mix:

- Fossil fuels (diesel, gasoline, jet fuel, heavy fuel oil);
- Advanced biofuels;
- Electricity;
- Hydrogen; and
- Natural gas (LNG).

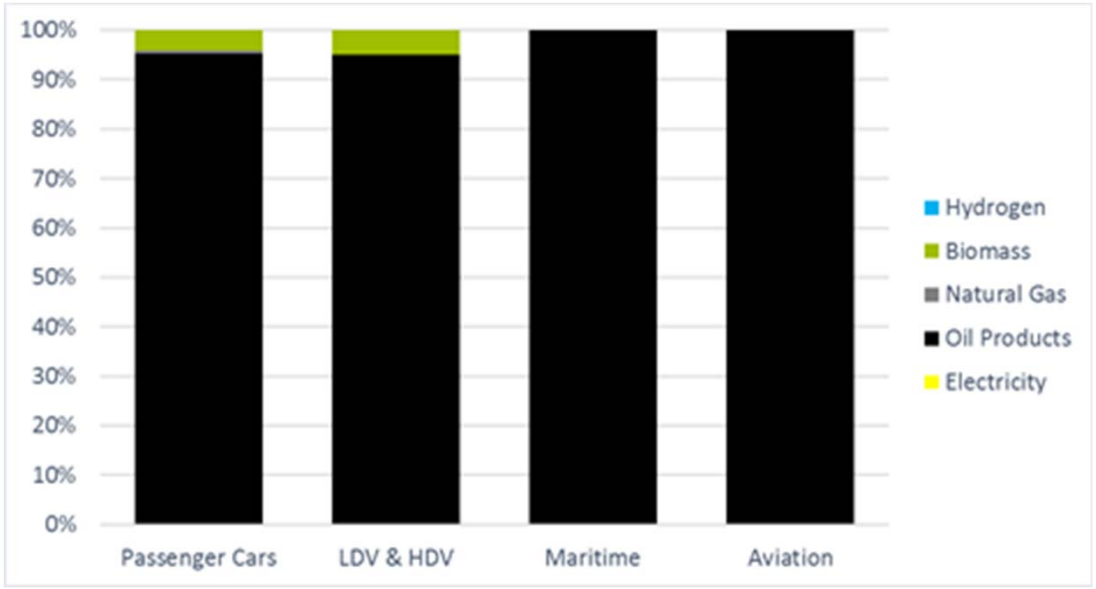
Approach: A mix of desk study and scenario modelling (future oriented).

In the current energy mix, fossil fuels still dominate the entire transport sector

