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2011 JEC Biofuels Study and the Renewable Energy Directive

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2011 JEC Biofuels Study: Objectives

- Objectives of the JEC Biofuels Study:
  - Clarify the opportunities and barriers to achieve 10% renewable energy (on an energy basis) in the transport sector by 2020
  - Focus on road transport with the development of an EU27+2 "Fleet & Fuels" Model as the main supporting tool
  - Focus on conventional and alternative fuels and biofuel blends while accounting for growth in alternative powertrains over decade
  - Develop biofuel implementation scenarios in which the introduction of biofuel blends to meet the 2020 target is seamless to consumers and results in no detrimental impact on vehicle performance and emissions
- Three-year study initiated in February, 2008 and published in 2011

JEC Biofuels Study and the RED Amendment Proposal

- The European Commission recently issued a proposed amendment to the 2009 Renewable Energy Directive (RED) that caps conventional biofuels and changes accounting rules for more advanced products

- A re-analysis of the 2011 JEC* Biofuels Study was warranted using the new RED proposal and the following assumptions:
  - The RED Amendment's 5% cap on conventional biofuels and new counting rules for advanced biofuels have been applied
  - The fleet parc and fuel demand from the 2011 study have not been changed
  - Four of the nine biofuel implementation scenarios in the 2011 study have been dropped because they are no longer considered as realistic by 2020
  - The dates assumed in the remaining five biofuel implementation scenarios have not been changed even though some of these dates have already passed

** JEC = JRC, EUCAR, and CONCAWE*

concawe New Counting Rules Based on RED Amendment

- EC's RED Amendment Proposal:
  - **5% accounting cap** on "conventional" biofuels (those competing with food and feed). But no prohibition to use them more than 5%
  - **Quadruple counting** (quantity x 4) for municipal solid waste, aquatic material, agricultural, aquaculture, fisheries and forestry residues and renewable liquid and gaseous fuels of non-biological origin
  - **Double counting** (quantity x 2) for other waste and non-food ligno-cellulosic and ligno-cellulosic materials from non-residues
  - Substances **intentionally modified** do not qualify as wastes

- Used cooking oils and animal fats are the main resources for multiple counting
  - Potentially available quantities estimated to be 0.95 and 2.25 Mtoe, respectively
  - Total volume not expected to grow in the coming decade
  - Assumed that about 1/3 of the available resource (1 Mtoe) to be used in transport in 2020
  - Biofuels from this resource count double (2 Mtoe) toward the 10% RED target
  - Source: information received from European Commission's DG ENER

EC Proposal on RED Amendment

Key aspects for **both RED and Fuel Quality Directive (FQD)**

- To qualify for sustainability(1), the direct (i.e. not including ILUC) biofuel GHG savings must:
  - for old plants (pre-1.7.2014): exceed 35% savings now, 50% from 2018
  - for new plants (post 1.7.2014): exceed 60%
- Subsidies for all biofuels produced from food crops to disappear as of 1.1.2021 (but Member States will have to decide)
- 2014 review on achievability of targets (both RED and FQD)
- Estimated indirect land-use change (ILUC) emissions to be included in the reporting for both RED and FQD:
  - 12 gCO_2/MJ if from cereals
  - 13 gCO_2/MJ if from sugars
  - 55 gCO_2/MJ if from oil crops
- **NO ILUC impact included in the calculation of the FQD target which requires -6% GHG intensity in road fuels by 2020**

(1) And therefore to qualify for subsidies and for being counted toward RED and FQD targets

'Fleet & Fuels' Model: Before RED Amendment

Calculation of the overall RED-% of renewable energy in transport (Art. 3(4) of the RED):

$$\text{RED-\%} = \frac{\text{All types of energy from renewable sources consumed in } \textbf{all forms of transport}\ ^{1)}}{\text{Petrol, diesel, biofuels consumed in road and rail transport, and electricity (in transport) but excluding off-road}\ ^{2)}}$$

1) Renewable energy in Road, Rail, Aviation, Inland Navigation and Pipeline Transport

2a) Off-road means mobile machinery (forestry, agriculture, and construction) ~20Mtoe

2b) CNG & LPG in road transport are not included, BUT: Biogas (= biofuel) is included

Application of factors:

- "*Advanced Biofuels*" count 2 times in numerator (support)
  - Definition: biofuel from waste, residue and non-food cellulosic material, Article 21(2)
- "*Green Electricity*" for road transport counts 2.5 times in numerator & denominator (efficiency factor)
  - Definition: electricity from renewable sources, Article 3(4)

'Fleet & Fuels' Model: After RED Amendment

Calculation of the overall RED-% of renewable energy in transport (Art. 3(4) of the RED):

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2b) CNG & LPG in road transport are not included, BUT: Biogas (= biofuel) is included

