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AMBITION

ADVANCED BIOFUEL PRODUCTION WITH ENERGY SYSTEM INTEGRATION

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Some introductory comments on Transportation Energy

- Our market economy is based on growth
- Growth is based on energy, cheap energy widely available
- Today's energy systems
 - Limited cross sectorial integration
 - Overall efficiency is not a top priority in each individual sector
 - Fossil energy carriers' high marginal cost
- New integration systems are needed for
 - Sustainable production of feedstocks
 - Biomass as a source of energy, chemicals, materials and food/feed
 - Comprehensive systems with improved environmental record, means energy AND carbon efficiency
 - Transportation: symbiosis of electricity, gaseous and liquid fuels

Low Energy Return of Investment
Renewable fuels are more expensive

Energy transition:

De(fossil)carbonization of transport

Phase out fossil fuels

Simultaneously
Reduce/remove carbon
loss from feedstock
during processing

Sustainable
produced biomass

Efficient conversion
technologies

Liquid renewable
fuels



Optimization along a value chain

Sector coupling



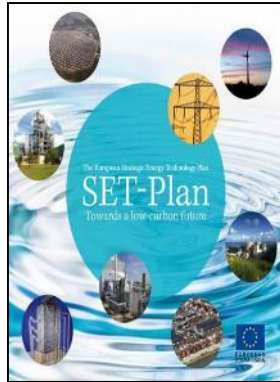
Competitive renew-
able electricity

Electrification of
society and industry

Hydrogen as
energy carrier

The Scene for Ambition

- Links to policy agenda: **2020 targets for energy & climate**
- Focus on individual technologies with market and target impact up to 2020



-20 %
Greenhouse Gas
Emissions

20%
Renewable
Energy

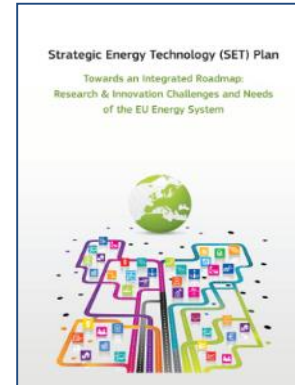
20 %
Energy
Efficiency

RED II

- **Renewable target: 32%**
- **Targets for Renewable Transport:**
 - **14% overall,**
 - **3.5% advanced**