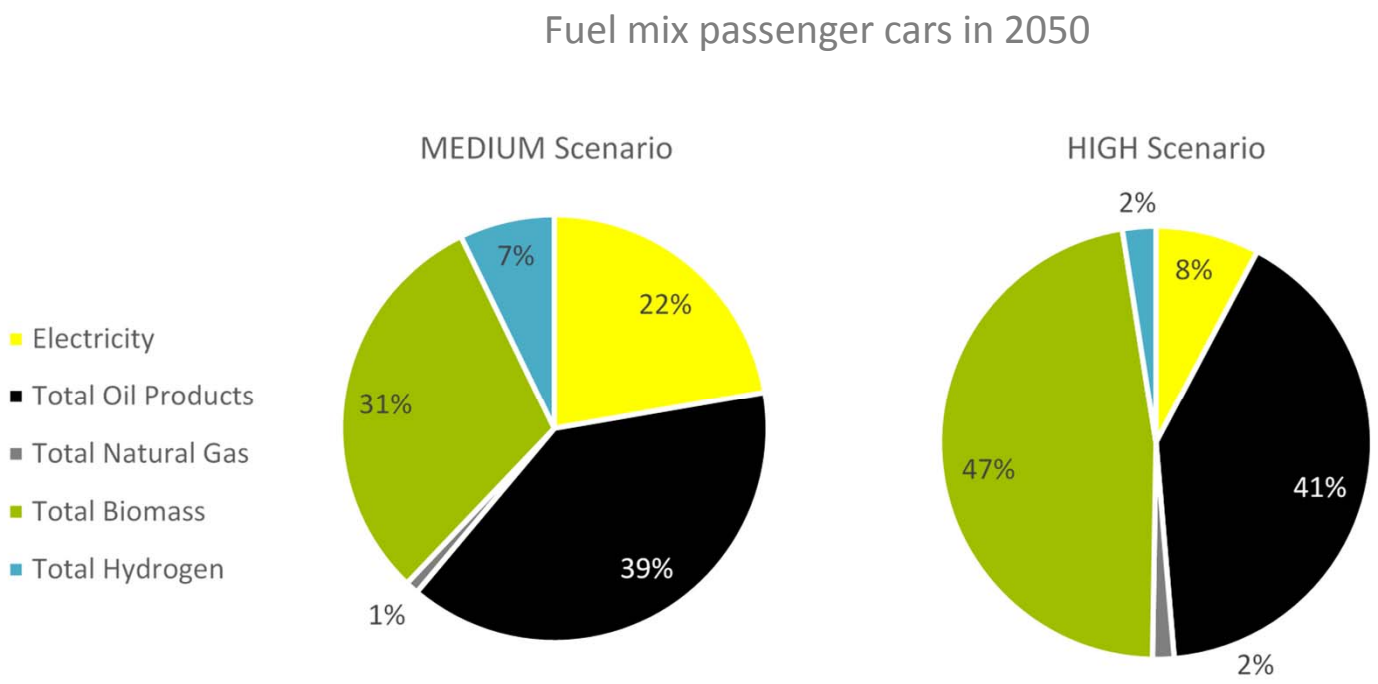
- **Current situation**: due to low prices and ease of use (high energy content), fossil fuels dominate all transport sectors
  - Road transport: mostly dependent on gasoline & diesel
  - Maritime transport: low quality residual fuels
  - Aviation: conventional kerosene

- The share of alternative (non-fossil) fuels is limited.

Fuel mix transport sector 2020



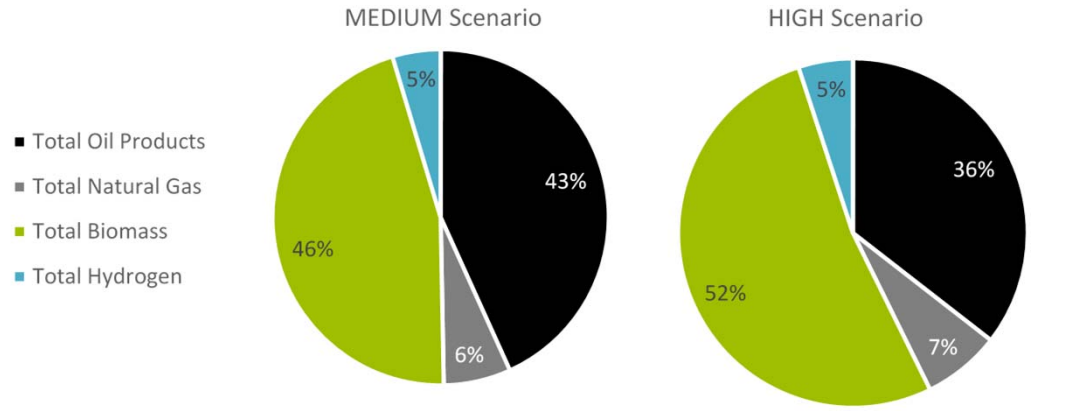
Competition between advanced biofuels and electrification in passenger transport