Application of factors:

- "*Advanced Biofuels*" count 2 times in numerator
  - Definition: biofuel from used cooking oil, animal fats, residue and non-food cellulosic material, Annex IX
- "*Advanced Biofuels*" count 4 times in numerator
  - Definition: algae, biomass from municipal & industrial waste, straw, manure & sewage sludge, palm oil mill effluent, tall oil pitch, crude glycerine, bagasse, grape marcs and wine lees, nut shells, husks, cobs, bark, branches, leaves, saw dust and cutter shavings
- "*Green Electricity*" for road transport counts 2.5 times in numerator & denominator (efficiency factor)
  - Definition: electricity from renewable sources, Article 3(4)

Share of biofuels produced from cereal and other starch rich crops, sugars and oil crops limited to 5% of the final consumption of energy in transport in 2020 for RED% calculation purposes

concawe RED and FQD Article 7a: Before RED Amendment

Impact of Renewable Fuels on Fuel Quality Directive Article 7a (2009/30/EC):

- GHG savings includes fuels used in on-road vehicles, non-road mobile machinery (including rail and inland marine), agricultural and forestry tractors and recreational craft

- GHG savings assumptions for biofuels and alternative fuels (vs. 2010 fossil fuel baseline):
  - 2010 fossil fuel baseline emissions per unit energy = 86.7 g CO_2/MJ [1)]
  - Biofuel GHG reductions determined against Fossil Fuel Comparator: assumed to be same as 2010 baseline = 86.7 g CO_2/MJ (not 83.8 g CO_2/MJ as in FQD annex IV)
  - GHG savings do not assume potential improvements in biofuel production higher than 60% GHG reduction
    - 50% GHG reduction for existing biofuel plants up to 1/1/2017 (i.e. biofuel EF ≤ 43.4 g CO_2/MJ)
    - 60% GHG reduction for new biofuel plants from 1/1/2017 (i.e. biofuel EF ≤ 34.7 g CO_2/MJ)
  - Reductions apply uniformly to all ethanol, FAME, HVO, BTL, DME, road electricity, and biogas component in CNG
  - CNG is assumed to contain 20% biogas in 2020 (of which 50% is "advanced")
  - Road electricity receives a 2.5 times credit; Rail electricity is excluded

1) Source: JEC WTW Version 2c fossil fuel default values and Fleet & Fuels model 2010 fossil fuel demand

concawe RED and FQD Article 7a: After RED Amendment

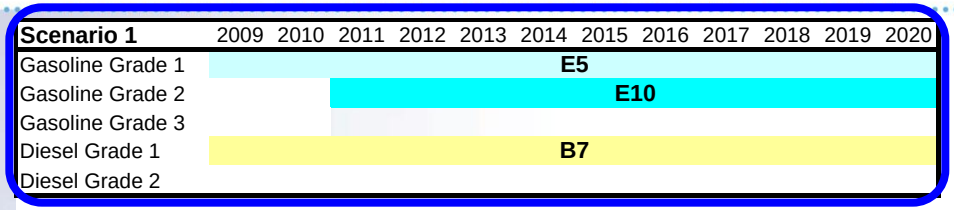
Impact of Renewable Fuels on Fuel Quality Directive Article 7a (2009/30/EC):

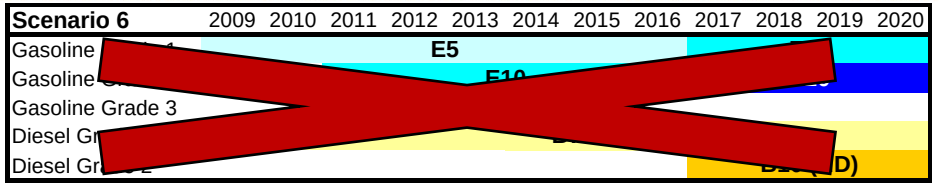
- GHG savings includes fuels used in on-road vehicles, non-road mobile machinery (including rail and inland marine), agricultural and forestry tractors and recreational craft