Paris Agreement

- **Limit Global warming to 1.5°C**
- **Reduction in CO2 emissions by 80-95%**

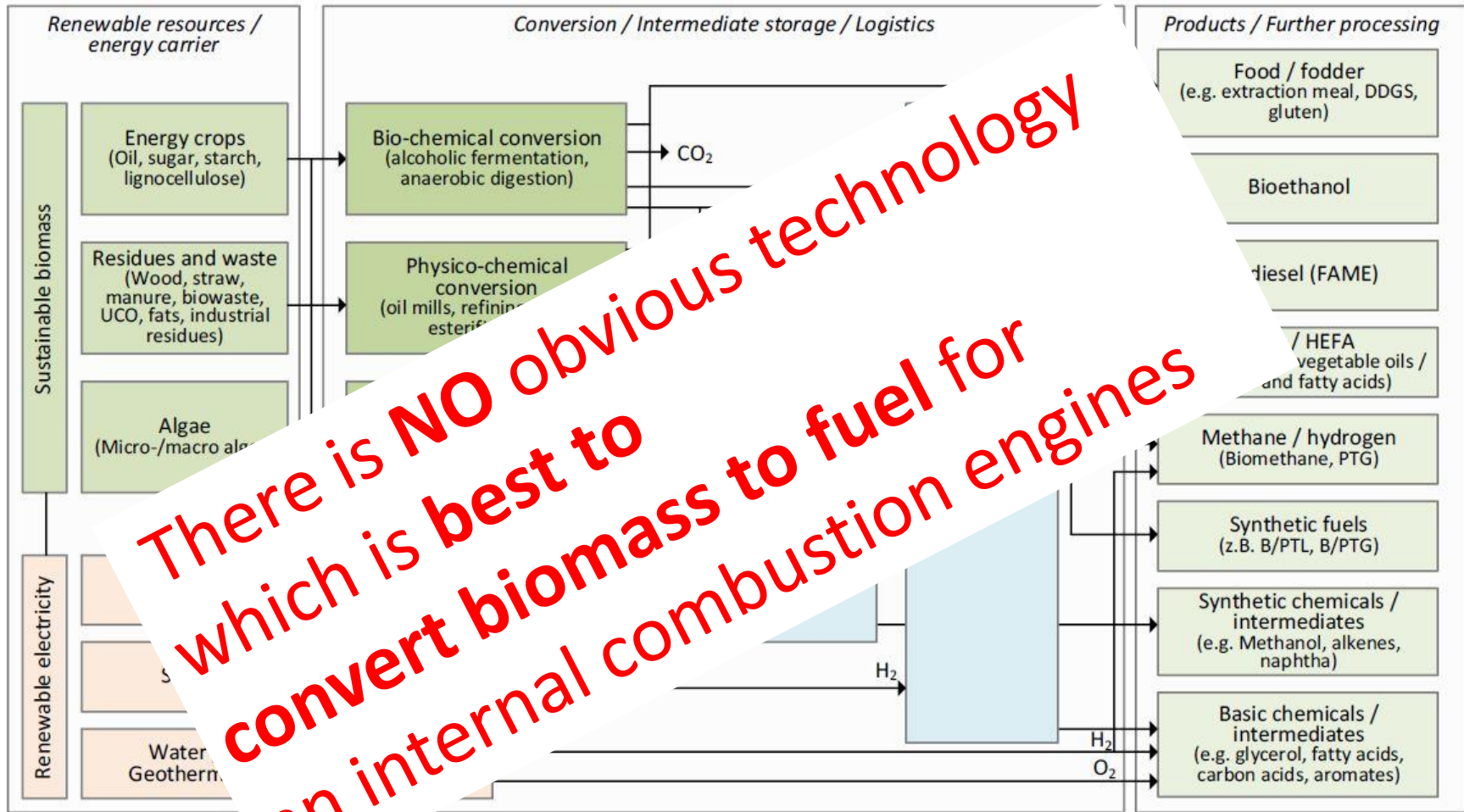


- 40 %
Greenhouse Gas
Emissions

27 %
Renewable
Energy

27%
Energy
Efficiency

- Links to policy agenda: **2030 targets for energy & climate**
- Focus on :
 - **Consumer**
 - **Energy Efficiency**
 - **System optimization**
 - **(Supply) Technology**



AMBITION – Scope

The AMBITION project is dedicated to the

- definition and initial execution of a **European Common Research and Innovation Agenda (ECRIA)** considering **key unit operations** in the production of **next generation liquid biofuels**
- **subsequently linking energy systems** (grid electricity and biofuels in particular) to improve overall efficiencies.
- specific advances shall be adaptable to **existing biofuel production schemes** or integrated to enable **new considerably improved, environmentally friendly** and **economically competitive processes**.