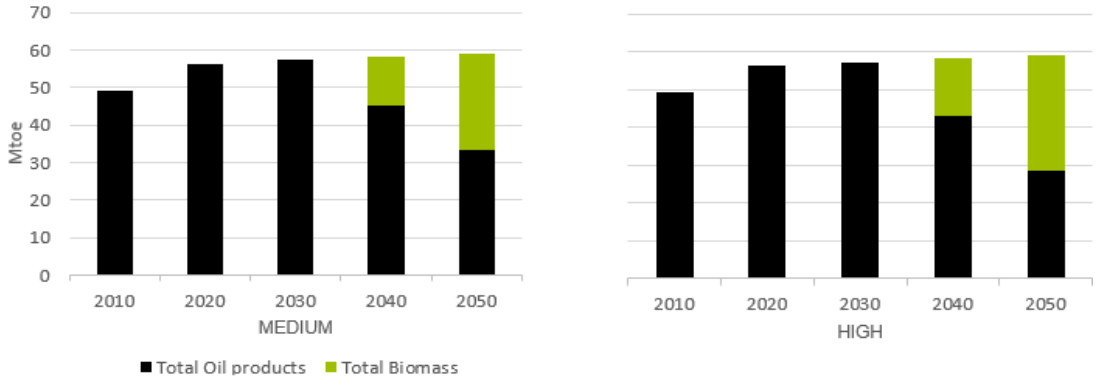
- Passenger cars are front-runners in the adoption of electric powered motors.
- Both advanced biofuels and electrification are necessary to cover overall demand.

Advanced biofuels are the main alternative for aviation, maritime, and heavy-duty road transport

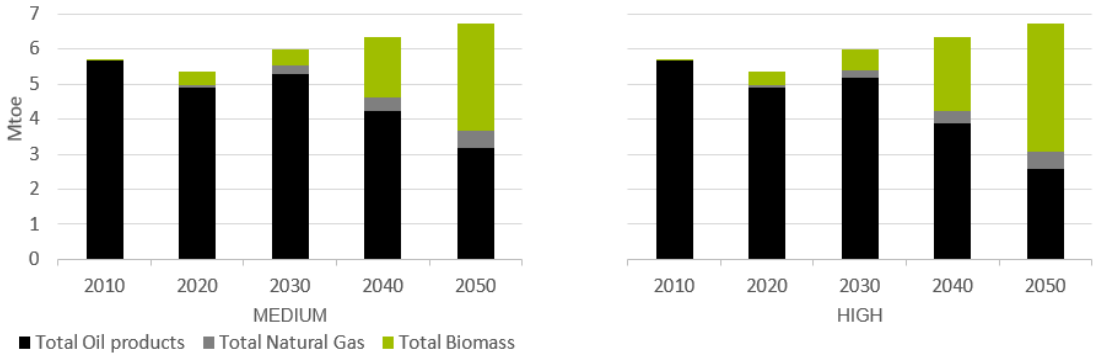
Fuel mix heavy duty road transport in 2050