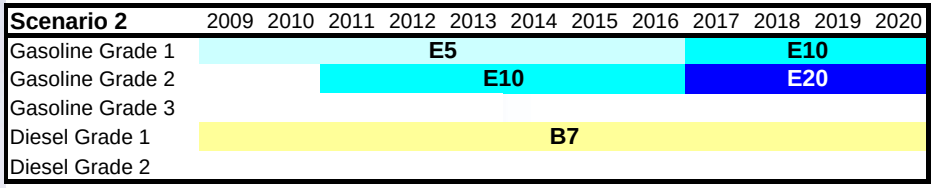
- GHG savings assumptions for biofuels and alternative fuels (vs. 2010 fossil fuel baseline):
  - 2010 fossil fuel baseline emissions per unit energy = 88.4 g CO_2/MJ [1)]
  - Biofuel GHG reductions determined against Fossil Fuel Comparator: assumed to be as in ILUC IA = 90.3 g CO_2/MJ (this is worst case => FQD GHG savings are about 0.3% further away from 6% target than with FFC = 83.8 g CO_2/MJ as in FQD annex IV)
  - GHG savings do not assume potential improvements in biofuel production higher than 60% GHG reduction
    - 50% GHG reduction for existing biofuel plants up to 1/7/2014 (i.e. biofuel EF ≤ 45.2 g CO_2/MJ)
    - 60% GHG reduction for new biofuel plants from 1/7/2014 (i.e. biofuel EF ≤ 36.1 g CO_2/MJ)
  - Reductions apply uniformly to all ethanol, FAME, HVO, BTL, DME, road electricity, and biogas component in CNG
  - CNG is assumed to contain 20% biogas in 2020 (of which 50% is "advanced")
  - Road electricity receives a 2.5 times credit; Rail electricity is excluded
  - Application of ILUC emission factors from food-crop biofuels (for reporting only): 12 gCO_2/MJ if from cereals;13 gCO_2/MJ if from sugars; 55 gCO_2/MJ if from oil crops

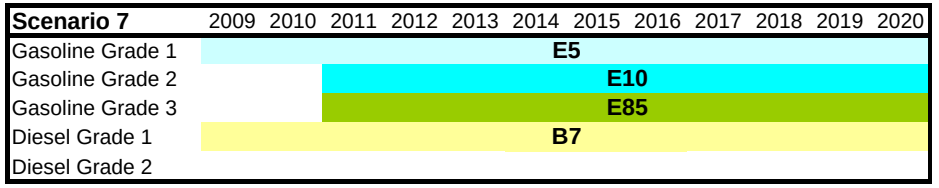
1) Source: JEC WTW Version 3c fossil fuel default values and Fleet & Fuels model 2010 fossil fuel demand

