Renewable Fuels Agency

Addendum 003 – RFA Carbon and Sustainability Reporting Guidance, Part 2

Oilseed rape to ME biodiesel

Fuel chain summary

Version 1.3: pages 57-70.

	Carbon intensity [kg CO_2 / t biodiesel]								
Module	**Australia**	**Canada**	**Finland**	**France**	**Germany**	**Poland**	**Ukraine**	**United Kingdom**	**USA**
1 - Crop production	1933	1853	1903	1591	1598	1475	2028	1945	3189
2 - Drying and storage	0	65	67	62	71	75	68	71	73
3 - Feedstock transport	22	109	29	87	87	87	62	29	28
4 - Feedstock transport	693	0	0	0	0	0	89	0	0
5 - Conversion (crushing)	-469	-490	-484	-503	-466	-451	-480	-468	-459

6 - Feedstock transport	8	86	0	7	11	25	0	0	23
7 - Feedstock transport	0	0	0	0	0	0	0	0	116
7 - Conversion (esterification)	471	471	471	471	471	471	471	471	471
8 - Liquid fuel transport and storage	0	0	35	0	0	0	0	0	0
TOTAL	2658	2094	2021	1715	1772	1682	2238	2048	3441

Selected default options

Stage	Module	Input	Options
1	Crop production	Nitrogen fertiliser emissions factor	Ammonium nitrate (AN), Ammonium sulphate (AS),Urea, Calcium nitrate (CN), Urea ammonium nitrate liquid (UAN), NPK (Urea / TSP / MOP)
1	Crop production	Phosphorus fertiliser emissions factor	Triple superphosphate (TSP), Rock phosphate, Mono ammonium phosphate (MAP)
2	Drying and storage	Fuel emissions factor	Diesel, Heavy fuel oil, Coal, Natural gas
3, 4	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
5	Conversion (crushing)	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
6, 7	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
8	Conversion (esterification)	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
9	Liquid fuel transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain

Stage 1 - Crop Production

Description	Cultivation and harvesting of oilseed rape						
Basic Data							
	Units						
Yield @ traded moisture content	[t/ha.a]	*value*	Y				
Traded moisture content	%	*value*					
Soil Emissions							
				Emissions co-efficient [$kgCO_{2e}$/ha]		Total Emissions ($kgCO_{2e}$/t OSR)	
N2O emissions	[total kg N/ha.a]	*N_FERT*	x	*6.163*	÷ Y =	*calculation*	1
Farming Inputs							
		Mass of input		Emissions co-efficient [$kgCO_{2e}$/kg nutrient]		Total emissions	
N fertiliser	[kg nutrient/ha.a]	*value (N_FERT)*	x	*value*	÷ Y =	*calculation*	2
P fertiliser (P2O5)	[kg nutrient/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	3
K fertiliser (K2O)	[kg nutrient/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	4
Lime (CaO)	[kg nutrient/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	5
				Emissions co-efficient [$kgCO_{2e}$/kg]			
Pesticides	[kg/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	6
Machinery Inputs							
Diesel fuel consumption	[litres/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	7
Totals						Total Emissions ($kgCO_{2e}$/t OSR)	
Module total					1 + 2 + 3 + 4 + 5 + 6 + 7 =	*calculation*	8
						Total Emissions [$kgCO_{2e}$/t biodiesel]	
Contribution to fuel chain					8 ÷ z1 ÷ z2 × AF=	*calculation*	Stage_1

Stage 2 - Drying and storage

Description	Drying and storage of oilseed rape						
Basic Data							
Moisture removed	% by weight	*value*					
				Emissions factor [kgCO2e/MJ]		Emissions ($kgCO_{2e}$/t OSR)	
Drying and storage inputs							
Fuel for heating	[MJ/t OSR]	*value*	x	*value*	=	*calculation*	9
Electricity	[MJ/t OSR]	*value*	x	*value*	=	*calculation*	10
Totals						Emissions ($kgCO_{2e}$/t OSR)	
Module total					9 + 10 =	*calculation*	11
						Total Emissions [$kgCO_{2e}$/t biodiesel]	
Contribution to fuel chain					11 ÷ z1 ÷ z2 × AF =	*calculation*	Stage_2

Stage 3 - Feedstock Transport

Description	From farm to oilseed crusher						
				Emissions factor [kgCO2e/MJ]			
Transport distance	[km]	*value*	dist_1				
Fuel consumption	[MJ/t-km]	*value*	FC_1				
Totals						Emissions ($kgCO_{2e}$/t OSR)	
Module total	[MJ/t OSR]	*value*	x	*value*	=	*calculation*	12
						Total Emissions [$kgCO_{2e}$/t biodiesel]	
Contribution to fuel chain					12 ÷ z1 ÷ z2 × AF =	*calculation*	Stage_3

Stage 4 - Feedstock Transport

Description	From farm to oilseed crusher							
					Emissions factor [kgCO2e/MJ]			
Transport distance	[km]	*value*	dist_2					
Fuel consumption	[MJ/t-km]	*value*	FC_2					
Totals							Emissions ($kgCO_{2e}$/t OSR)	
Module total	[MJ/t OSR]	*value*		x	*value*	=	*calculation*	13
							Total Emissions [$kgCO_{2e}$/t biodiesel]	
Contribution to fuel chain						13 ÷ z1 ÷ z2 × AF =	*calculation*	Stage_4

