www.core-jetfuel.eu

CORE-JetFuel

Coordinating research and innovation in the field of sustainable alternative fuels for Aviation

Andreas Sizmann - BHL

This project has received funding from the European Union's Seventh Programme for research technological development and demonstration under grant agreement No 605716

Bauhaus Luftfahrt
Neue Wege.

SENASA

FNR
Fachagentur Nachwachsende Rohstoffe e.V.

AIRBUS GROUP

IFP Energies nouvelles

WIP

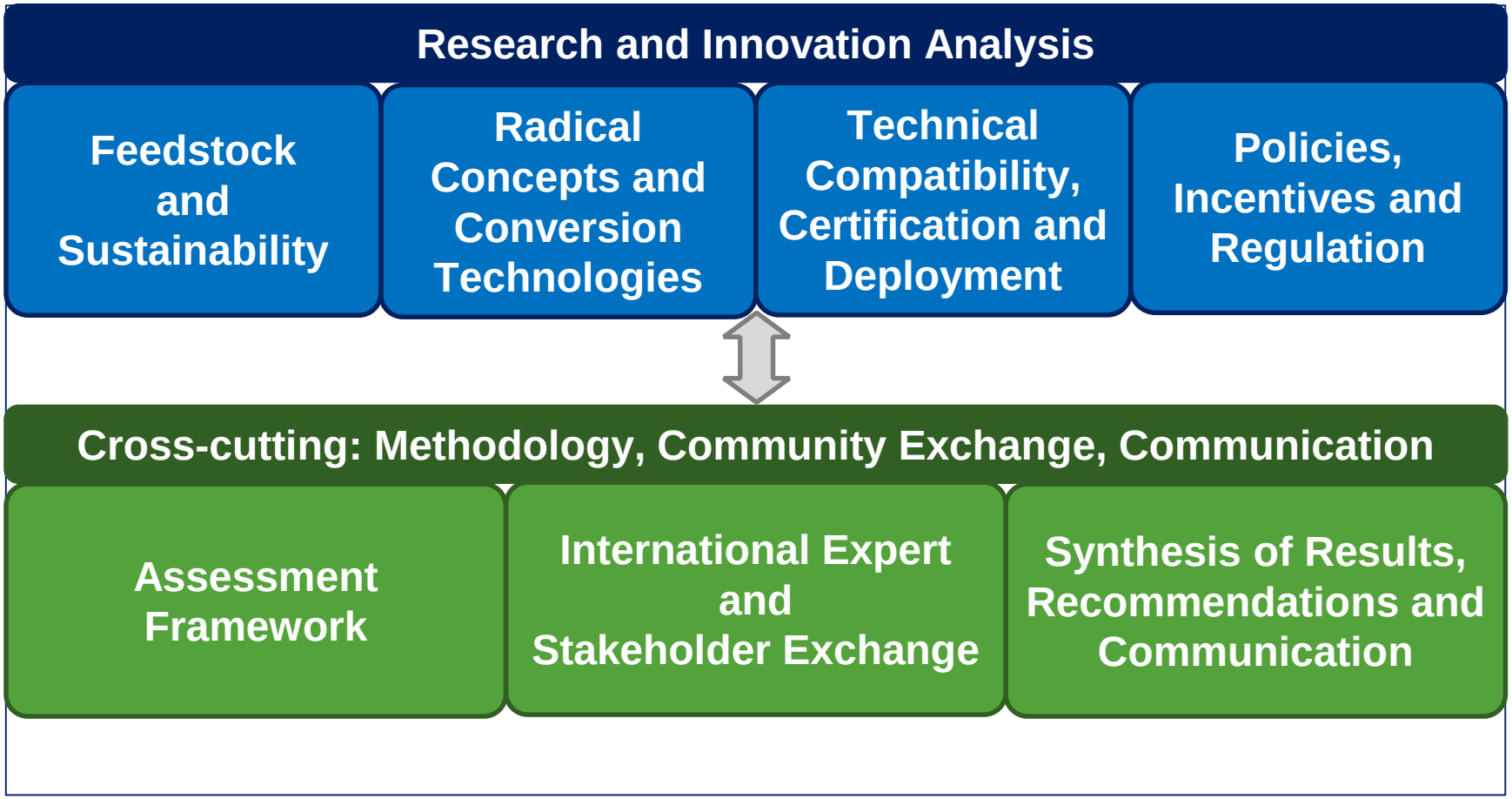
Content

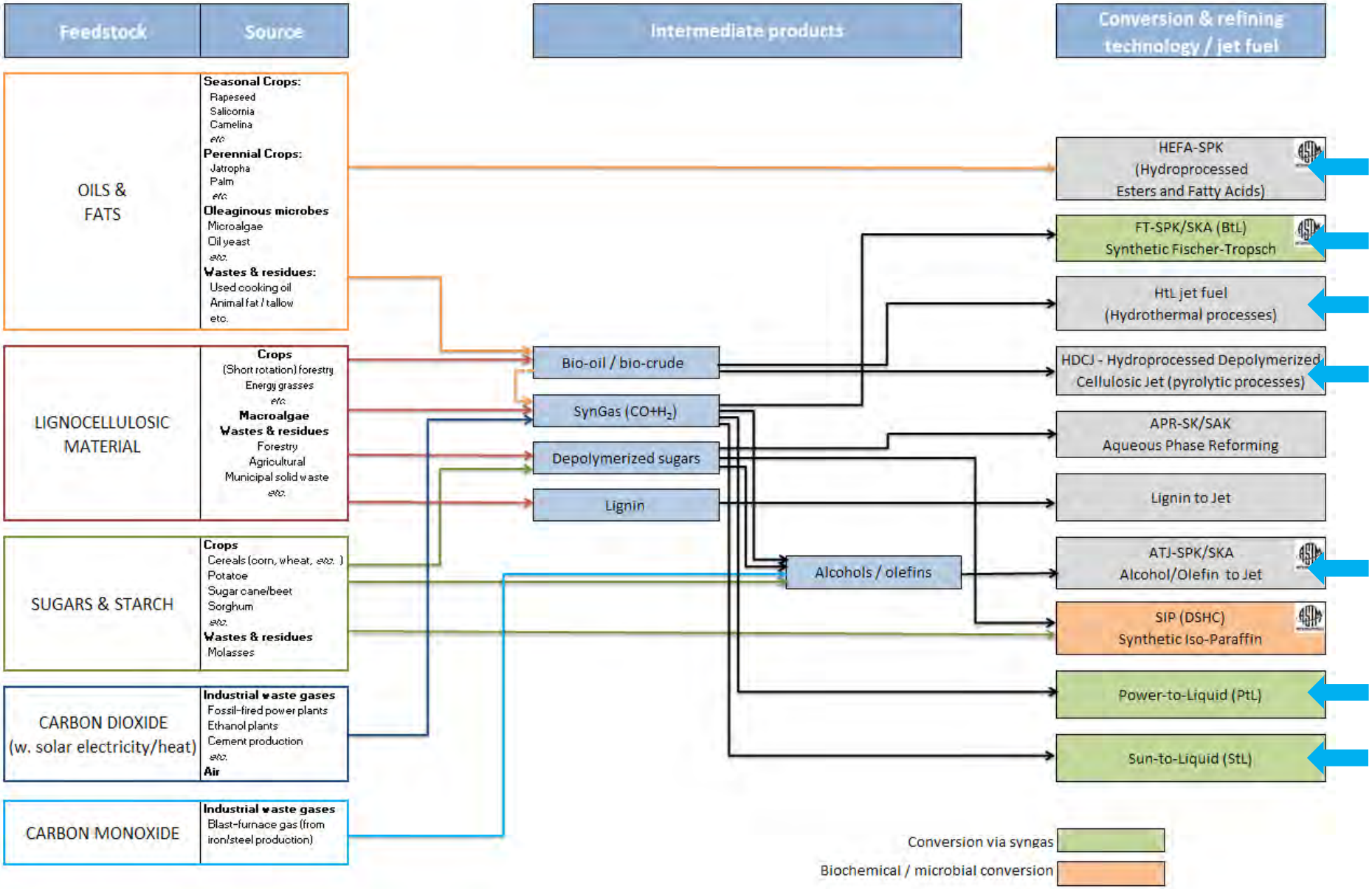
- Background and objectives
- Performance indicators
- Trade-offs in technology assessment
- Roadmaps for R&D and deployment
- Conclusions and recommendations

Content

- Background and objectives
- Performance indicators
- Trade-offs in technology assessment
- Roadmaps for R&D and deployment
- Conclusions and recommendations