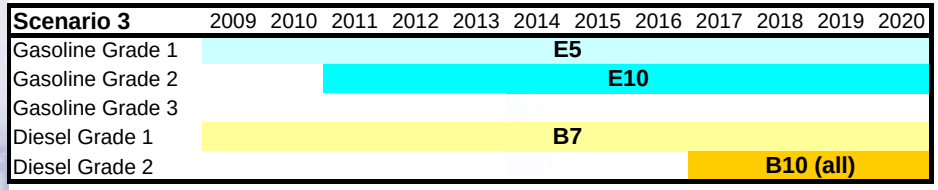
JEC Biofuel Implementation Scenarios

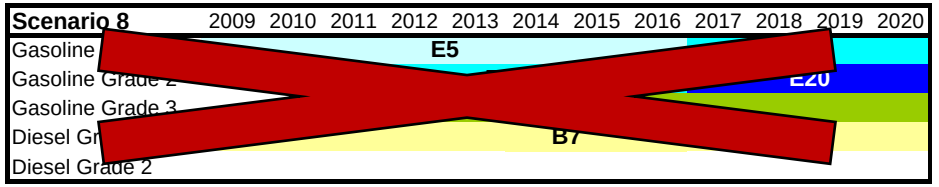


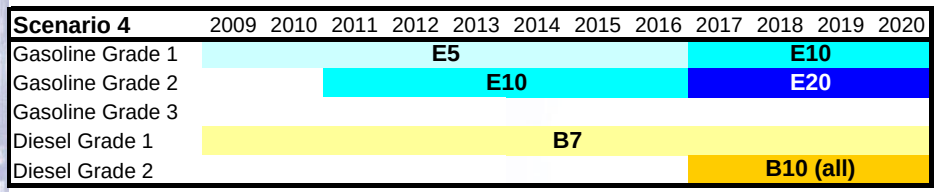


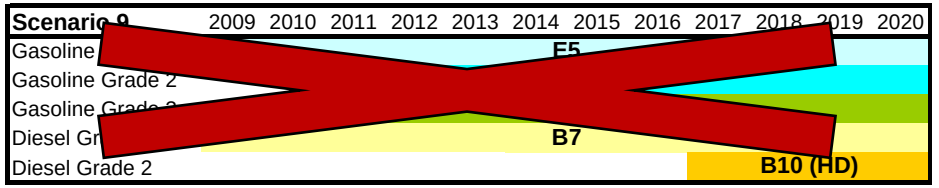


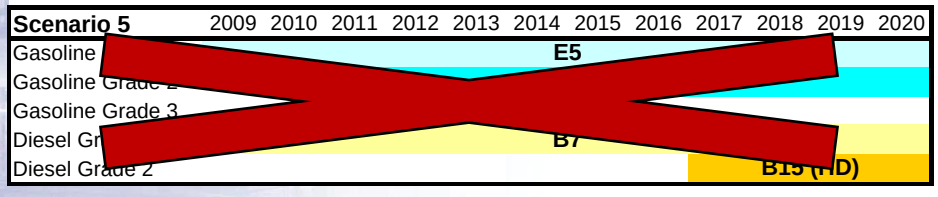








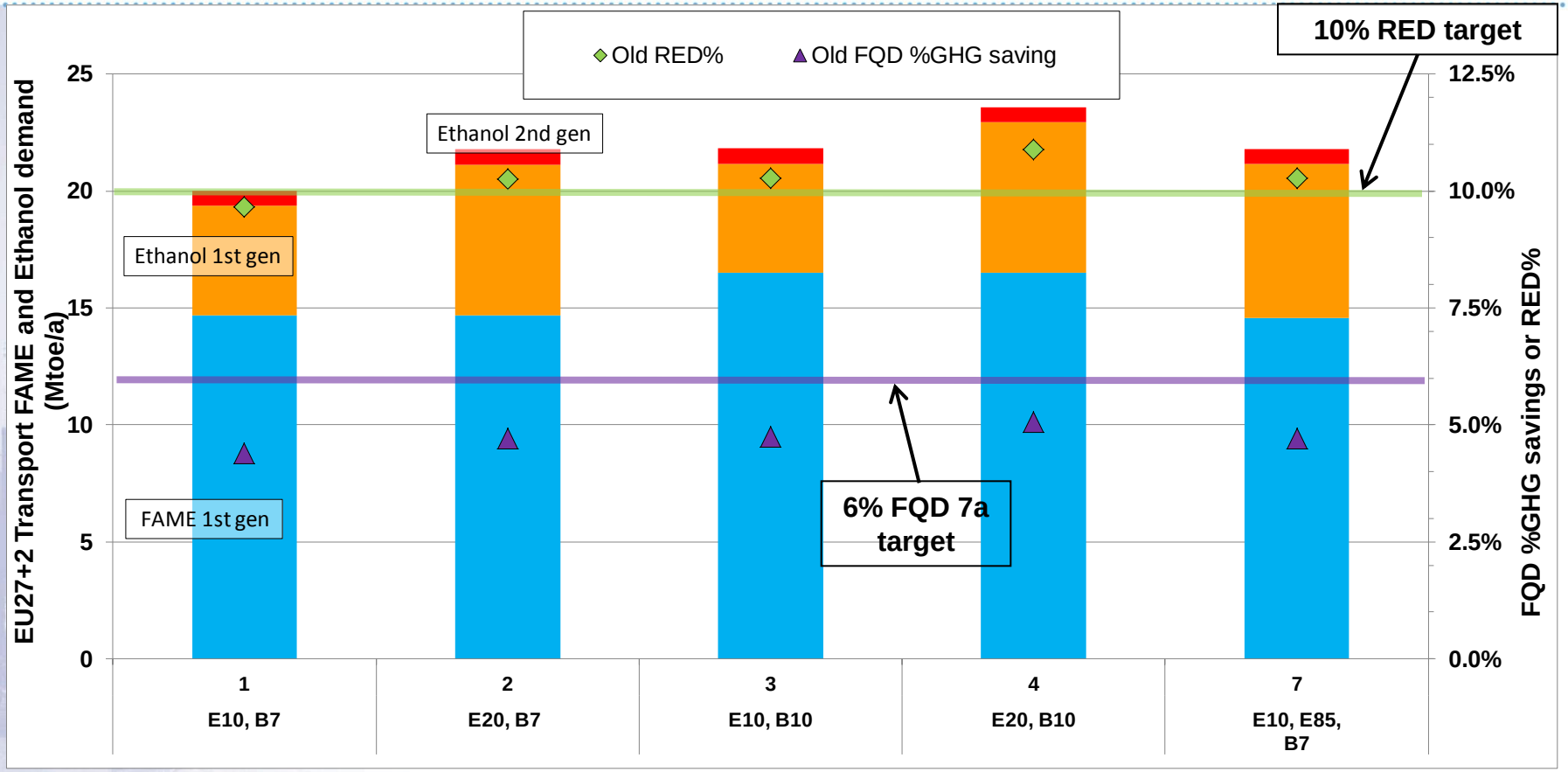




- **Scenario 1: Reference Case**
- Scenarios 2-4: Higher Biofuel Grades
- Scenarios 5-6: High Biodiesel Grades (HD)
- Scenarios 7-9: Plus Flex-Fuel Vehicles (FFVs)

Source: JEC Biofuels Study (2011)

