SWAFEA
Results and outcomes overview

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Sustainable Way for Alternative Fuel and Energy in Aviation

A study funded by the European Commission (DGMOVE)

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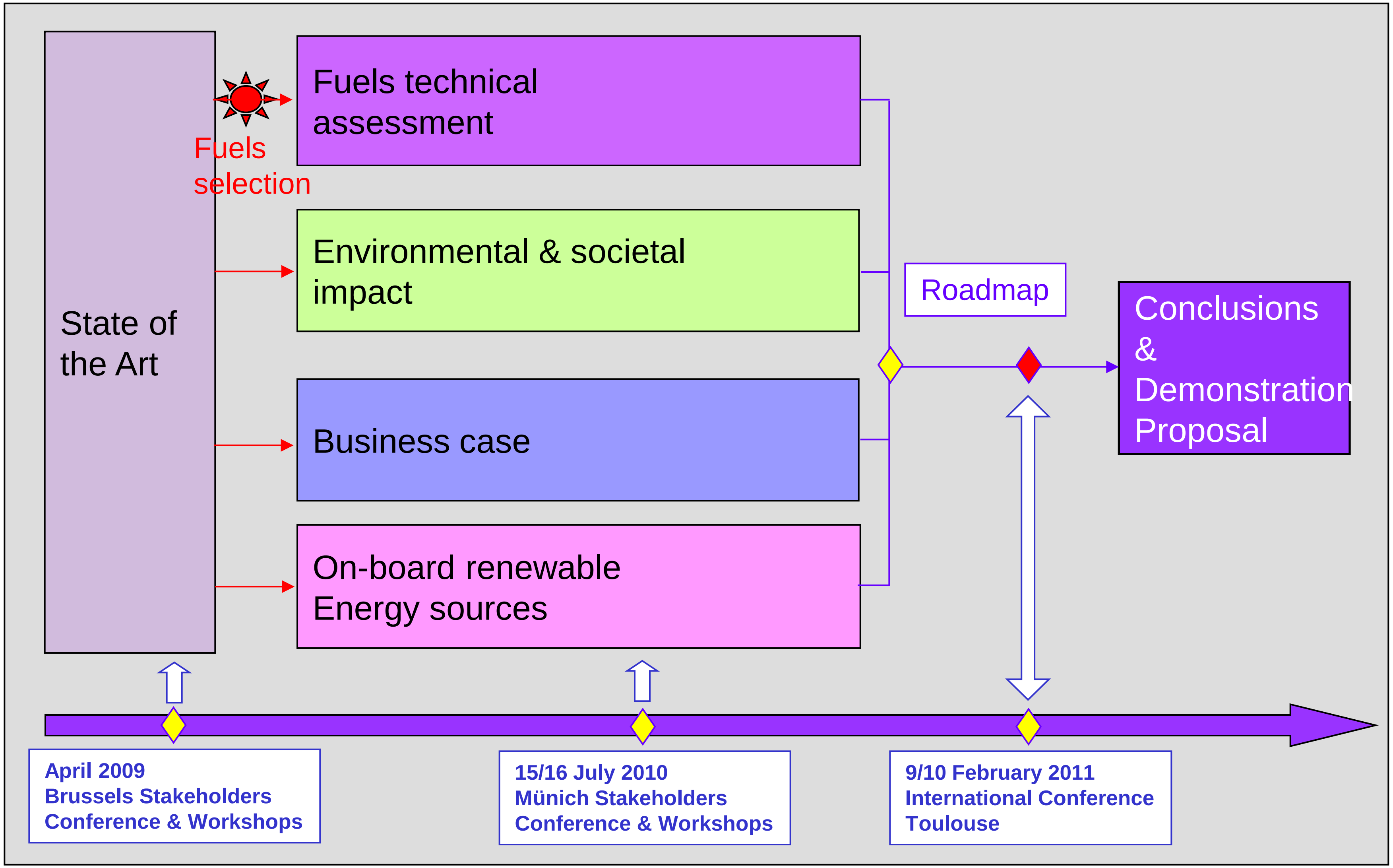
- **A study for the European Commission DG MOVE**
  - ⇨ February 2009 – April 2011
- **Purpose :** **"Feasibility Study and Impact Assessment on the Use of Alternative Fuels for Aviation"**
  - Comparative assessment of the possible options
  - Possible vision and roadmap for deployment

