ESFERA

Evaluation of SAF Policy scenario variants

Dr. Inge Mayeres (Transport & Mobility Leuven)

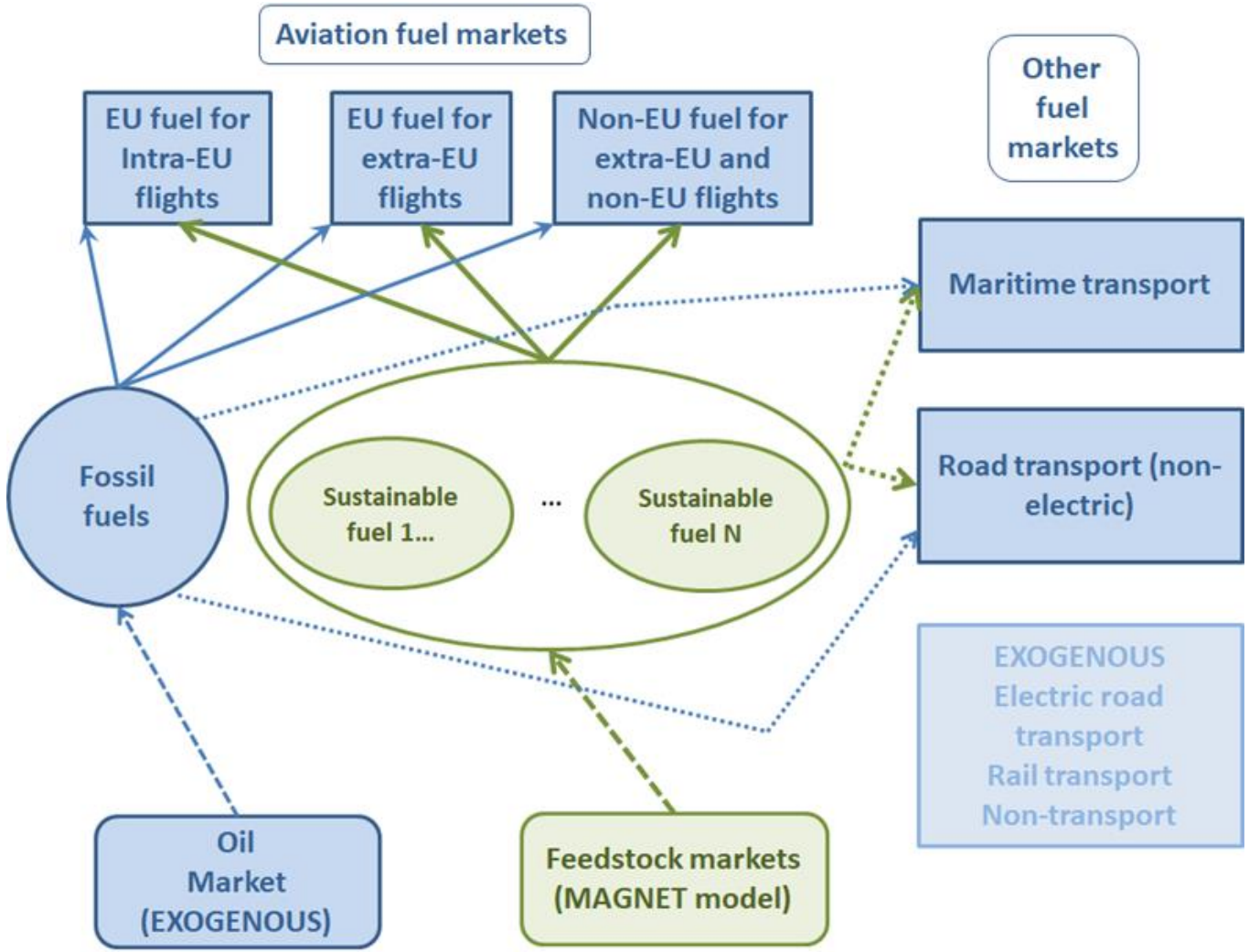
Brussels

27 November 2019

Introduction

- **Aim: Evaluation of policy options for promoting the uptake of sustainable aviation fuels (SAFs)**
- **Quantitative analysis using economic model for the transport fuel markets**
- **Drawing upon insights from different WPs in ESFERA project:**
  - Characteristics of fuel/feedstock combinations
  - Greenhouse gas emissions of fuel/feedstock combinations
  - Supply functions for different types of feedstock (based on MAGNET model)