RED Implementation Scenarios: Old RED & FQD results

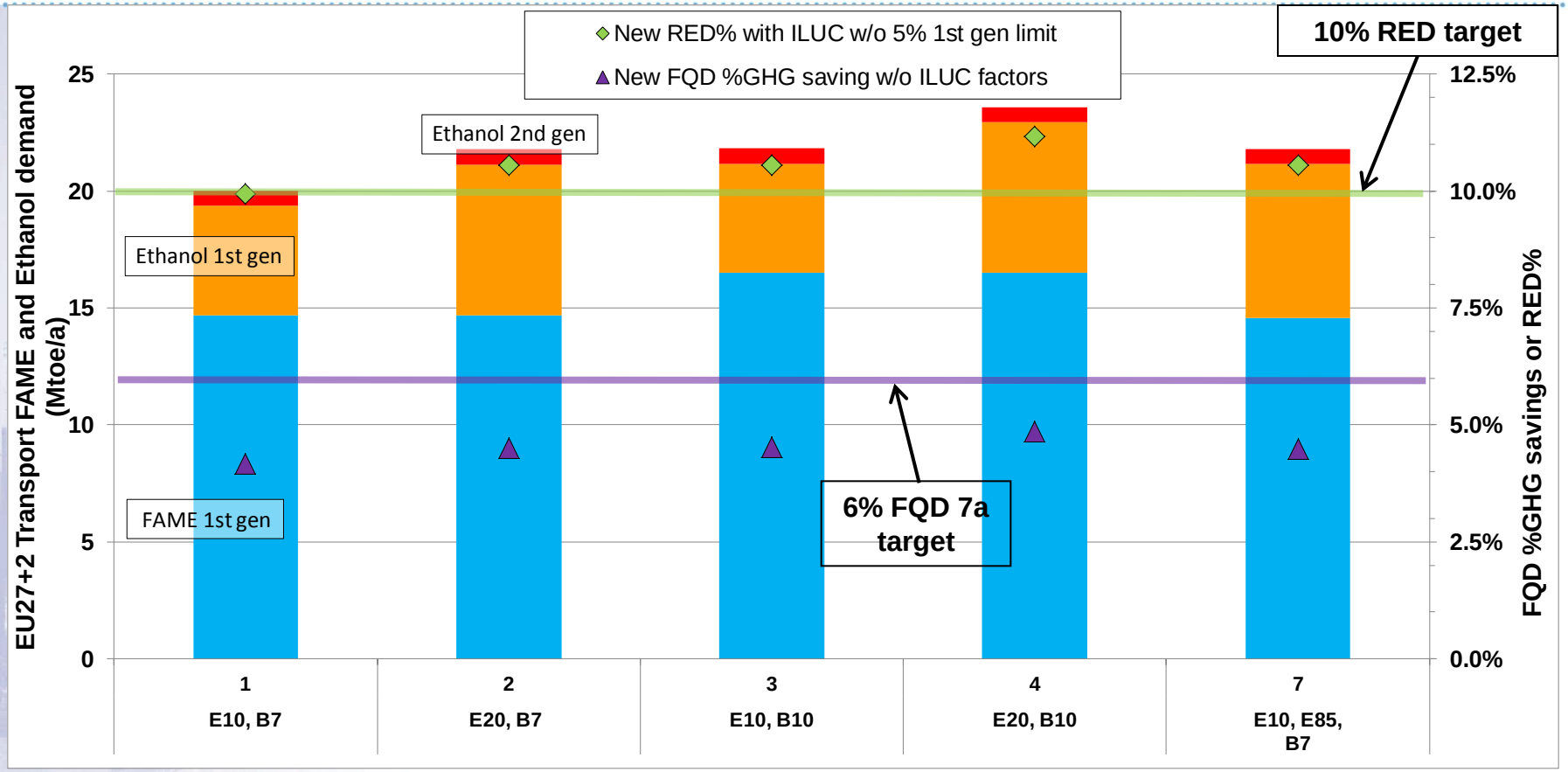


(1) EurObserv'ER Biofuels Barometer

- FAME demand: 14.6 to 16.5 Mtoe ……..compared to 10.9 Mtoe in 2011 (1)
- Ethanol demand: 5.3 to 7.2 Mtoe, of which 0.6 Mtoe 2nd gen …… compared to 2.9 Mtoe in 2011 (1), all 1st gen

- RED % : 9.7% to 10.9%
- FQD % savings: 4.4% to 5.1%

concaweRED Implementation Scenarios: New RED & FQD results (1)