Fuel mix aviation transport in 2050

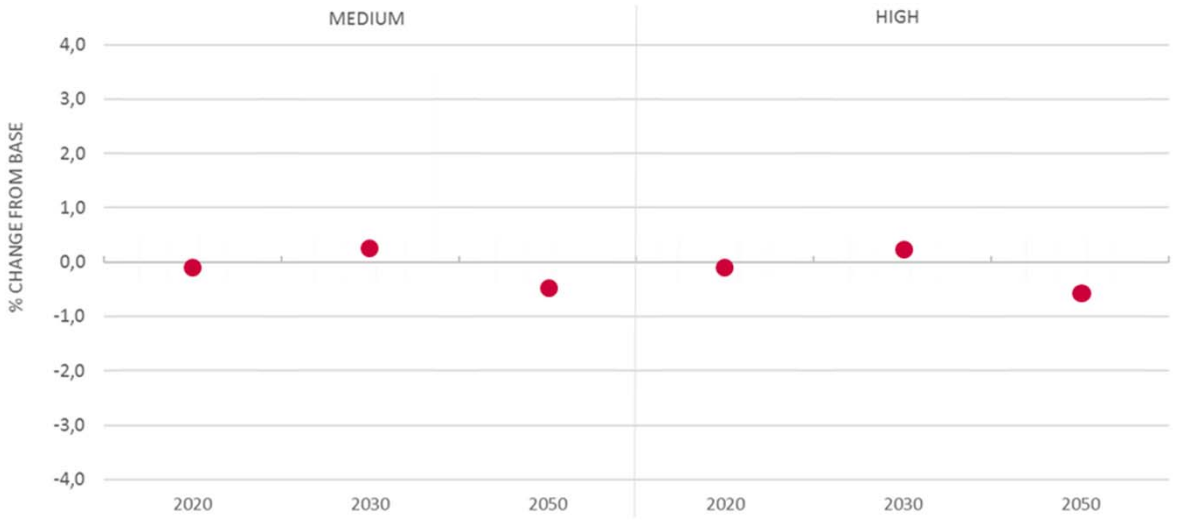


Fuel mix maritime transport in 2050



Decarbonizing the energy system using advanced biofuels is achievable without a negative impact on GDP

Decomposition of GDP impact- EU28



108,000 new jobs are created up to 2050 in the HIGH scenario

Decarbonizing the energy system using advanced biofuel has positive effects on employment

- Almost all sectors benefit from employment growth in the decarbonisation scenario, especially in the sector “biofuels” and agriculture related jobs.
- **108,000** new jobs are created up to 2050 in the HIGH scenario.

Employment by sector in the HIGH scenario

Sector	% change from MEDIUM (2020 – 2050)
Agriculture (non - biofuels)	0.12%
Biofuels	26.15%
Basic Metals	-0.01%
Other Energy Intensive Industries	0.02%
Construction	0.02%
Transport Equipment	0.00%
Other Equipment Goods	-0.05%
Consumer Goods Industries	0.09%
Services	0.04%
Energy	-0.61%
Total	**0.054%**

Conclusions

Highlight of conclusions:

→ Impact R&I measures:

*Up to **+120%** available feedstock – at lower prices*
*Up to **-40** to **-60%** capex for conversion*

→ Role of Adv. Biofuel:

*Up to **50%** share of transport energy demand*
*Only **limited competition** with other green fuels*
Reaching fossil fuel price levels in 2050

→ Macro-economic impact

*€365 billion market (**1.6%** of EU's GDP)*
***No negative GDP** impact and **+108k** jobs*
Net increase energy security

→ Feedstock limitations

Scale drives cost reduction
- improve feedstock mobilisation
- focus on fuel and feedstock flexibility
- EV and FCV: competitors or complementary?
- synergies with fossil and 1st gen. feedstock

The development of advanced biofuels requires R&I instruments on several fronts:

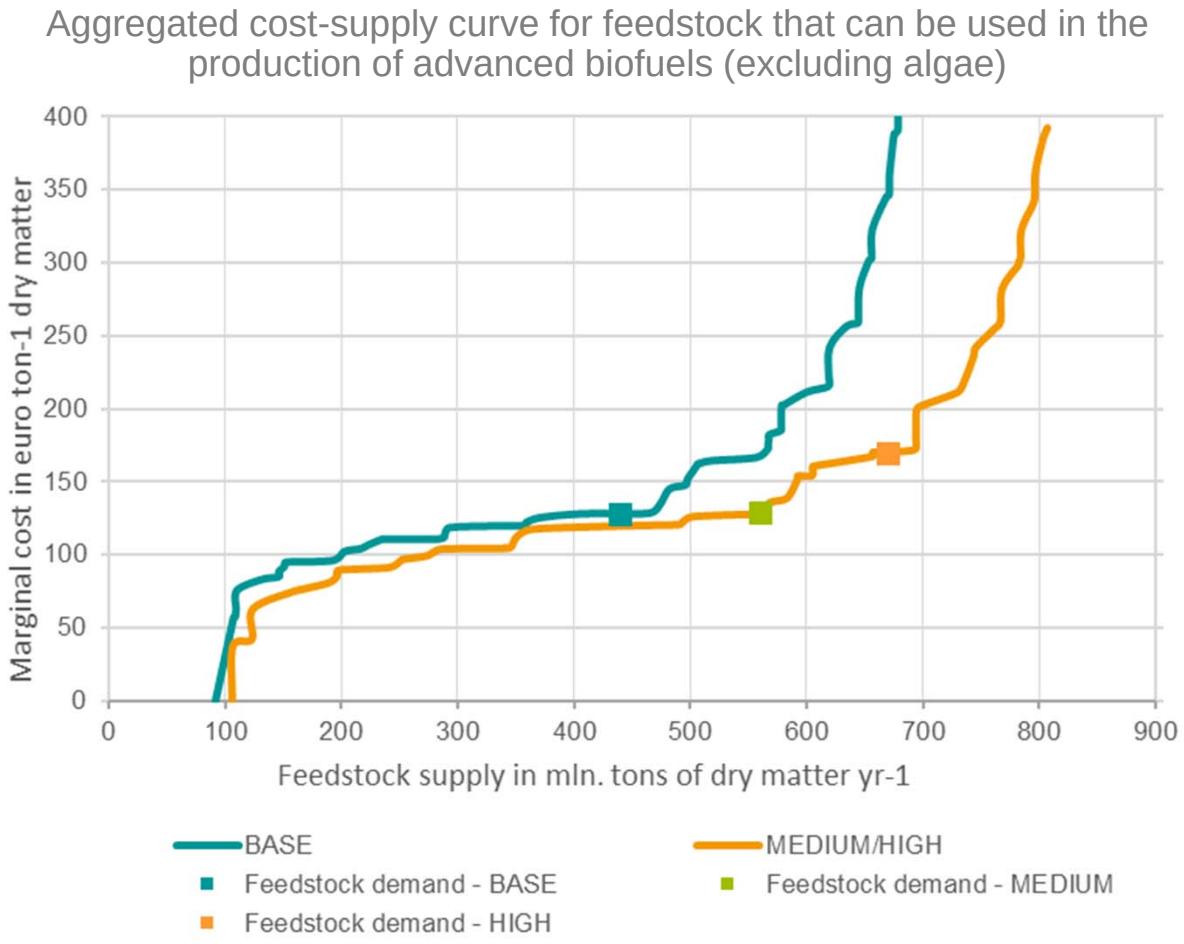
- R&I can improve the supply of biomass feedstock by **50- 120%**;
- R&I can improve advanced biofuels production processes to reduce conversion costs by decreasing investment costs by **20%** on average (by **40-60%** for the most relevant conversion technologies); and

If successfully developed:

- Share of advanced biofuels in overall transport **sector energy mix can reach 50%** by 2050;
- Substitution of imported fossil fuels with domestically produced advanced biofuels **improves energy security;** and
- Absolute market volume could reach **€365 billion** (1.6% of EU's GDP).