AMBITION – Objectives

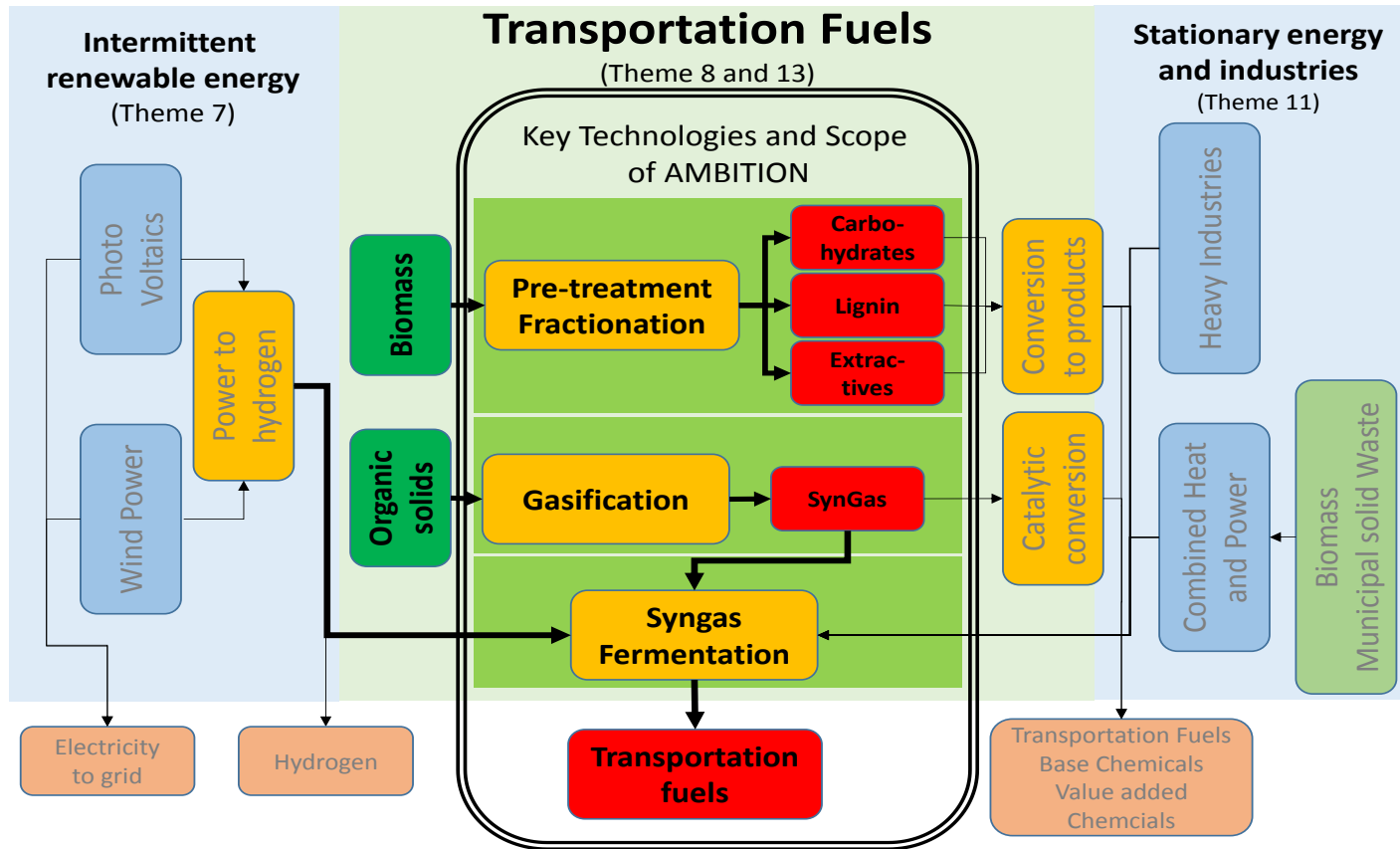
- ❑ **Creation of a strong, focused and sustainable research partnership:**
 - ❑ develop a **long-term research agenda and strategy**, which defines research priorities, technology development and innovation in a transnational setting,
 - ❑ develop of **joint projects/programmes**, including **researcher exchanges** and **joint use of installations**.

- ❑ **Development of innovative key unit operations in biofuels production:**
 - ❑ Biomass pre-treatment / fractionation,
 - ❑ Gasification and gas cleaning and conditioning,
 - ❑ Biochemical syngas conversion to liquid biofuels (syngas fermentation)
 - ❑ Facilitate their integration along a value chain as well as across value chains