The CORE-JetFuel Approach




Feedstock
Source
Intermediate products
Conversion & refining technology / jet fuel
OILS & FATS
Seasonal Crops:
Rapeseed
Salicornia
Camelina
etc.
Perennial Crops:
Jatropha
Palm
etc.
Oleaginous microbes
Microalgae
Oil yeast
etc.
Wastes & residues:
Used cooking oil
Animal fat / tallow
etc.
LIGNOCELLULOSIC MATERIAL
Crops
(Short rotation) forestry
Energy grasses
etc.
Macroalgae
Wastes & residues
Forestry
Agricultural
Municipal solid waste
etc.
SUGARS & STARCH
Crops
Cereals (corn, wheat, etc.)
Potatoe
Sugar cane/beet
Sorghum
etc.
Wastes & residues
Molasses
CARBON DIOXIDE (w. solar electricity/heat)
Industrial waste gases
Fossil-fired power plants
Ethanol plants
Cement production
etc.
Air
CARBON MONOXIDE
Industrial waste gases
Blast-furnace gas (from iron/steel production)
Bio-oil / bio-crude
SynGas (CO+H2)
Depolymerized sugars
Lignin
Alcohols / olefins
HEFA-SPK
(Hydroprocessed Esters and Fatty Acids)
FT-SPK/SKA (BtL)
Synthetic Fischer-Tropsch
HtL jet fuel
(Hydrothermal processes)
HDCJ - Hydroprocessed Depolymerized Cellulosic Jet (pyrolytic processes)
APR-SK/SAK
Aqueous Phase Reforming
Lignin to Jet
ATJ-SPK/SKA
Alcohol/Olefin to Jet
SIP (DSHC)
Synthetic Iso-Paraffin
Power-to-Liquid (PtL)
Sun-to-Liquid (StL)
Conversion via syngas
Biochemical / microbial conversion

Objectives of Research Analysis

- Technology assessment: identification of promising “clusters”
  - State of the art and potentials w.r.t.
    - environmental,
    - economic and
    - technical

    performance parameters

- Portfolio assessment: mapping of R&D landscape
  - Impact and balance of R&D portfolio at European level

Content

- Background and objectives
- Performance indicators
- Trade-offs in technology assessment
- Roadmaps for R&D and deployment
- Conclusions and recommendations

Comparison of options: Technology assessment

- Relevant questions
  - How much can we make?
  - What is the potential environmental impact?
  - How much would it cost?
  - Drop-in capable or not?
  - What is the current state of development (maturity)?

- The assessment of alternative fuel technologies requires a multiple-criteria approach

Multiple-criteria assessment framework

- Criteria selection and definition of metrics (performance indicators)

Criterion	Metric	
Technical maturity	Technology Readiness Level	TRL (1-9)
Feedstock production maturity	Feedstock Readiness Level	FSRL (1-9)
Conversion technology maturity	Conversion Technology Readiness Level	CTRL (1-9)
Technical compatibility	Maximum blending ratio	$r_{Blend,Max}$ [%]
Economic competitiveness	WtT production costs relative to spot price in 2013	γ [%]
***Global* substitution potential**	Production potential relative to demand in 2050	σ [%]
***European* substitution potential**	Production potential relative to demand in 2050	σ [%]
Specific GHG emissions reduction	Specific lifecycle GHG emissions relative to conventional jet	ε [%]