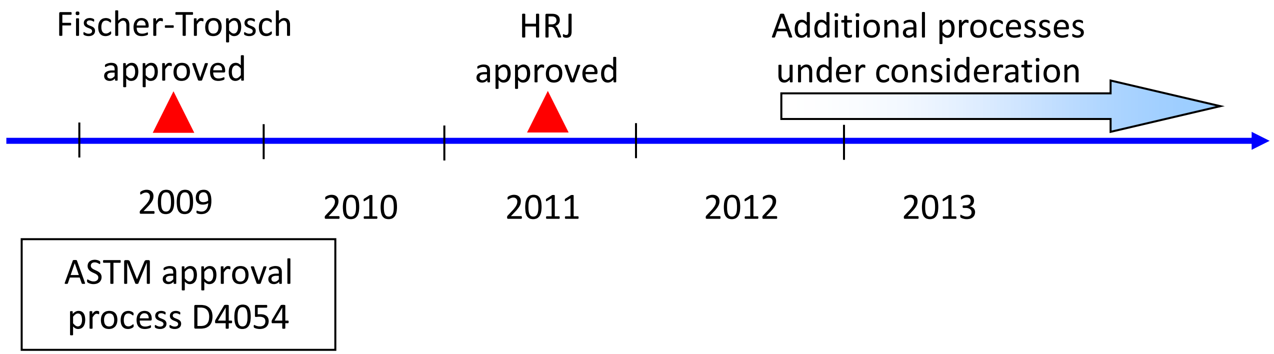
  ⇨ Ultimate goal: information and decision elements for policy makers
- **Multidisciplinary approach:** suitability, sustainability and economics
- **20 organisations involved**
  - ☞AIRBUS, AIFFRANCE, ALTRAN, BAUHAUS LUFTFAHRT, CERFACS, CONCAWE, DLR, EADS-IW, EMBRAER, ERDYN, IATA, INERIS, IFP, ONERA, PLANT RESEARCH INTERNATIONAL, ROLLS-ROYCE, SHELL, SNECMA, University of Sheffield

Study overview



Recent evolution

- **In 3 years, move from "technical feasibility" to "deployment issue"**



- **No commercial deployment yet**
  - Limited fuel production
  - Flight demonstrations over the last 3 years
  - Announced projects for demonstration on commercial routes

Directions of work in SWAFEA

⇨ What's beyond currently approved fuel?

- **Focus on potentially "drop-in" fuels**
  - Increased flexibility in SPK specifications
    - Blending limit ⇨ Aromatics
    - Blend stock specifications ⇨ IFP/Shell "SPK10"
  - Additional processes of interest
    - Naphteno-aromatics compounds
    - Sugar to hydrocarbons routes
  - Consequences of oxygen molecules (FAE)

+ Complementation of existing data base for SPK blends

⇨ Lean combustion chamber : emissions and relight

Fuel test matrix

Fuel family	Purpose	Fuel / blend	Tests
HRJ	Upper blending limit	75% HVO + 25% Jet-A1	
HRJ	Trade-off quality / economics	75% SPK75 + 25% Jet-A1	
		10% SPK10 + 90% Jet A1	
Naphteno aromatics	Potential blendstock	Neat product	
	Potential as substitute to aromatics	50% NA + 50% HRJ	
FAE	Potential for limited blending ratio Investigation of the consequence of oxygen	10% FAE + 90% Jet-A1	

1	Standard tests, Chemical analysis
2	Compatibility: polymers / metals Thermal stability & oxydation Biocontamination Chemical properties
3	APU combustion test

SWAFEA outcomes

- **Positive effect of aromatics reduction on soot emissions**

  …. but minimum content required for drop in

  ⇨ Synthetic aromatics is a viable option (pyrolysis, liquefaction)