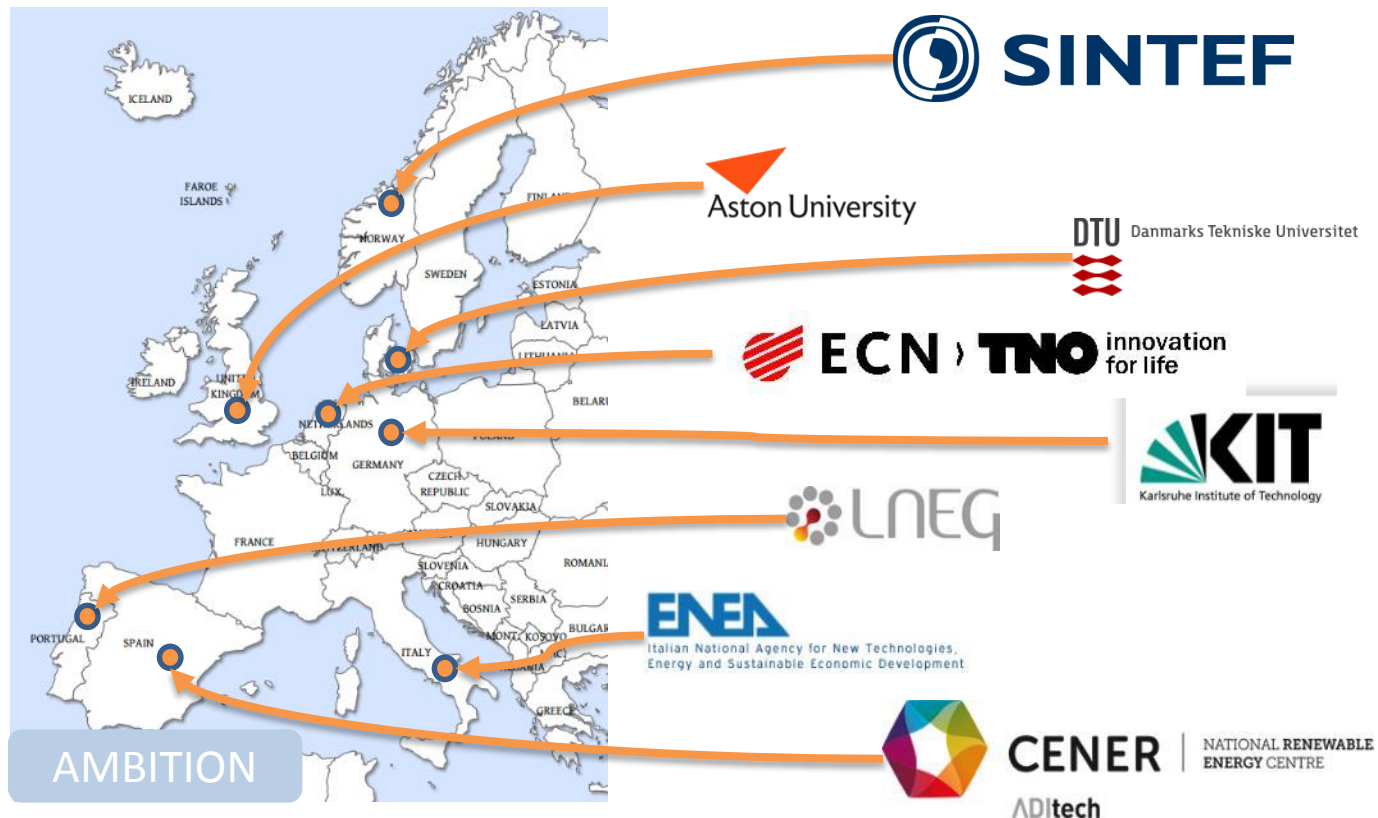
- ❑ **Evaluation of the technical, economic and environmental feasibility of integrating biofuels production from lignocellulosic biomass into today's energy system**