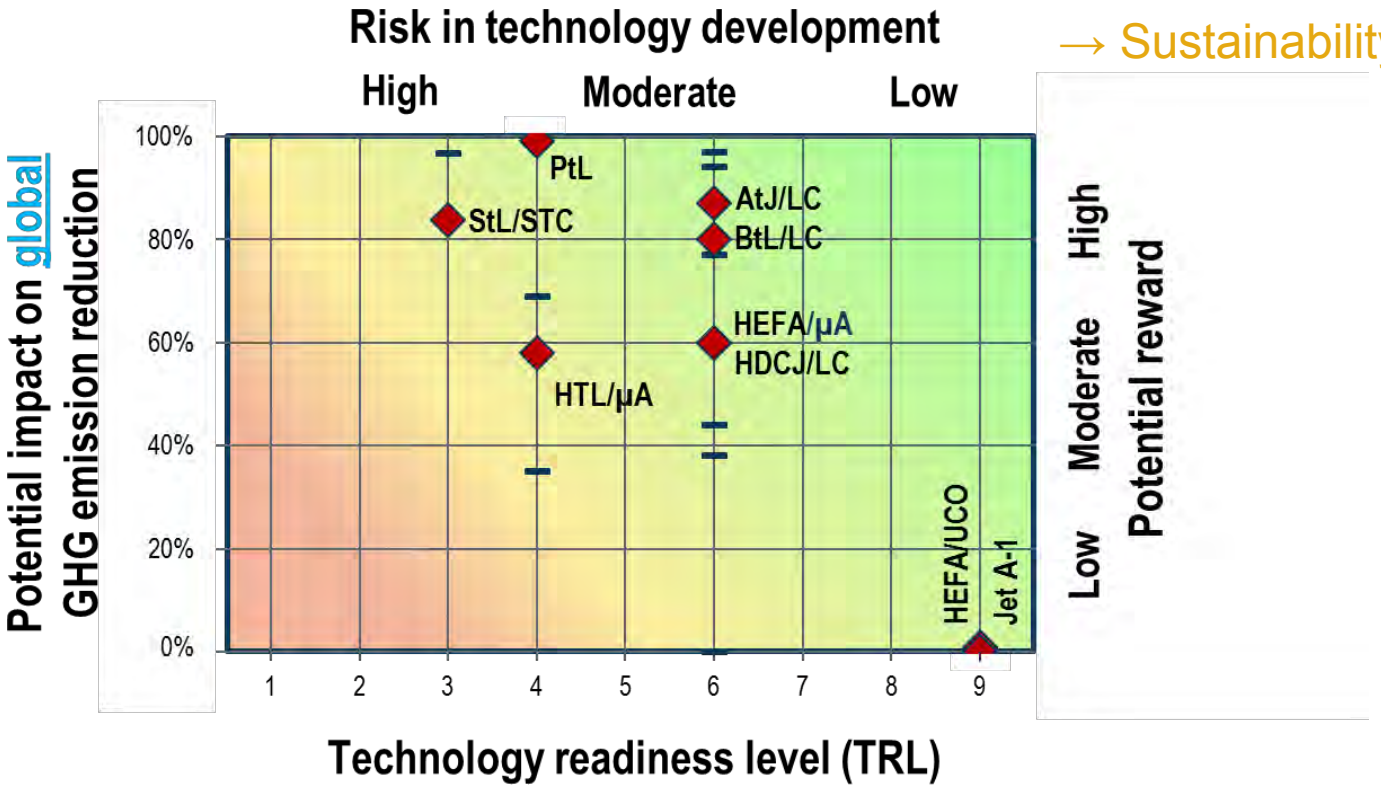
Content

- Background and objectives
- Performance indicators
- Trade-offs in technology assessment
- Roadmaps for R&D and deployment
- Conclusions and recommendations