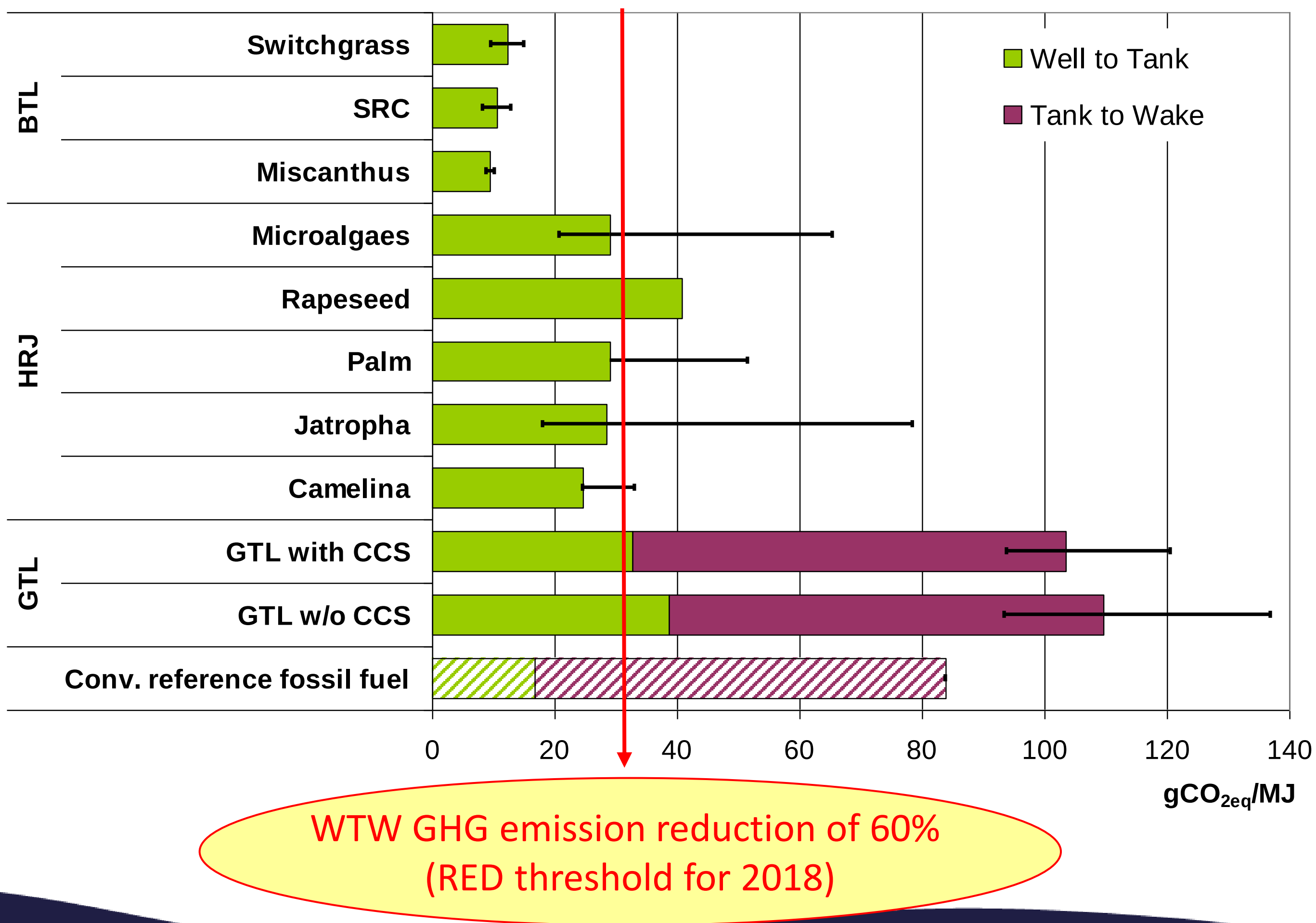
- **Possible alternative approach for SPK biofuel early introduction:**
  - Low blending ratio
  - « Relaxed » cold flow properties

  ⇨ Better economical efficiency

- **Significant challenges for oxygenated molecule**
- **« Fermentation » routes not evaluated but of real interest**
- **Importance of quality control**
- **Recommendation to create a technical network for fuel evaluation in Europe**

Life cycle green house gas emissions

SWAFEA assessment - Well to Tank GHG emissions



- **GTL (& CTL): No GHG emissions reduction**
  - ⇨ CCS currently not sufficient

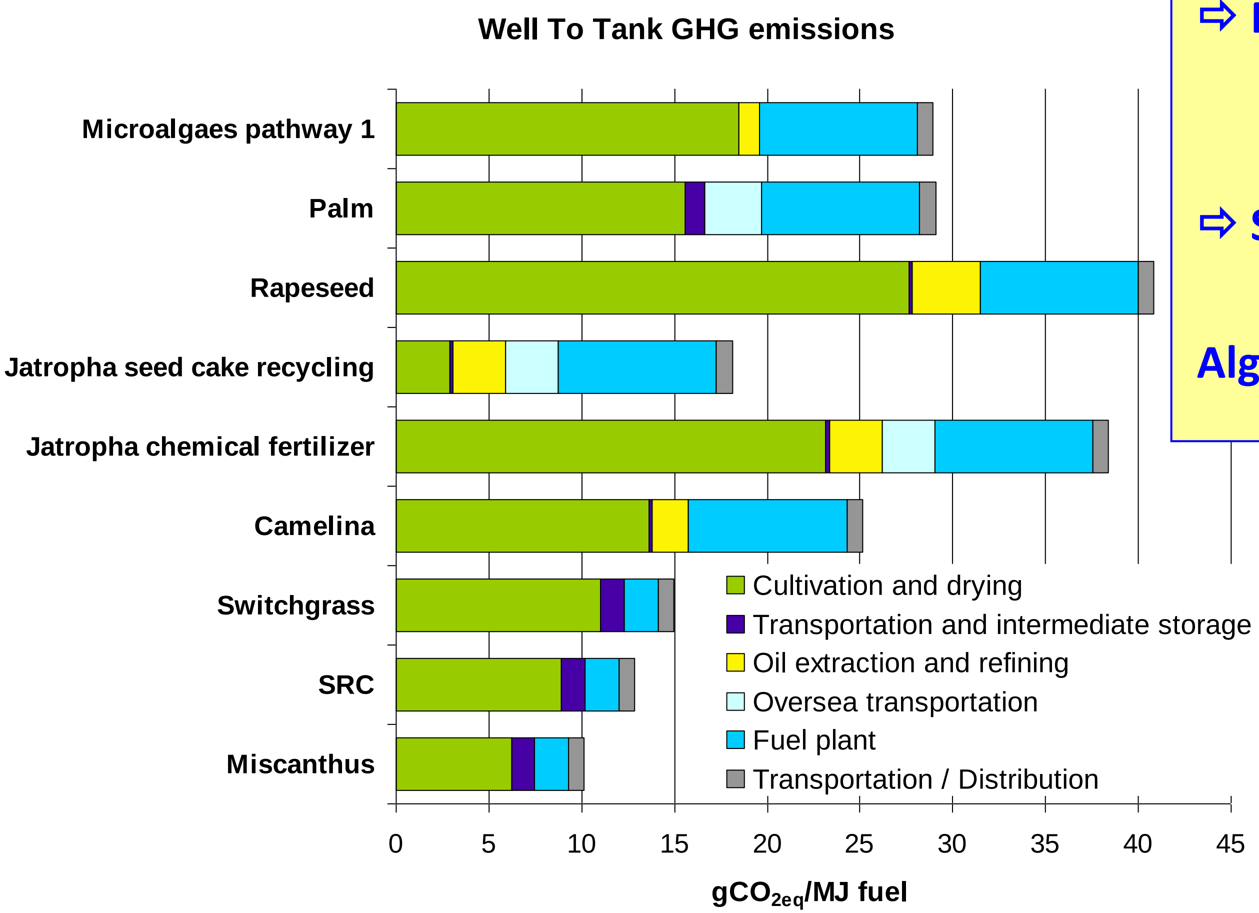
Note: Co-feeding with biomass to be further investigated