AMBITION Approach

Advanced biofuel production with energy system integration



AMBITION – Partners



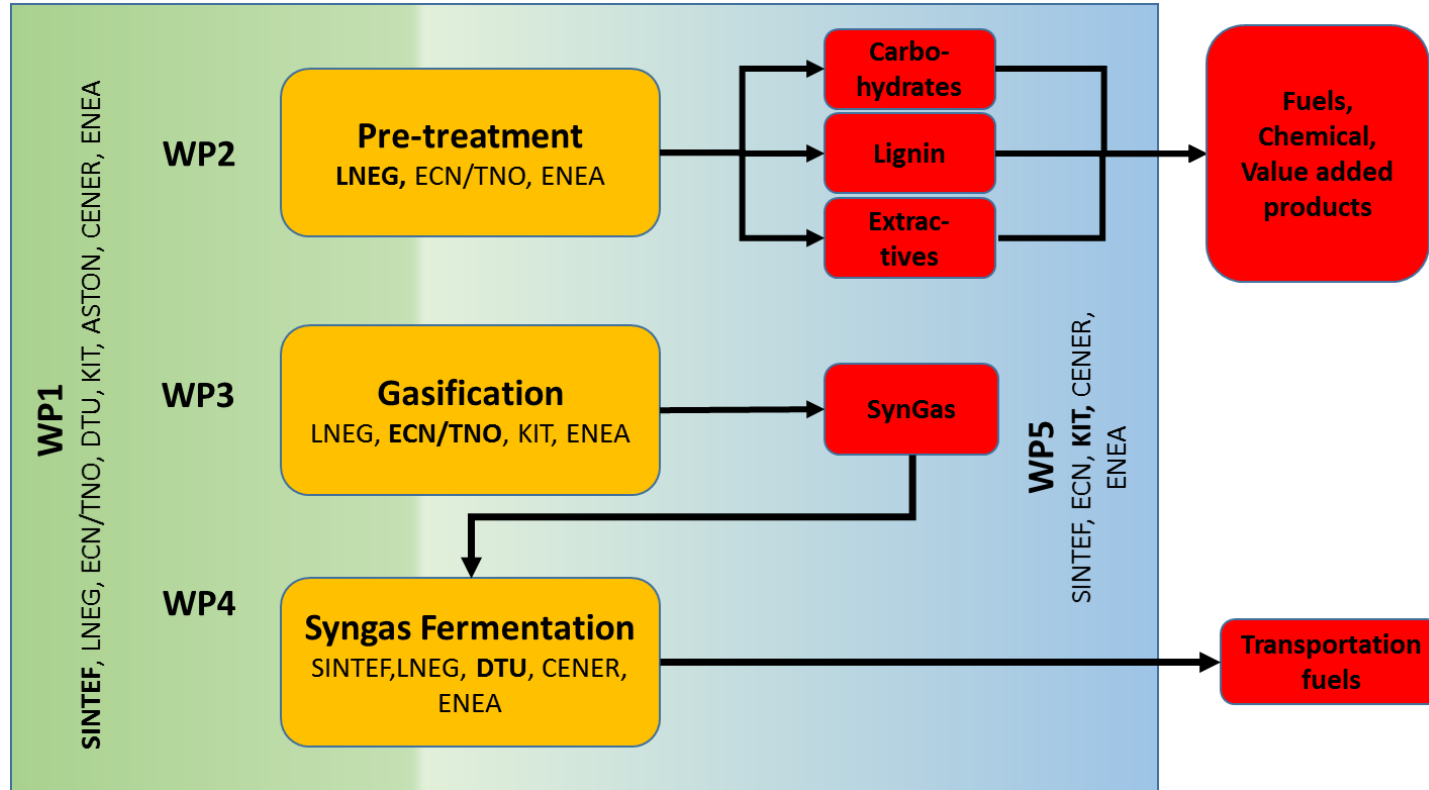
AMBITION



AMBITION – Work packages

WP	WP leader	Title
1	SINTEF	Common agenda, coordination and networking
2	LNEG	Efficient low-temperature pre-treatment to generate valuable sugars and lignin streams
3	ECN>TNO	Gasification and gas cleaning and conditioning
4	DTU	Synthesis Gas Fermentation
5	KIT	Energy system integration and process design
6	ASTON	Exploitation, Dissemination and Communication
7	SINTEF	Project Management

Work package structure and partner involvement



AMBITION – Specific objectives (WP1)

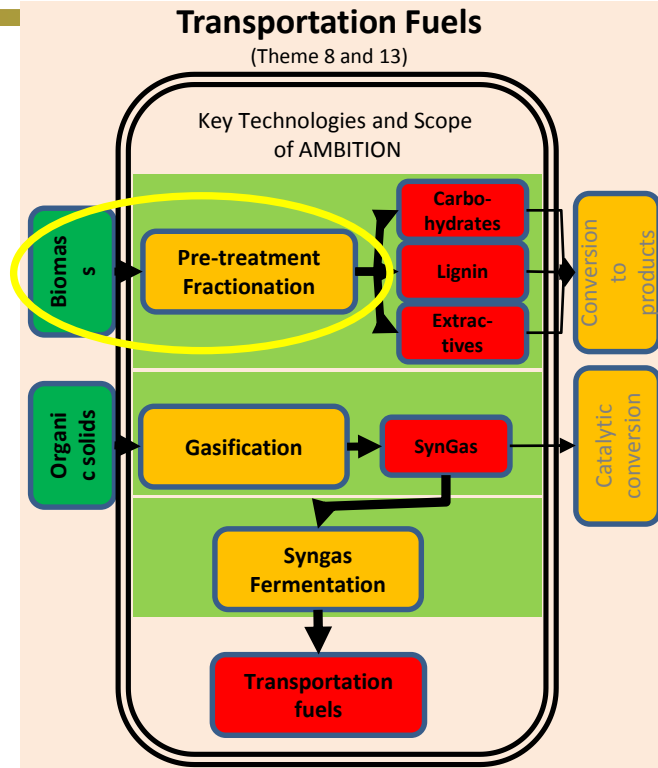
Common agenda, coordination and networking

Tasks	Challenges and actions
3 Shared use of Research Infrastructures	<ul style="list-style-type: none">• Overview of relevant infrastructures• Link to ideas (T2) and research mobility (T4)
2 Foster a culture of co-operation to establish a strategic long-term vision and synergies	<ul style="list-style-type: none">• Identify stake holders• Scheduling of workshops for idea generation
4 Researcher exchange / mobility	<ul style="list-style-type: none">• Identify topics and infrastructure for research exchange• Execute research sprints
1 Definition of a common research and innovation agenda	<ul style="list-style-type: none">• How can we make an impact in Europe?• Involve key players both in R&D and industry