Potential global impact

Potential impact on GHG emissions reduction given by specific LC carbon balance and production potential

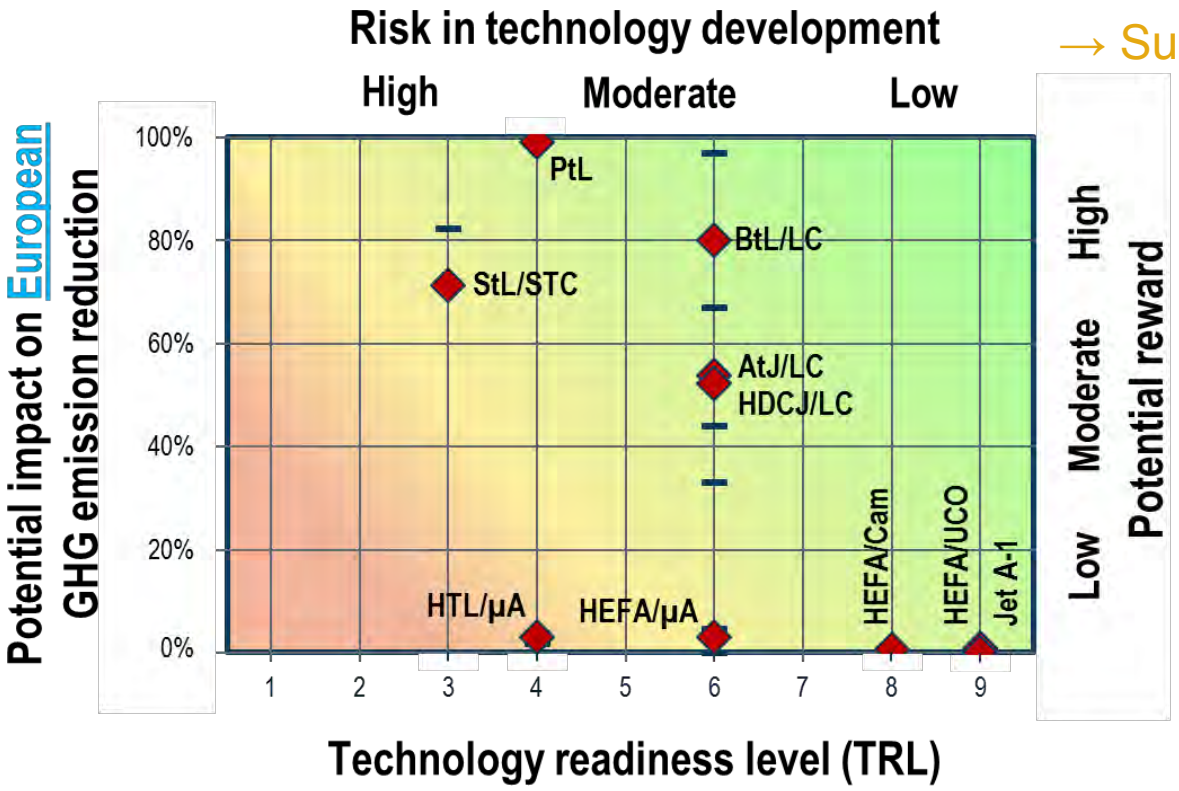
→ Sustainability AND scalability!