- **Biofuels : potential for reduction**
  - BTL: matches RED thresholds
  - HRJ:
    - Higher LCA emission than BTL ⇨ H_2 use
    - GHG reductions depending on feedstock and cultivation

Situation without land use change

Life cycle green house gas emissions

Biofuels life cycle components



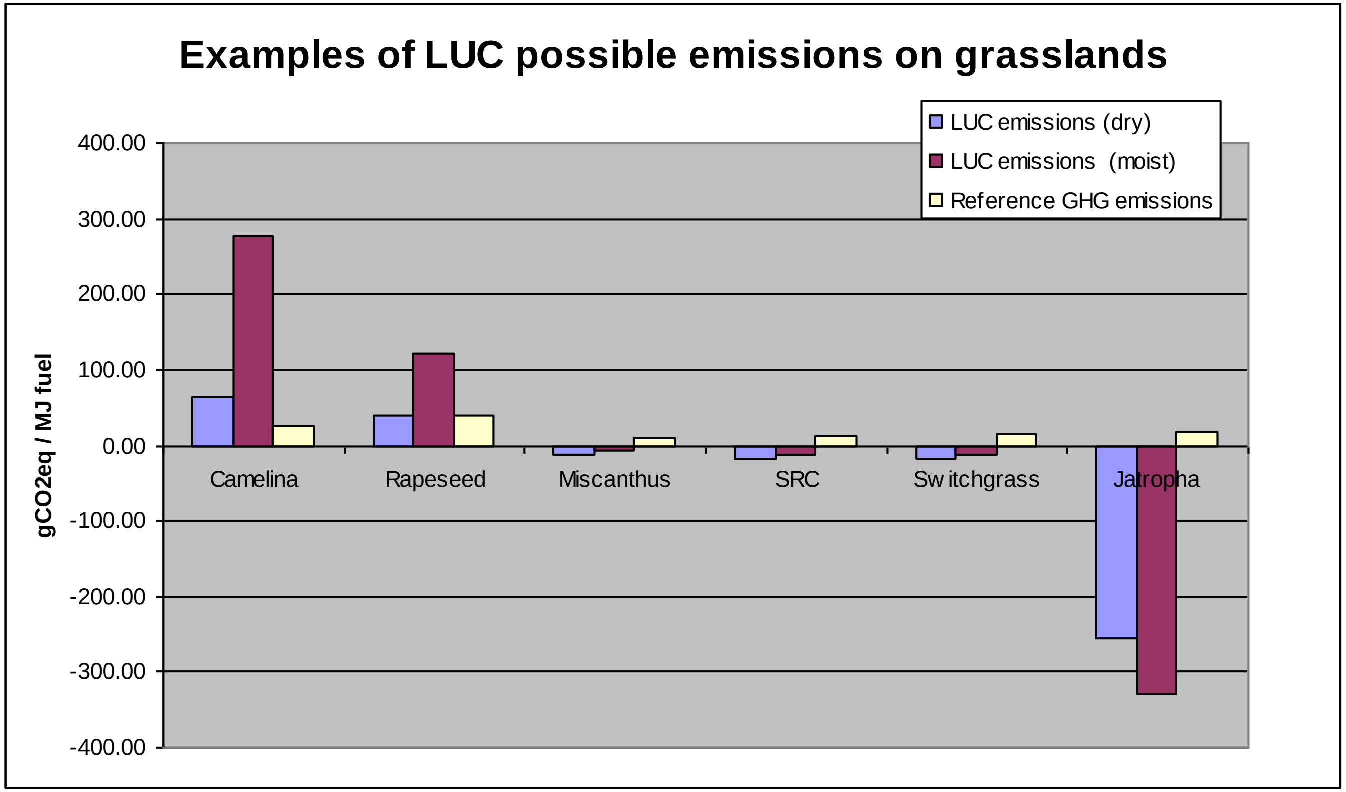
- ⇨ **Major importance of feedstock production**
  - Feedstock
  - Cultivation steps
- ⇨ **Sensitivity to inputs data**