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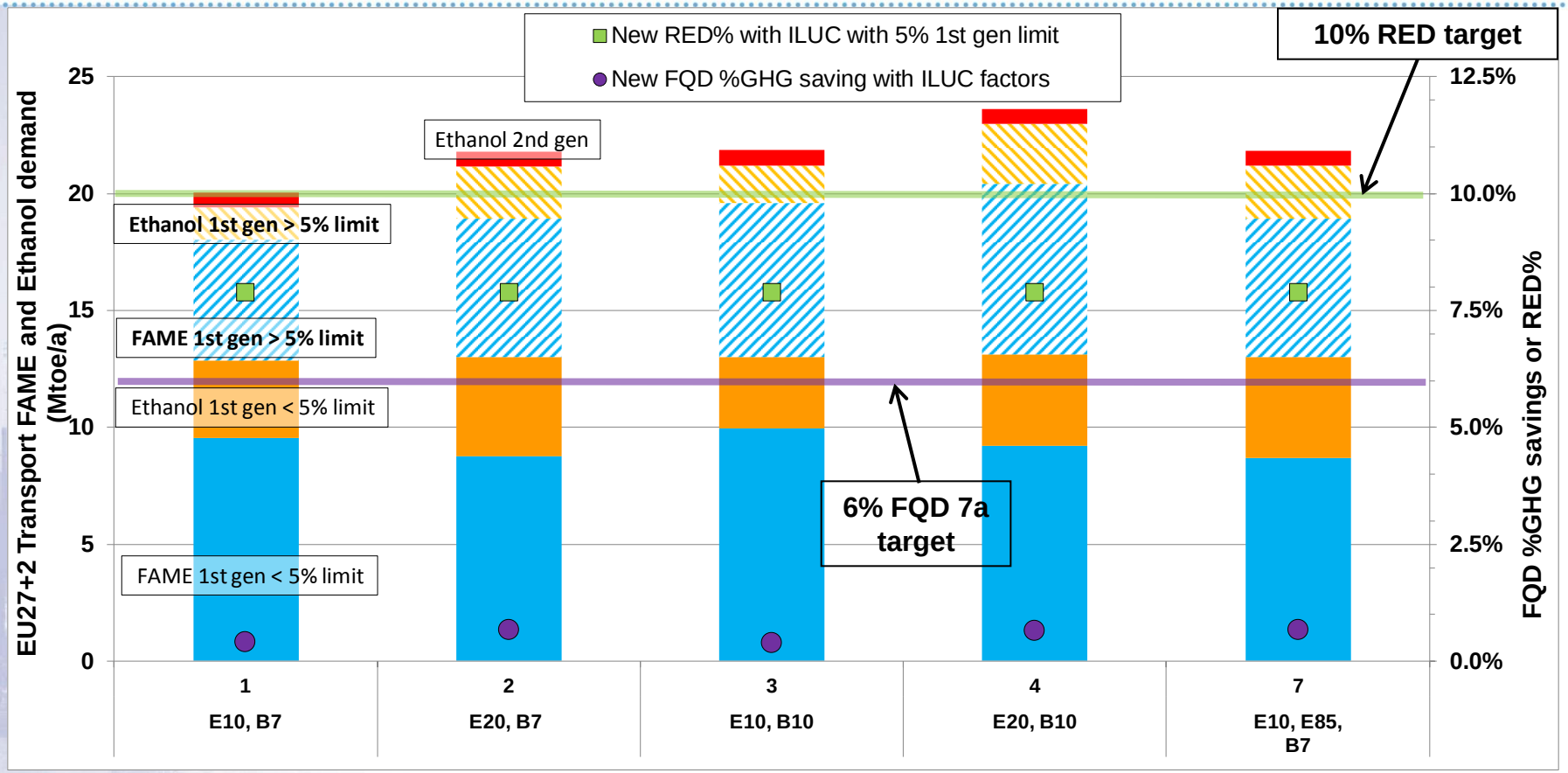
- FAME demand: 14.6 to 16.5 Mtoe ……..compared to 10.9 Mtoe in 2011 (1)
- Ethanol demand: 5.3 to 7.2 Mtoe, of which 0.6 Mtoe 2nd gen …… compared to 2.9 Mtoe in 2011 (1), all 1st gen

- RED % : 9.9% to 11.2% without 5% limit on 1st gen (slightly higher than old RED due to 4x factor on 0.4 Mtoe advanced biogas, assumed from municipal waste)
- FQD % savings: 4.2% to 4.9% without ILUC factors (lower than old FQD due to higher Fossil Fuel Comparator, hence higher biofuel emissions)

concaveRED Implementation Scenarios: New RED & FQD results (2)



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- FAME demand: 14.6 to 16.5 Mtoe ……..compared to 10.9 Mtoe in 2011 (1)
- Ethanol demand: 5.3 to 7.2 Mtoe, of which 0.6 Mtoe 2nd gen …… compared to 2.9 Mtoe in 2011 (1), all 1st gen