Potential European impact

Potential impact on GHG emissions reduction given by specific LC carbon balance and production potential

→ Sustainability AND scalability!

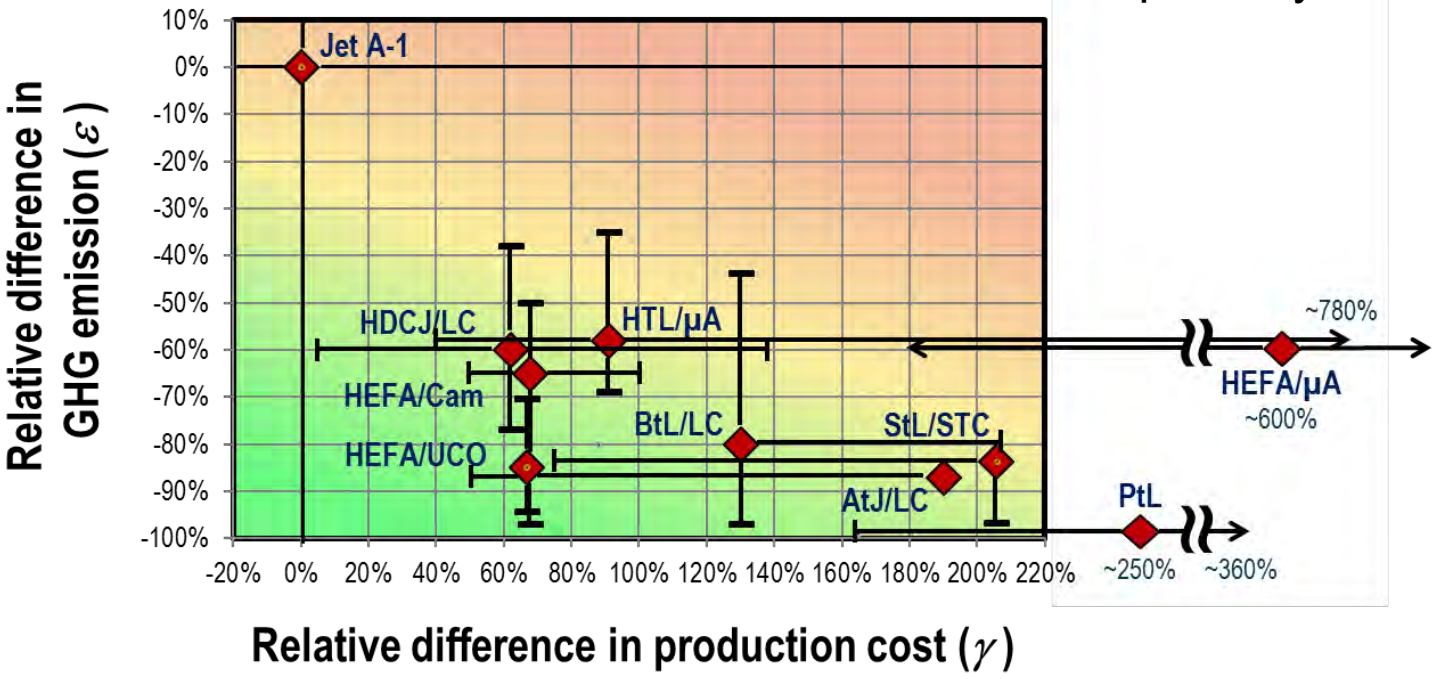


Potential global impact

Broad range of published values

Many pathways show favorable LC carbon balance