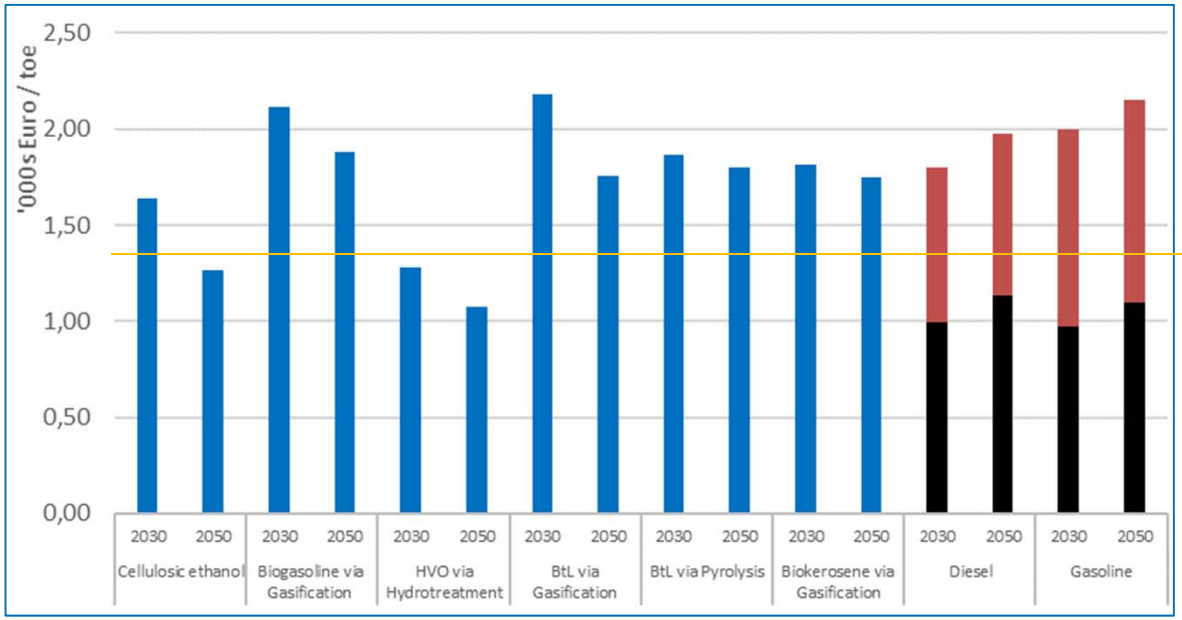
The decarbonisation of the energy mix using advanced biofuels could be achieved **without negative GDP impact** and with positive effects on employment, a **net increase of 108,000 extra jobs.**

For every level of feedstock demand, R&I significantly decreases the cost of biomass



Average production costs of advanced biofuels decrease significantly by 2050, some reaching the price of fossil fuels

Average production costs of advanced biofuels (scenario HIGH):
Most advanced biofuel types become a cost-competitive alternative if the tax levels for fossil fuels remain in place and advanced biofuels are untaxed



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

- The long-term use of advanced biofuels, complementary with renewable alternative fuels in the road transport sector (other renewable alternative fuels account for **47-60%** of the 2050 fuel mix); and
- Transport sectors, such as heavy duty road transport, aviation and shipping, as they have limited alternatives: advanced biofuels account for **50-60%** of the 2050 fuel mix, and conventional oil and natural gas accounts for the remainder.

Successful diffusion of advanced biofuels depends on:

- Creation of incentives for stakeholders (farmers, forestry owners, innovators, industrial investors, consumers) to ensure the establishment of efficient logistic chains from biomass source to production facility; and

Scaling up the advanced biofuels sector will **take time:**

- Transition period **15-20 years**;
- Alternative “competing” technologies will also be evolving simultaneously.

Overview: socio-economic benefits of advanced biofuels at a glance

- 330 Mt of net CO2 emissions savings, accounting for 65% of the required transport sector emissions reduction by 2050, and air quality improvement through a 60% reduction of overall emissions, including emissions reductions of CO, NO_x and SO_2.

- Increased energy security – the EU becomes less dependent on fossil fuel imports from possibly politically unstable regions.

- EU market for biofuels of 260 - 365 billion € in 2050, amounting to ca. 1.6 – 2.6% of the total EU GDP in 2050.
- More than 100,000 additional jobs in the advanced biofuels sector in the period 2020-2050.

- Extension and consolidation of EU's frontrunner position regarding advanced biofuels related R&I and substantial knowledge spill-overs to other innovative sectors.

- The development of an advanced biofuels sector is an integral part of the EU's transition to a circular, sustainable and low-carbon economy.

Thank you for your attention!