Economic model of transport fuel markets



Sustainable aviation fuels

- Hydrocarbon-based, “drop-in” fuels derived from non-petroleum sources
- Various production pathways with different feedstocks, costs and impacts on emissions
- Still large uncertainty about costs and life cycle emissions

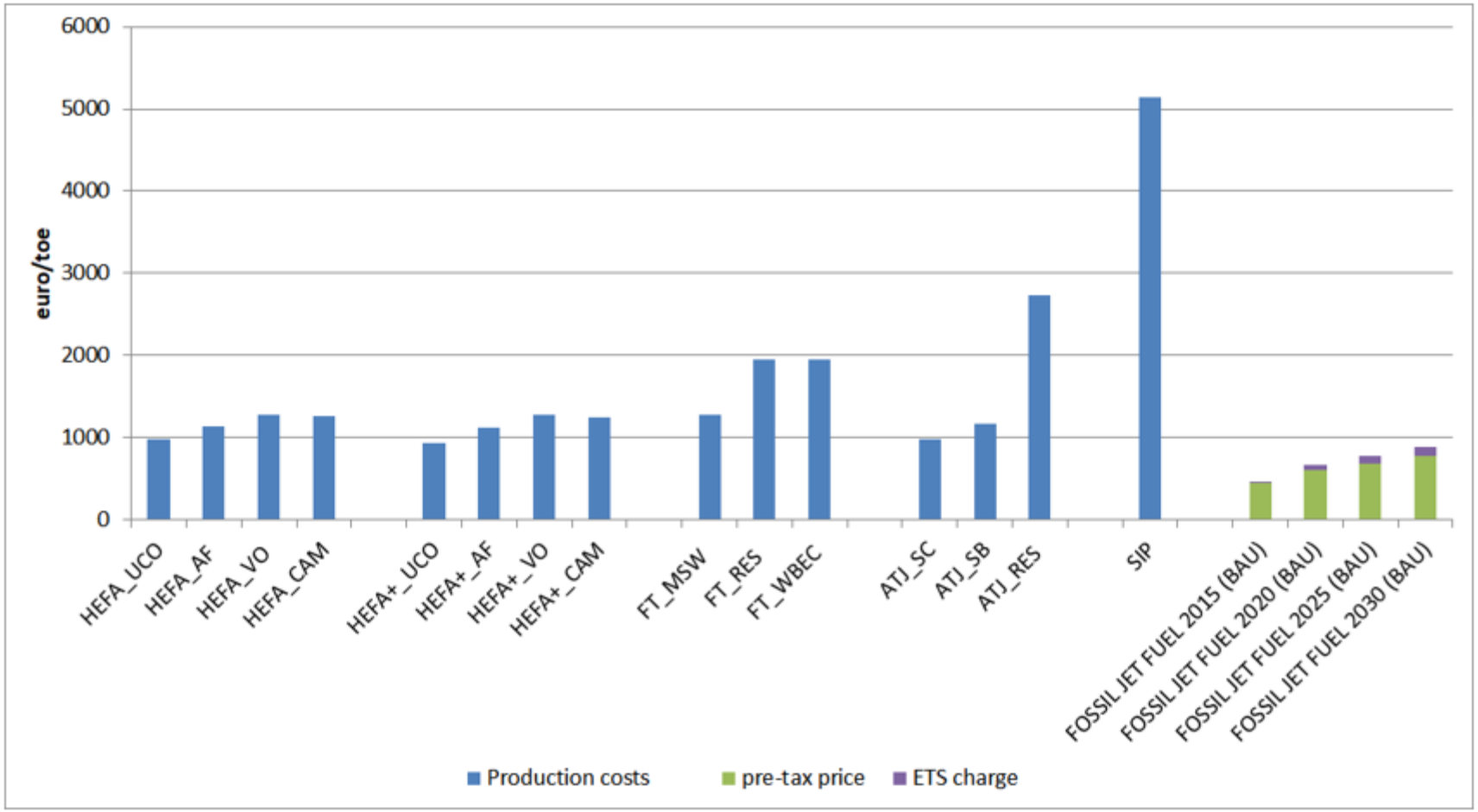
SAFs considered in the analysis and their WTW CO_{2eq} emissions