Algae: Importance of process integration

Situation without land use change

Life cycle green house gas emissions

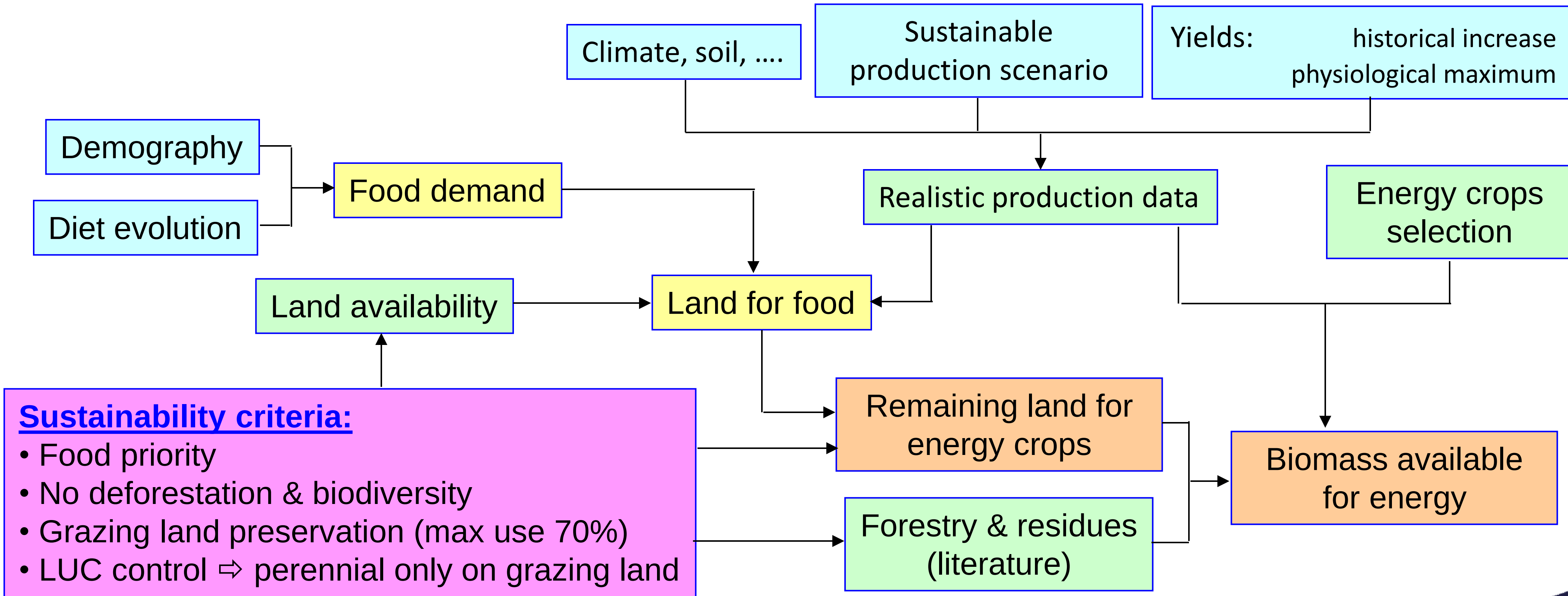
- **Land use change: potentially the dominating effect**



⇨ **Control of land use is a major issue of biofuel**

Biomass availability

- **Purpose: "potential" biomass availability for biofuel production**
  - ⇨ "Traditional" biomass: agriculture, forestry and residues
- **Methodology: Simulation of possible agriculture production**



Biomass availability – Detailed results

- **Energy demand / Energy biomass availability in 2050**

	Energy EJ/y	Total	Biomass
Total	Primary energy	750	150
Transport	Final energy	112	29
	Share of demand	-	26%

Biomass available for energy: 183EJ/y

(SWAFEA assessment)

- **Aviation target in 2050**
  - 50% reduction / 2005: 24.4 EJ/y ⇨ Use of 76% of total biomass
  - "Carbon neutral growth at 2020 level": 16.7 EJ/y ⇨ Use of 52% of total biomass
    - 58 EJ/y of biofuel in transport
    - 88 EJ/y available for other non food use of biomass (96 EJ/y in IEA "Blue Map")
    - EU27 could produce 38% of the aviation biofuels uplifted in its territory