AMBITION – Specific objectives (WP2)

Biomass pre-treatment:

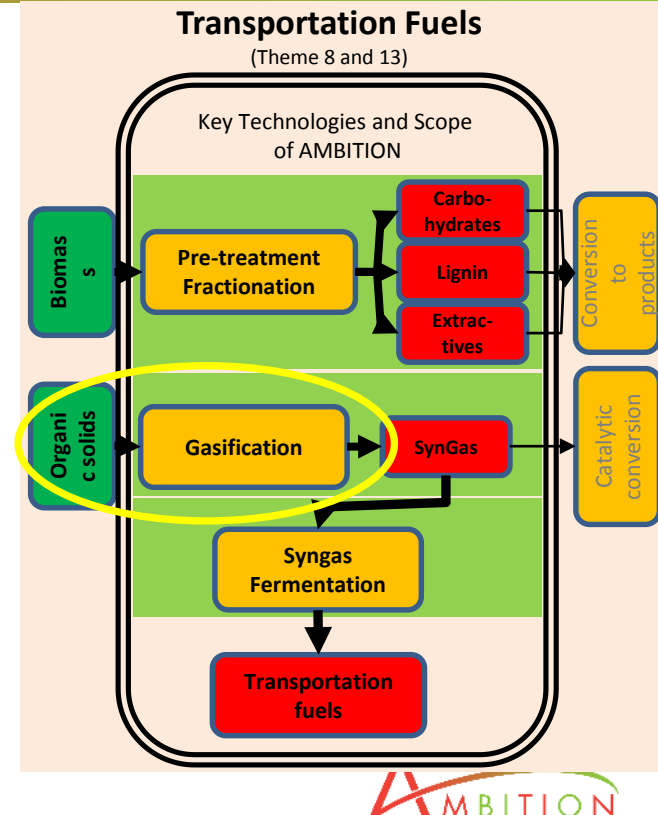
- ❑ Development of disruptive methodologies for lignocellulosic biomass (LCB) pre-treatment based on **low-temperature** (120-140°C) processes with a **low energy requirement** and **use of non-hazardous catalysts and/or green solvents** to avoid the use of mineral acids, as a key unit operation for high-added-value valorisation of all LCB fractions (sugars and lignin); in combination with:
- ❑ Energy-efficient (integrated) **separation and recovery** of all LCB fractions in LCB pre-treatment.



AMBITION – Specific objectives (WP3)

Gasification and gas cleaning and conditioning:

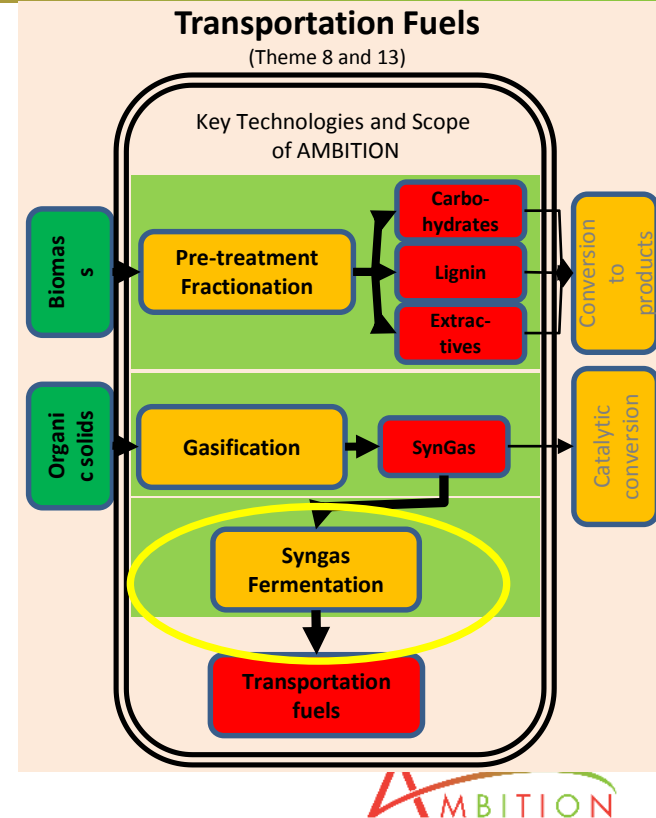
- ❑ Adaptation of gasification technologies to allow their application for the **valorisation of biorefinery residues**, in particular lignin-rich fractions from, e.g., 2G bioethanol production.
- ❑ Development of energy-efficient, economically viable pathways for **syngas cleaning and conditioning**, with particular focus on syngas valorisation by means of syngas fermentation.
- ❑ Development of pathways for improved high-added-value carbon utilization from the biomass with particular focus on **obtaining proper H_2/CO ratios** for downstream syngas processing
- ❑ Operation optimization: temperature, steam, bed material/additives, feed-in of **H_2 from intermittent energy sources** or recycling of CO_2 .