Process	Feedstock	WTW emissions	WTW with ILUC emissions
		tonne CO2eq/toe	tonne CO2eq/toe
HEFA and HEFA+	UCO	0.58	0.58
	Animal fats	0.94	0.94
	Camelina	1.76	1.76
	Vegetable oils	1.56	2.79
SIP	Residues	NA	NA
	Sugarcane	1.37	NA
FT	Residues	0.33	0.33
	WBEC	0.47	-0.20
	MSW	1.36	1.36
ATJ	Residues	1.11	1.11
	Sugarcane	1.01	1.34
	Sugar beets	NA	NA
Fossil jet fuel		3.73	3.73

Note: not all fuels are allowed in all scenarios that are analysed

UCO: Used cooking oils, WBEC: woody biomass and herbaceous energy crops, MSW: municipal solid waste

Production costs for SAFs and comparison with fossil fuel



Note: UCO: used cooking oils; AF: animal fats; VO: vegetable oils; MSW: municipal solid waste; RES: residues; WBEC: woody biomass and herbaceous energy crops; SC: sugarcane; SB: sugar beets

Evaluation of policy options for promoting the uptake of sustainable aviation fuels

- **SET1: EU RED II scenario variants**
  - RED: Renewable Energy Directive
- **SET2: EU RED II Aviation scenario variants**
  - EU RED II for road/rail and specific target for aviation
- **SET 3: CORSIA scenario variants**
  - Based on the CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) of ICAO
- **Evaluation compared to reference scenario up to 2030 based on EU 2016 Reference Scenario**

  Taking into account transport fuel taxes, EU RED I, intra-EU aviation included in EU ETS

Scenario Set 1: EU RED II variants

- Renewable energy share of 14 % in 2030 for transport
- Blending mandate
- The target applies to road and rail transport, but air and maritime transport may contribute to them
- Multipliers

Multiplier	Mode	Feedstock
1	Road, rail	Food & feed based
1.2	Road, rail	Part A Annex IX (requiring advanced technologies) Part B Annex IX (mature technologies)
2.4	Aviation	Part A and Part B Annex IX
4	Road	Renewable electricity
1.5	Rail	Renewable electricity

Scenario Set 1: EU RED II variants

- **Only small take-up of sustainable aviation fuels (SAFs)**
  - Central case (phase out of food & feed based fuels by 2030)
    - 0.6 Mtoe in 2030 (1 % of EU aviation fuel demand)
    - Almost no impact on user price of fuel for aviation
  - Even smaller take-up if less restrictions on fuels that can be used in road & rail
    (If no phase out of food and feed based fuels, but non-zero maximum share or no restriction)
  - With higher multiplier for SAFs (4 instead of 2.4)
    - 1.6 Mtoe in 2030 (2.8 % of EU aviation fuel demand)
    - Less renewable fuels in total (road + rail + aviation) than in central case

Scenario Set 2: EU RED II Aviation variants

No.	Scenario	Policy instrument aviation	Food & feed based fuels in aviation	Target share SAFs by 2030	Policy instrument road/rail	Food & feed based fuels road/rail
2A	EU RED II Aviation – blending mandate	Blending mandate	Not allowed	3.5%	Blending mandate	Phase out by 2030
2B	EU RED II Aviation – Subsidy	Subsidy sustainable fuels (~ auctioning)	Not allowed	3.5%		Phase out by 2030
2C	EU RED II Aviation – Tax	Tax fossil fuel	Not allowed	3.5%		Phase out by 2030
2D	EU RED II Aviation +	Blending mandate	Not allowed	5.3%		Phase out by 2030