Biomass availability - Conclusion

⇨ **Biomass availability is a critical bottleneck**

- Radically more efficient biomass and processes required to halve emissions in 2050
- Ramp-up of biomass production likely to constraint biofuel ramp-up
  - ⇨ Carbon neutral growth not expected to be (physically) achievable as early as 2030
- Key importance of biomass production development regarding “fuel versus food”

☞ **A consolidation of biomass availability is recommended**

- Strong uncertainties on forestry, residue
- Regional approach

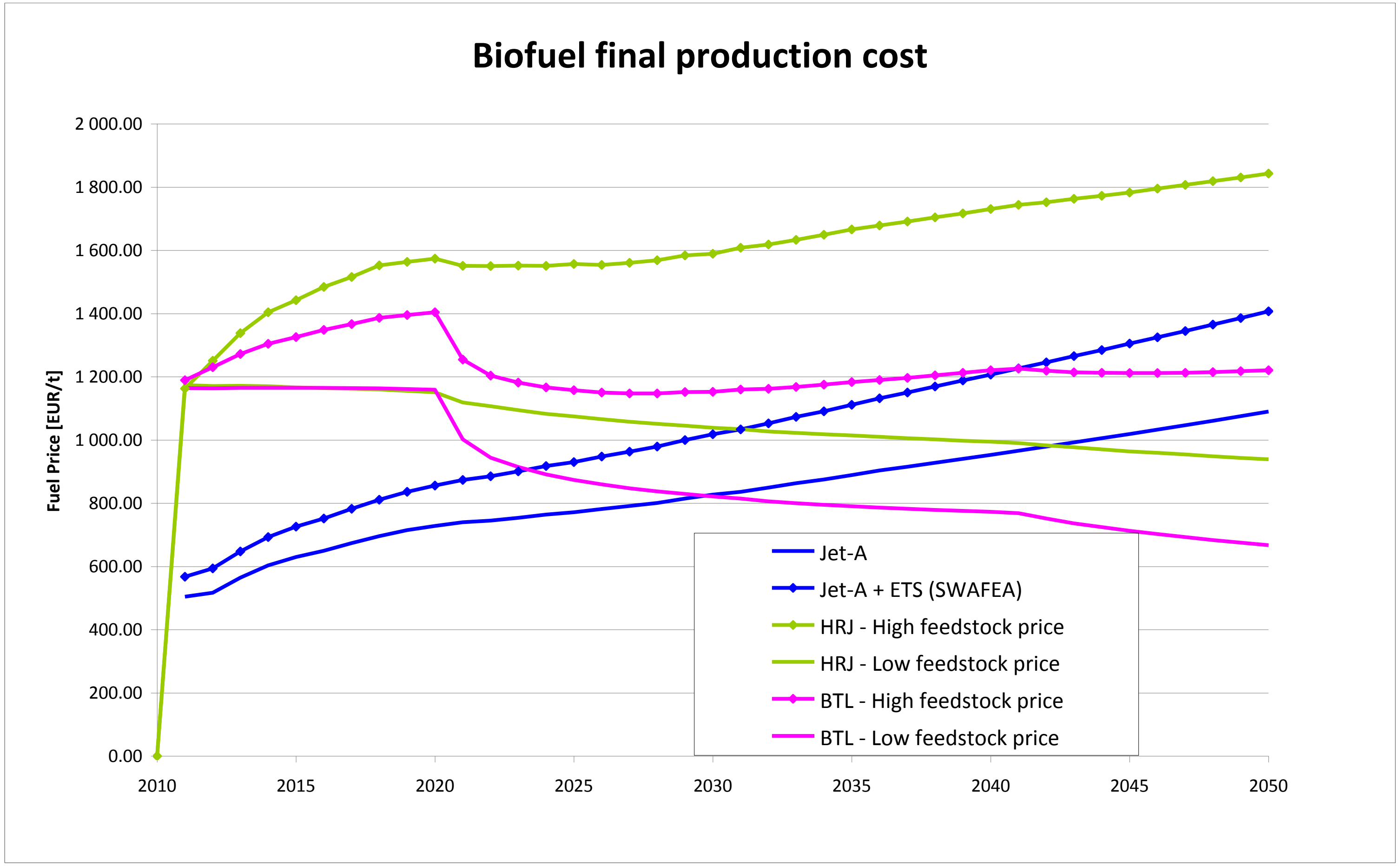
Atmospheric impact

- **Aviation emissions impact radiative forcing beyond CO_2 effect**
  - No_x impact on ozone
  - Soot impact on contrails and cirrus