- RED % : 7.9% with 5% limit on 1st gen (= 5.0% 1st gen + 1.9% adv biofuels + 0.8% renewable elec in rail + 0.1% renewable elec in road)
- FQD % savings: 0.4% to 0.7% with ILUC factors (average biofuels EF increases by 40-43 gCO2/MJ to reach 84-87 gCO2/MJ, i.e. only 3-8% lower than FFC)

Scenario Summary: Before RED Amendment

Scenario		1 (Ref)	2	3	4			7		
	Blends in 2020	E5, E10, B7	E10, **E20**, B7	E5, E10, B7, **B10**	E10, **E20**, B7, **B10**			E5, E10, **E85,** B7		
RED Contri-bution by	**1st Gen Biofuels**	6.4%	7.0%	7.0%	7.6%			6.4%		
	HVO, BTL, Adv. Ethanol	1.4%	1.4%	1.4%	1.4%			1.4%		
	Alt. vehicles LD: CNGV, EV, FFV HD: CNGV, E95V, DMEV	0.8%	0.8%	0.8%	0.8%			1.4%		
RED: Road contribution *)		8.6%	9.2%	9.2%	9.8%			9.2%		

RED contributions	Road	8.6%	9.2%	9.2%	9.8%			9.2%		
	Rail	0.9%	0.9%	0.9%	0.9%			0.9%		
	Water	0.1%	0.1%	0.1%	0.1%			0.1%		
	Aviation	0.0%	0.0%	0.0%	0.0%			0.0%		
	Other off-road	0.0%	0.0%	0.0%	0.0%			0.0%		
RED-% *)		**9.7%**	**10.3%**	**10.3%**	**10.9%**			**10.3%**		

*) might show rounding effects

Scenario Summary: After RED Amendment

Scenario		1 (Ref)	2	3	4			7		
	Blends in 2020	E5, E10, B7	E10, **E20**, B7	E5, E10, B7, **B10**	E10, **E20**, B7, **B10**			E5, E10, **E85,** B7		
RED Contri-bution by	**1st Gen Biofuels incl. HVO & Biogas**	4.9%	4.9%	4.9%	4.9%			4.9%		
	Adv biofuels (BTL, EtOH, DME, Adv. Biogas)	1.9%	1.9%	1.9%	1.9%			1.9%		
	Alt. vehicles EV	0.1%	0.1%	0.1%	0.1%			0.1%		
RED: Road contribution *)		6.9%	6.9%	6.9%	6.9%			6.9%		

RED contributions										
	Road	6.9%	6.9%	6.9%	6.9%			6.9%		
	Rail	0.9%	0.9%	0.9%	0.9%			0.9%		
	Water	0.1%	0.1%	0.1%	0.1%			0.1%		
	Aviation	0.0%	0.0%	0.0%	0.0%			0.0%		
	Other off-road	0.0%	0.0%	0.0%	0.0%			0.0%		
RED-% *)		**7.9%**	**7.9%**	**7.9%**	**7.9%**			**7.9%**		

*) might show rounding effects

Scenario Summary: RED vs. FQD (Before)

Scenario		1	2	3	4			7		
Biofuel Blends In 2020	Gasoline 1	E5	E10	E5	E10			E5		
	Gasoline 2	E10	E20	E10	E20			E10		
	Gasoline 3							E85		
	Diesel 1	B7	B7	B7	B7			B7		
	Diesel 2			B10 (ALL)	B10 (ALL)					
RED-%	All modes	**9.7%**	**10.3%**	**10.3%**	**10.9%**			**10.3%**		
GHG Savings FQD Art 7a		**-4.4%**	**-4.7%**	**-4.7%**	**-5.1%**			**-4.7%**		

- Contribution of renewable fuels is sufficient to achieve the RED target but not enough to meet the FQD Article 7a target for the scenarios evaluated in this study
- To achieve the 6% GHG saving target (FQD Art.7a), average GHG savings for all biofuels assumed in these scenarios would need to be in the range of 63 - 73%

Scenario Summary: RED vs. FQD (After)

Scenario		1	2	3	4			7		
Biofuel Blends In 2020	Gasoline 1	E5	E10	E5	E10			E5		
	Gasoline 2	E10	E20	E10	E20			E10		
	Gasoline 3							E85		
	Diesel 1	B7	B7	B7	B7			B7		
	Diesel 2			B10 (ALL)	B10 (ALL)					
RED-%	All modes	**7.9%**	**7.9%**	**7.9%**	**7.9%**			**7.9%**		
GHG Savings FQD Art 7a	**w/o ILUC factors**	**-4.2%**	**-4.5%**	**-4.5%**	**-4.9%**			**-4.5%**		
	with ILUC factors	**-0.4%**	**-0.7%**	**-0.4%**	**-0.7%**			**-0.7%**		