Scenario Set 2: EU RED II Aviation variants

	Units	Set 2: EU RED II Aviation (2030)				BAU 2030
		(2A) Blending mandate	(2D) Aviation +	(2B) Subsidy	(2C) Tax	
SAFs used in EU aviation	Mtoe	2.0	2.9	2.0	1.0	0 Mtoe
	% of EU air fuel demand	3.50%	5.25%	3.50%	3.50%	
EU aviation fuel demand	Mtoe	56.3	54.7	57.6 (= BAU)	27.5	57.6 Mtoe
Change in user price aviation						
Intra-EU	Change wrt BAU (%)	4.26%	10%	-0.2%	100%	803 euro/toe
Extra-EU	Change wrt BAU (%)	5.45%	12.36%	-0.2%	131%	696 euro/toe
User price road	Change wrt BAU (%)	1.18%	1.14%	1.17%	1.30%	1668 euro/toe
Renewable energy EU road + rail + aviation	Mtoe	21.9	22.9	22.0	20.8	20.4 Mtoe
CO2eq (EU road + aviation)	Change wrt BAU (%) *					
TTW		-1.6%	-2.4%	-1.2%	-10.7%	
WTW		-2.8%	-3.5%	-2.4%	-12.2%	
WTW with ILUC		-4.7%	-5.4%	-4.3%	-13.9%	
Welfare cost (based on worldwide emission reduction of road and aviation)	Euro/ton CO2eq					
WTW		314	318	369	177	
WTW with ILUC		177	195	194	149	

* Taking into account phase out of food/feed based fuels in road/rail transport by 2030 (instead of non-zero cap in Reference scenario)

Scenario Set 3: CORSIA variants

- **offsets for CO_{2eq} emissions above those in 2020**
  - Offsets required depend on WTW emissions of fuels
  - ICAO: CORSIA applies to international aviation only
  - In model simulations: both domestic and international aviation
  - Cost of carbon offsets not yet known → 2 values
  - Intra-EU aviation: with and without EU ETS

No.	Scenario	Policy instrument aviation	Offset cost (euro/tonne CO_{2eq})	Policy instrument road/rail	Food & feed based fuels road/rail
3A	CORSIA – offset cost 10 euro	CORSIA charge	10	Blending mandate	Phase out by 2030
3B	CORSIA – offset cost 50 euro	CORSIA charge	50		Phase out by 2030
3C	ETS and CORSIA– offset cost 50 euro	CORSIA charge and ETS charge for intra-EU aviation	50		Phase out by 2030

Note: ETS charge intraEU aviation in 2030 = 35 euro/tonne CO_{2eq} (EU Ref2016)

Scenario Set 3: CORSIA variants

	Units	Set 3: CORSIA (2030)		
		(3A) offset cost 10 euro	(3B) offset cost 50 euro	(3C) offset cost 50 euro and intra-EU ETS
SAFs used in world aviation	Mtoe	0	0	0
Aviation fuel demand				
EU	Change wrt BAU (%)	0.3%	-7.0%	-9.2%
nonEU	Change wrt BAU (%)	-1.9%	-9.2%	-9.1%
Change in user price aviation				
Intra-EU	Change wrt BAU (%)	-9.4%	5.8%	19.0%
Extra-EU and nonEU	Change wrt BAU (%)	4.5%	22.1%	21.9%
CO2eq (world aviation)	Change wrt BAU (%)	-1.6%	-8.9%	-9.1%
Welfare cost (based on emission reductions of world aviation and offsets)	Euro/ton CO2eq			
WTW		7	38	39

Conclusions

- **Reducing CO_2 emissions in the aviation sector by imposing an uptake of SAFs is costly**
- **If one wants to promote the uptake of SAFs → a specific target should be set for aviation**
  - If tax cannot be imposed on fossil fuel
  - target can be achieved at the lowest social cost by using a blending mandate
    - analysis considered shares of up to 3.5 % to 5.3 % in 2030, corresponding with 2 to 2.9 Mtoe of sustainable aviation fuels
    - With blending mandate of 3.5 % moderate increase in the fuel cost for aviation; this increases more than proportionally as the target share increases
    - Blending mandate implies a high social abatement cost for GHG emissions
- **Among the 3 sets of policy scenarios, the lowest social abatement costs are associated with the CORSIA scenarios**
  - however no uptake of SAFs

Contact information ESFERA team

- **SENASA:** Daniel Rivas Brousse (drivas@senasa.es)
- **ONERA:** Philippe Novelli (philippe.novelli@onera.fr)
- **Transport & Mobility Leuven & KU Leuven:**
  Inge Mayeres (inge.mayeres@tmleuven.be)
  Stef Proost (stef.proost@kuleuven.be)
- **Wageningen UR:** Sjaak Conijn (sjaak.conijn@wur.nl)

The research was financed by the European Commission, DG Energy (ENER/C2/2016-478)