⇨ **SWAFEA: preliminary simulation of alternative SPK fuels impact**

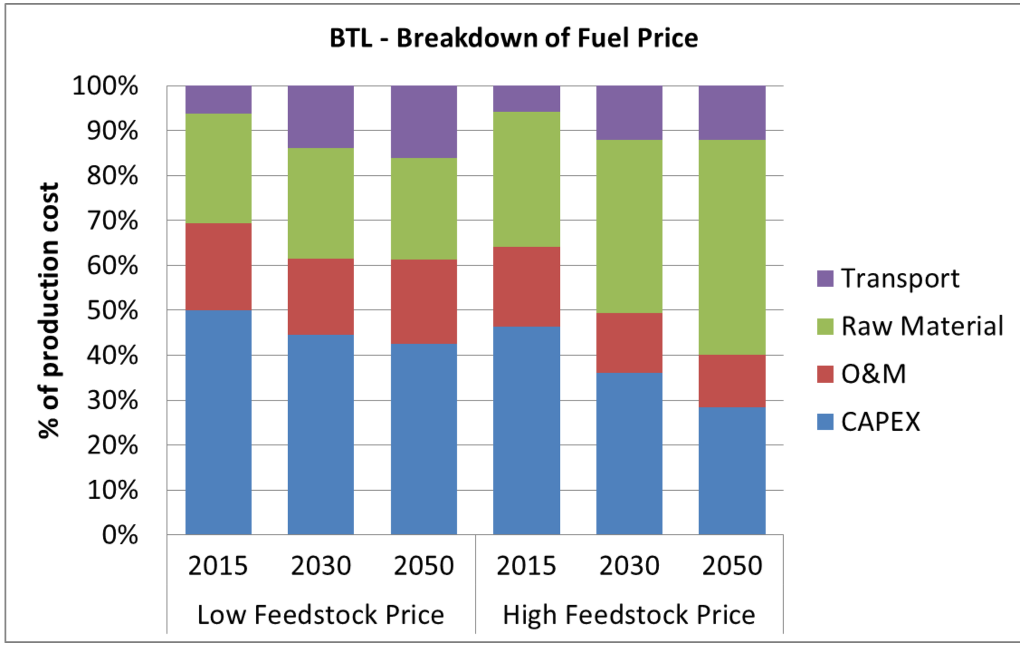
- Significant reduction in soot and So_x emissions
  - ⇨ Preliminary simulation: **significant decrease of contrails radiative forcing**
  - ⇨ Positive impact on local air quality
- Limited impact of other emissions on ozone

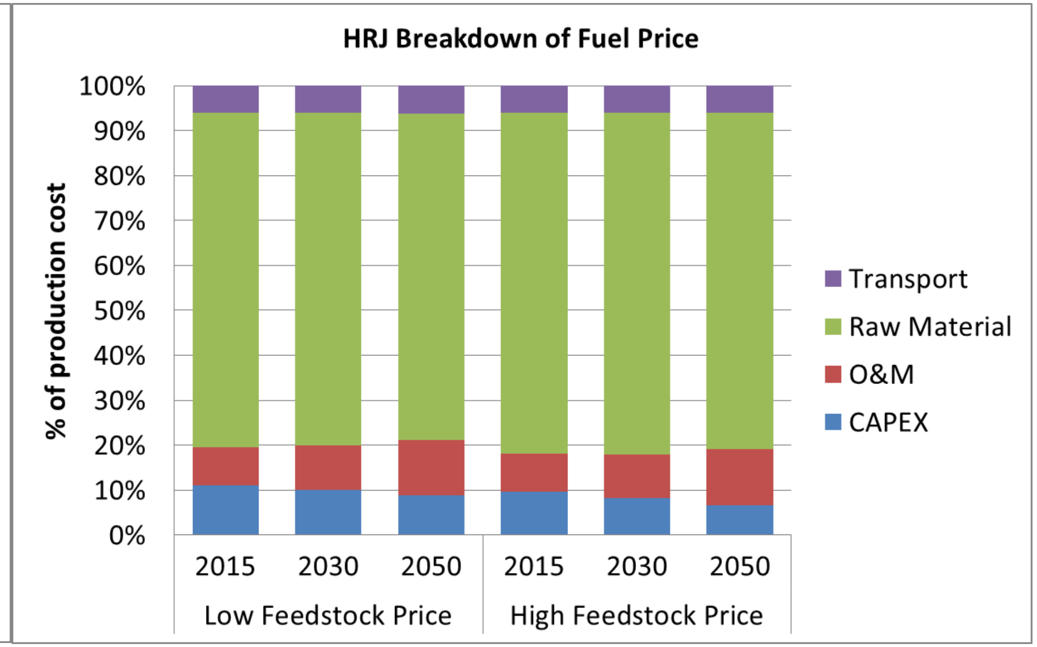
BTL and HRJ SWAFEA evaluation



- ⇨ **Major influence of feedstock price**
- ⇨ **Initial lack of competitiveness of biofuels**