AMBITION – Specific objectives (WP4)

Biochemical syngas conversion to liquid biofuels (syngas fermentation):

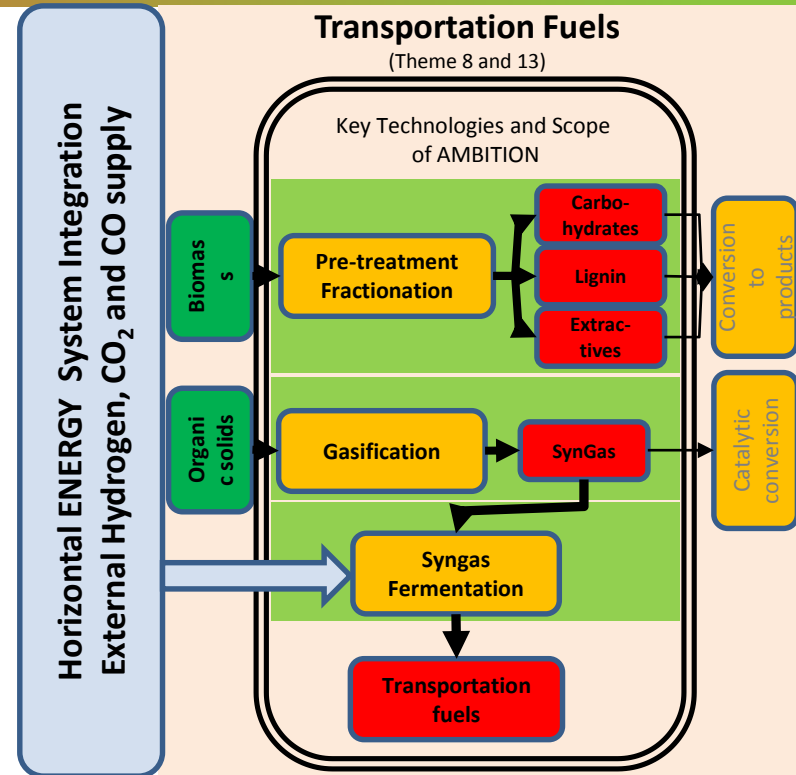
- ❑ Engineering of suitable bacterial strains and optimize the production of **1-butanol** with increased tolerance to product inhibition from syngas.
- ❑ Optimization of fermentation conditions for optimal production of 1-butanol from syngas.
- ❑ Optimization of the **biocatalytic production of butyric acid, enzymatic esterification** with 1-butanol to the **ester butyl butyrate** as a drop-in aviation biofuel.
- ❑ Evaluate the potential inhibitory effect of the impurities present in industrial scale syngas.



AMBITION – Specific objectives (WP5)

Process design and integration

- ❑ Design and optimize an innovative scheme for efficient material and energy usage is essential to improve the overall environmental and economic performance:
 - ❑ (i) the combination and integration of a thermo-chemical and a bio-chemical process route (unit operations)
 - ❑ (ii) the consideration of external hydrogen supply and CO₂ utilization (energy systems)
- ❑ Comparative techno-economic assessment in regard to most efficient process configurations
- ❑ Verification of major key indicators related to environmental impact



Preliminary Recommendations

- Base research for new technologies
- Enable building of large enough pilot systems
 - Testing of unit operations
 - Optimizing and trouble shot of sub-systems
 - System integration
 - Pre-prepare for scale up of complete
- Enable building of demonstration plants
 - First of a kind will (most probably not be commercial viable)
 - Time on stream to determine/solve long term operational challenges
- We can't wait for the best plant; development "on the fly" is risk; therefore few try it



Thanks for your attention!