- Contribution of renewable fuels is insufficient to achieve the RED target and not enough to meet the FQD Article 7a target for the scenarios evaluated in this study
- To achieve the 6% GHG saving target (FQD Art.7a) without ILUC factors, average GHG savings for all biofuels assumed in these scenarios would need to increase to about 75% (vs. current assumption of about 50%) or upstream emissions reductions would need to be about 20 Mt/a of CO_2 equivalent (i.e. about ½ of flaring emissions from Nigeria in 2008)
- To achieve the 6% GHG saving target (FQD Art.7a) with ILUC factors, upstream emissions reductions would need to be about 60 Mt/a of CO_2 equivalent

Conclusions: After RED Amendment Proposal

- **Bioethanol (produced from food crops):**
  - Bioethanol has to compete with biodiesel within the 5% cap for RED
    - With ILUC emission factors it would have a clear advantage versus biodiesel
  - Bioethanol can grow only if it is cost competitive with fossil fuel
  - If subsidies are cut after 2020, EU production will be less competitive compared to imports
- **Biodiesel (produced from food crops):**
  - Meets sustainability criteria ONLY if from an existing plant
  - Little or no incentive to grow (unless it becomes cost competitive with fossil fuel)
  - EU biodiesel industry from food crops likely to become unsustainable after 2020
- **Strong incentive for "unconventional" non food-competing biofuels,** but…. multiple counting raises concerns(1) and may not provide enough investment certainty to stimulate the unconventional biofuel industry
- **Achieving 10% RED: now very unlikely given biofuel cap and scenarios**
- **Achieving 6% FQD target: as in 2011 study, very unlikely with biofuel blending**

(1) e.g. abuse of rules as in Used Cooking Oil, future arbitrary changes in counting rules

Next Steps

Work in progress to update the 2011 JEC Biofuels study

- Fleet & Fuels model:
  - Revise historical baseline with latest available statistics
  - Revise fleet growth parameters for conventional and alternative vehicles
  - Revise biofuel blend scenarios
  - Revise assumptions for "advanced biofuels"
- Include RED Amendment Proposal
  - Multiple counting factors, 5% biofuel cap, ILUC factors
- Generate revised scenarios for 2020 fuels demand
- Evaluate attainment levels of RED 10% and FQD 6% targets

Expected study completion: second half 2013

Thank you for your attention!

Back-up Charts

concawe 'Fleet & Fuels' Model: Vehicle and Fuel Options

Adjustable parameters that can be changed individually for each vehicle type

- Sales and stock annual growth rate
- Vehicle activity: annual km driven (LD, LCV), annual t-km (HD)
- Vehicle fuel efficiency
- Alternative vehicle 2020 sales share
- Alternative vehicle sales start year
- % replacement of gasoline or diesel cars by alternative vehicle
- % use of alternative fuel in alternative fuel vehicles (e.g. E85 take-up rate for FFV)

Fuels implementation

- Optimistic assumption for biofuel blending at max allowed specification (e.g., 10% v/v ethanol minus 0.1% v/v blending tolerance)
- Up to 3 different gasoline grades: 'protection grade', main grade, and E85
- Up to 2 different diesel grades: 'protection grade' and main grade
  - For the main diesel grade, market uptake by HD, LCV, LD vehicle and vehicle vintage compatibility can be independently set
- Vehicle vintage compatible with each fuel grade
- HVO or BTL are included in diesel pool assuming full backward compatibility
- Advanced Ethanol (lignocellulose based) is replacing/added to gasoline
- Other Oxygenates (e.g. ETBE): not specifically modeled but would be allowed up to the maximum oxygen specification

Renewable Energy Directive specifics are implemented including "extra credits" for advanced biofuels and renewable electricity

Biofuel Supply Outlook: Demand from Scenarios

	Biofuel Type	Demand Outlook (Scenarios)	Demand Outlook (Scenarios & parameter variation)
Conventional Biofuels	Bio-ethanol from fermentation	Up to 8.5 Mtoe	Up to 12 Mtoe
	FAME (and FAEE)	Up to 17.5 Mtoe	Up to 19 Mtoe
Advanced Biofuels	Bio-ethanol from lignocellulose	0.6 Mtoe	1.3 Mtoe
	Hydrogenated Natural Oils (HVO)	3.0 Mtoe	4.5 Mtoe
	Biomass to Liquids (BTL)	0.25 Mtoe	0.5 Mtoe
Other Renewables	Biogas	Up to 0.7 Mtoe	Up to 1.0 Mtoe
	Electric from renewables	Up to 0.5 Mtoe	Up to 1.0 Mtoe

- Will these quantities of bio-components be available for European use through 2020:
  - From domestic production and from imports?
  - From sustainable sources meeting GHG reduction targets?
  - Primary focus on availability, not costs and investments