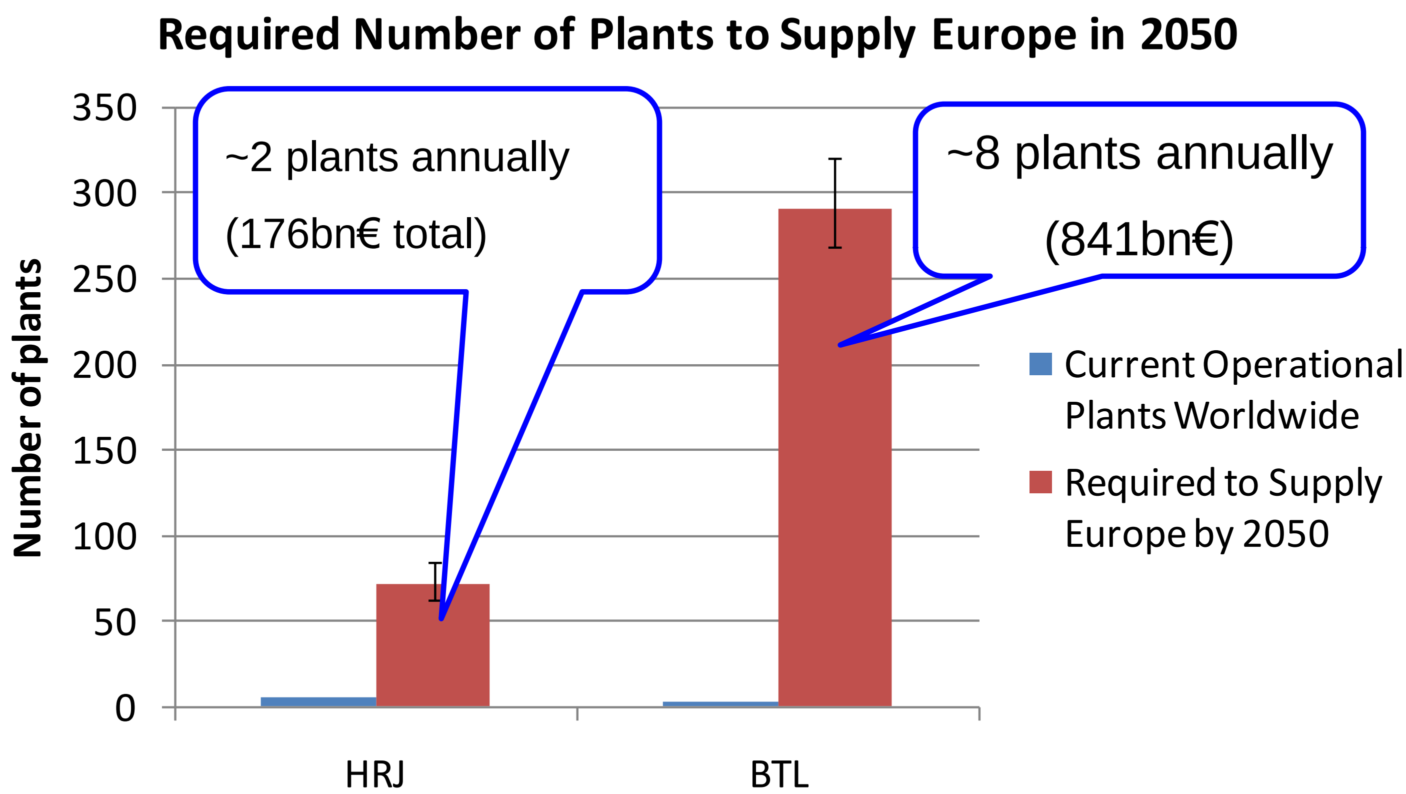
BTL and HRJ SWAFEA evaluation





- ⇨ **HRJ cost dominated by feedstock price**
- ⇨ **Strong contribution of CAPEX in BTL**

Needs for halving emissions by 2050



Conclusions

- **Critical impact of biomass production**
- **Need for more efficient and economic processes**
  - ⇨ Expectation from "fermentation" routes
- **No start-up of biofuel without incentive policy**
  - ⇨Currently, ETS effect not seen as sufficient

- **Technical availability of alternative fuel solution for aviation**
- **Potential emissions reduction with biofuels**
- **Potential positive effects on air quality and contrails**
- **Ramp-up of biofuels in aviation likely to be slowed down by biomass production**
  - Carbon neutral growth not expected to be achievable as early as 2030 without economic measures
  - Aviation emissions offsets will be needed beyond 2030
- **Need for research on process and feedstock to accelerate implementation**
- **No start-up of biofuel without incentive policy**

- **Aviation fully relies on liquid fuel**
- **Need to initiate the move to biofuel from now**

⇨ **A determined policy is required**

- Define a sectoral goal for 2020
- Promote a number of "end to end" projects
- Combine incentive policies
- Use ETS revenue to fund the initial deployment plan

END

➩ **Questions ?**

Credit IFPEN

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