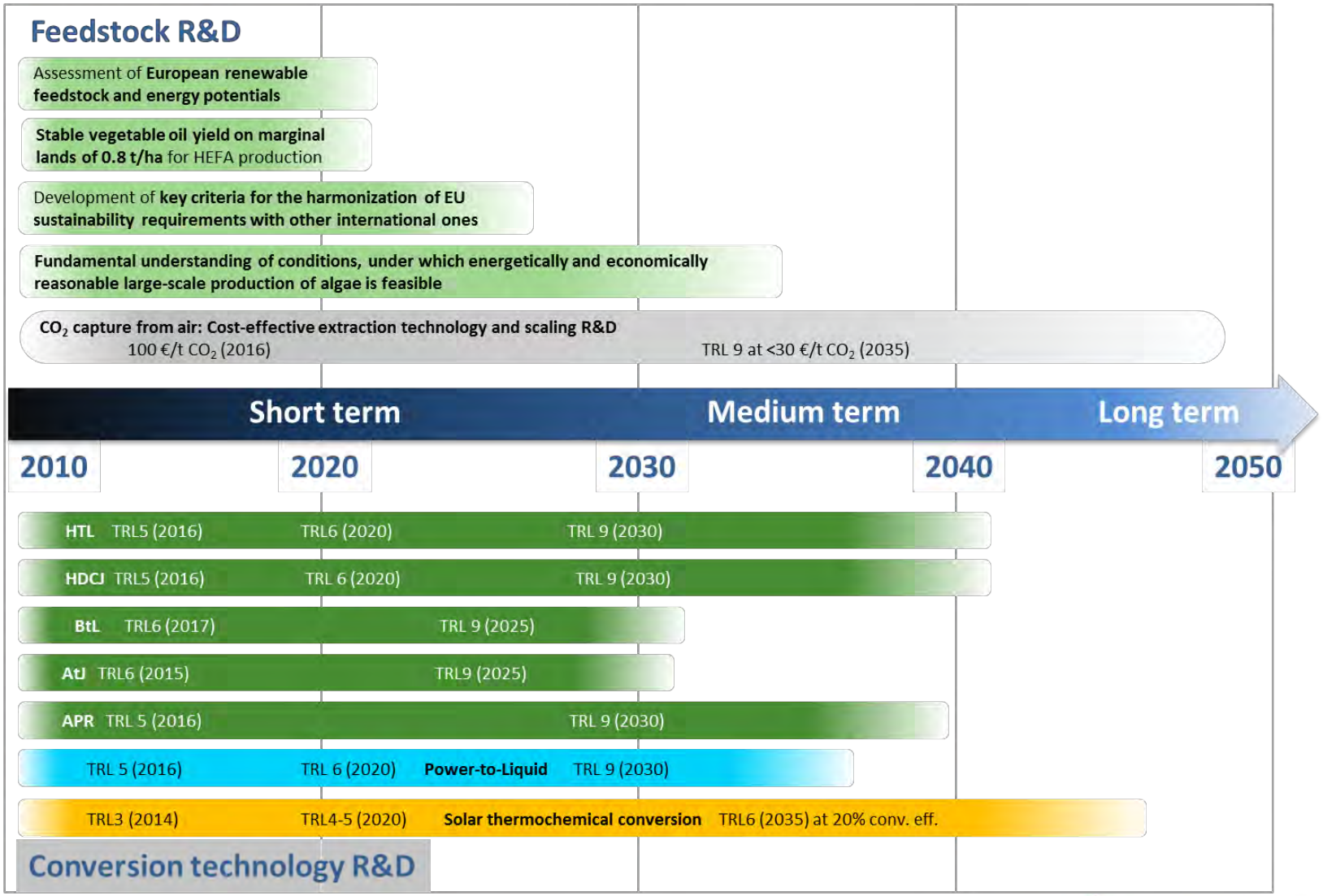
No pathway cost-competitive



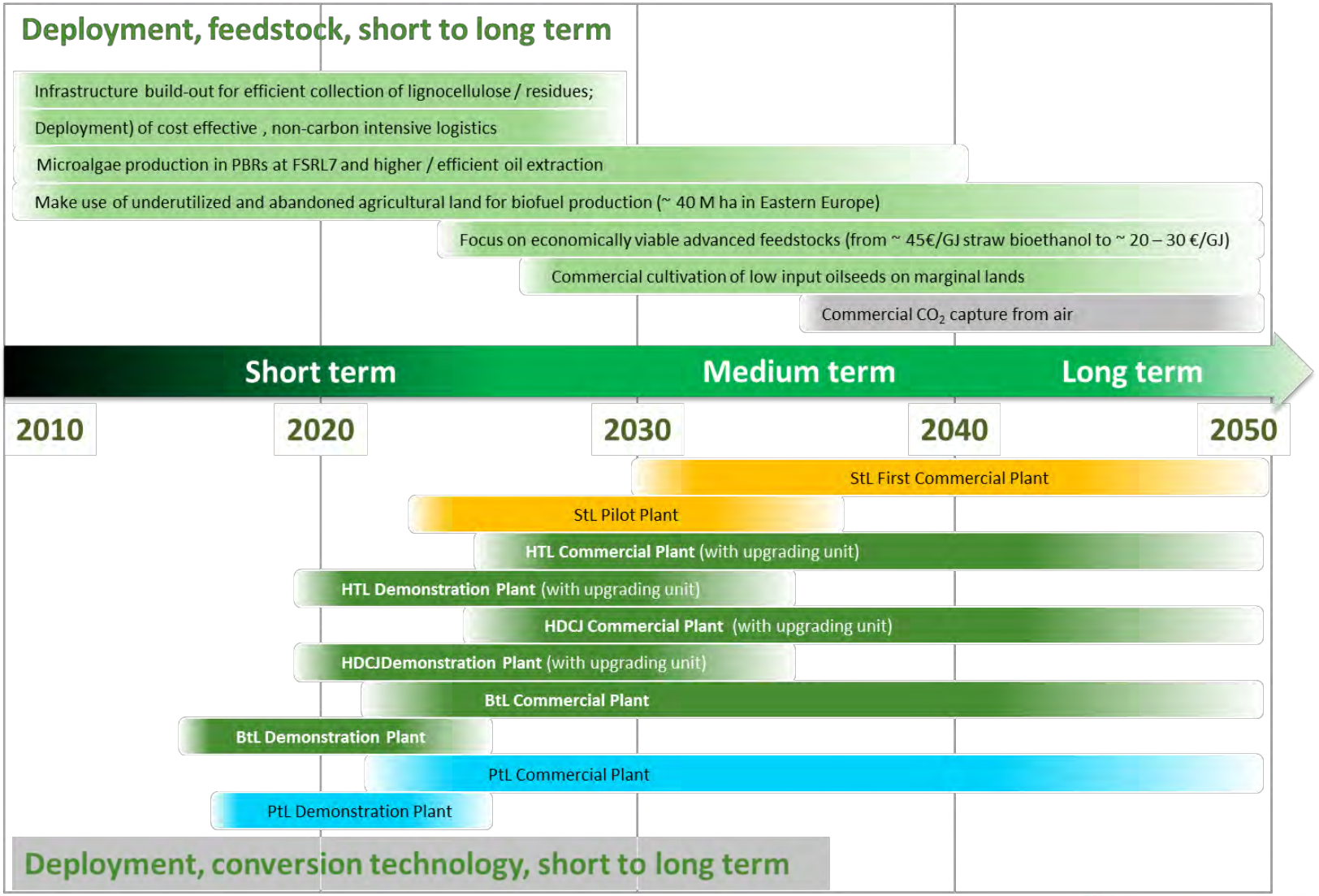
Content

- Background and objectives
- Performance indicators
- Trade-offs in technology assessment
- Roadmaps for R&D and deployment
- Conclusions and recommendations

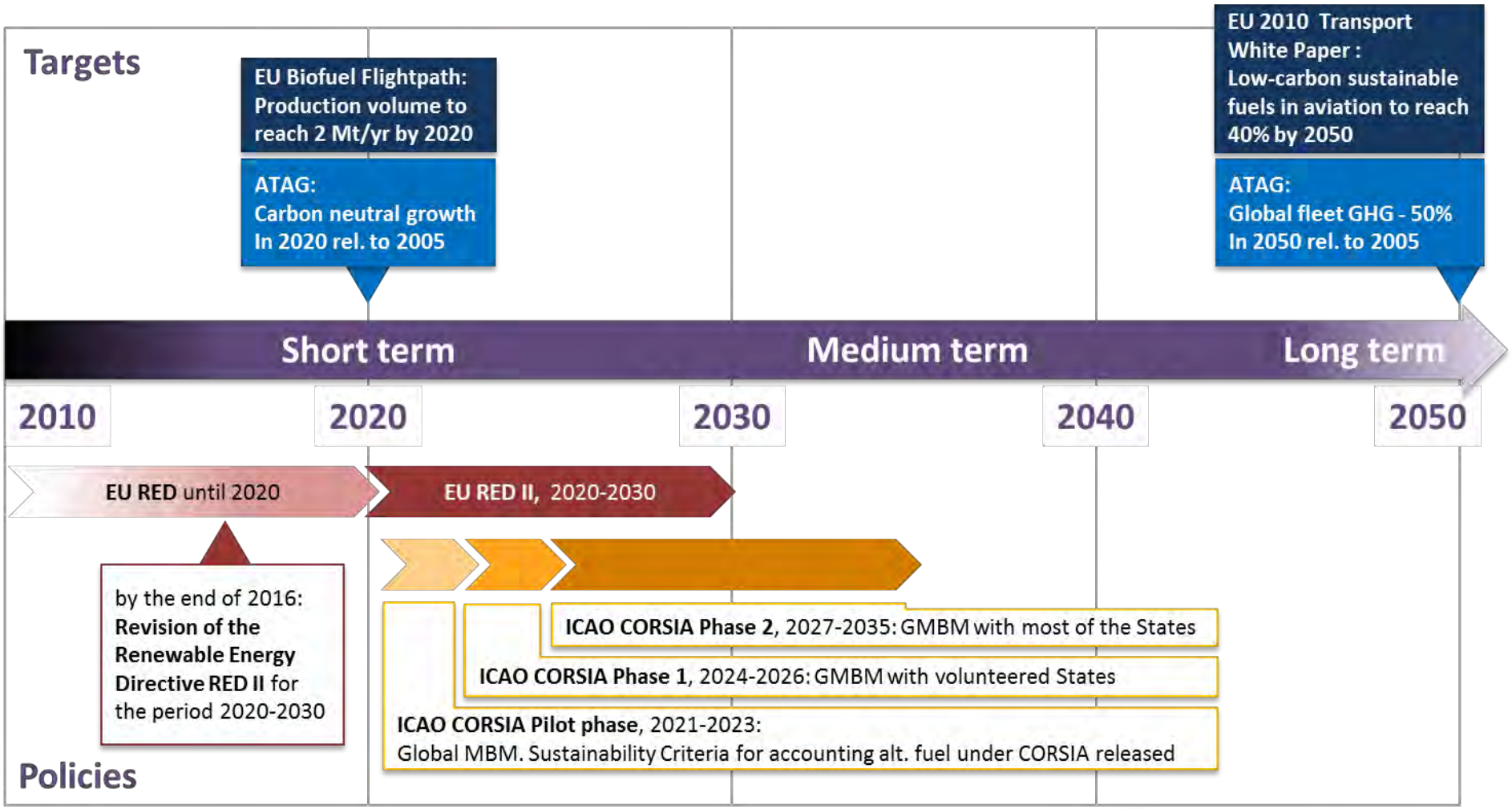
R&D Roadmap


Feedstock R&D
Assessment of European renewable feedstock and energy potentials
Stable vegetable oil yield on marginal lands of 0.8 t/ha for HEFA production
Development of key criteria for the harmonization of EU sustainability requirements with other international ones
Fundamental understanding of conditions, under which energetically and economically reasonable large-scale production of algae is feasible
CO_2 capture from air: Cost-effective extraction technology and scaling R&D
100 €/t CO_2 (2016)
TRL 9 at <30 €/t CO_2 (2035)
Short term
Medium term
Long term
2010
2020
2030
2040
2050
HTL TRL5 (2016) TRL6 (2020) TRL 9 (2030)
HDCJ TRL5 (2016) TRL 6 (2020) TRL 9 (2030)
BtL TRL6 (2017) TRL 9 (2025)
AtJ TRL6 (2015) TRL9 (2025)
APR TRL 5 (2016) TRL 9 (2030)
TRL 5 (2016) TRL 6 (2020) Power-to-Liquid TRL 9 (2030)
TRL3 (2014) TRL4-5 (2020) Solar thermochemical conversion TRL6 (2035) at 20% conv. eff.
Conversion technology R&D

Roadmap for Approval and Deployment



Policies and Regulatory Frameworks



Content

- Background and objectives
- Performance indicators
- Trade-offs in technology assessment
- Roadmaps for R&D and deployment
- Conclusions and recommendations

Conclusions and recommendations

- Key performance indicator: European/global GHG emissions reduction potential
  - Specific GHG balance AND production potential
- Balance development risks with rewarding GHG emissions reduction potentials
  - Sustainability and scalability are crucial
  - Processes based on lignocellulosics and renewable non-biogenic pathways promising
- Technical approval: Improve understanding of fuel properties
- Regulatory framework and/or incentives required to enable economic competitiveness of renewable jet fuel
  - Aviation-specific quantitative targets and strategies needed
  - Reliable knowledge of sustainable production potentials needed

CORE-JetFuel

A. Sizmann, A. Roth, C. Jeßberger

Bauhaus Luftfahrt e. V.
Willy-Messerschmitt-Strasse 1
82024 Taufkirchen
GERMANY

Web: www.bauhaus-luftfahrt.net
E-mail: andreas.sizmann@bauhaus-luftfahrt.net
arne.roth@bauhaus-luftfahrt.net