Stage 5 - Conversion

Description	Oil extraction							
Basic Data								
Plant yield	[t rapeseed oil / t oilseed rape]	*value*	z1					
Conversion Inputs								
					Emissions factor [kgCO2e/MJ]		Emissions ($kgCO_{2e}$/t biodiesel)	
Natural gas	[MJ/t rapeseed oil]	*value*		x	*value*	=	*calculation*	14
Electricity imported	[MJ/t rapeseed oil]	*value*		x	*value*	=	*calculation*	15
Co-products	**Description**	**Treatment**						
Co-product 1:	Rape meal - sold as animal feed	Substitution						
Co-products treated by substitution								
Co-product 1: rape meal								
- substitutes US soy meal (soybeans crushed in EU)					Credit [$kgCO_{2e}$/t rape meal]			
Quantity of rape meal produced & sold as animal feed	[t rape meal / t rapeseed oil]	*value*		x	*value*	=	*calculation*	16
Totals								
Module total						14 + 15 + 16 =	*calculation*	17
							Total Emissions [$kgCO_{2e}$/t biodiesel]	
Contribution to fuel chain						17 ÷ z2 × AF =	*calculation*	Stage_5

Stage 6 - Feedstock Transport

Description	From extraction facility to biodiesel plant							
					Emissions factor [kgCO2e/MJ]			
Transport distance	[km]	*value*	dist_3					
Fuel consumption	[MJ/t-km]	*value*	FC_3					
Totals							Emissions ($kgCO_{2e}$/t rapeseed oil)	
Module total	[MJ / t rapeseed oil]	*value*		x	*value*	=	*calculation*	18
Contribution to fuel chain						18 ÷ z2 × AF =	*calculation*	Stage_6

Stage 7 - Feedstock Transport

Description	From extraction facility to biodiesel plant							
					Emissions factor [kgCO2e/MJ]			
Transport distance	[km]	*value*	dist_4					
Fuel consumption	[MJ/t-km]	*value*	FC_4					
Totals							Emissions ($kgCO_{2e}$/t rapeseed oil)	
Module total	[MJ / t rapeseed oil]	*value*		x	*value*	=	*calculation*	19
Contribution to fuel chain						19 ÷ z2 × AF =	*calculation*	Stage_7

Stage 8 - Conversion

Description	Biodiesel plant							
Basic data								
Plant yield	[t biodiesel / t rapeseed oil]	*value*	(z2)					
Conversion Inputs					Emissions factor [kgCO2e/MJ]		Emissions ($kgCO_{2e}$/t biodiesel)	
Natural gas	[MJ/t biodiesel]	*value*	x	*value*	=	*calculation*		20
Electricity imported	[MJ/t biodiesel]	*value*	x	*value*	=	*calculation*		21
				Emissions factor (kgCO2e/kg)				
Methanol	kg/t biodiesel	*value*	x	*value*	=	*calculation*		22
Potassium hydroxide	kg/t biodiesel	*value*	x	*value*	=	*calculation*		23
Co-products	**Description**	**Treatment**						
Co-product 1:	Crude glycerine sold as chemical	Allocation - by market value						
Co-product 2:	Potassium sulphate	Allocation - by market value						
Co-products treated by allocation by market value								
Co-product 1: Glycerine				Market value [£ / t gylcerine]				
Quantity of crude glycerine produced	[t glycerine / t biodiesel]	*value*	x	*value*	=	*calculation*		24
Co-product 2: Potassium sulphate				Market value [£ / t potassium sulphate]				
Quantity of potassium sulphate produced and sold as chemical	[t potassium suplhate / t biodiesel]	*value*		*value*	=	*calculation*		25
Primary product: biodiesel				Market value [£ / t biodiesel]				
Market value of biodiesel				*value*	=	*calculation*		26
Total market value of products								
Total market value	[£ / t biodiesel]				24 + 25 + 26 =	*calculation*		27
Allocation factor (%age of emissions attributable to biodiesel)	%				26 ÷ 27 =	*calculation*		AF
Totals							Total Emissions ($kgCO_{2e}$/t biodiesel]	
Module total					(20 + 21 + 22 + 23) x AF =	*calculation*		28
Contribution to fuel chain					27 =	*calculation*		Stage_8

Stage 9 - Liquid fuel transport and storage

Description	From biodiesel plant to refinery / blending facility							
Transport distance	[km]	*value*	dist_4					
Fuel consumption	[MJ/t-km]	*value*	FC_4					
Totals					Emissions factor [kgCO2e/MJ]		Total Emissions ($kgCO_{2e}$/t biodiesel]	
Module total	[MJ/t biodiesel]	*value*	x	*value*	=	*calculation*		29
Contribution to fuel chain					29 =	*calculation*		Stage_9

Default value tables

Stage / Input	Units	Feedstock country of origin								
		Australia	**Canada**	**Finland**	**France**	**Germany**	**Poland**	**Ukraine**	**United Kingdom**	**USA**
Stage 1 – Crop production										
Yield @ traded moisture content	[t/ha.a]	1.19	1.46	1.30	3.18	3.44	2.38	1.12	3.03	1.56
Traded moisture content	%	9	9	9	9	9	9	9	9	9
N fertiliser	[kg N /ha.a]	61	75	67	155	170	102	60	185	150
Type of N fertiliser		AN	AN	AN	AN	AN	AN	AN	AN	AN
P fertiliser	[kg P_2O_5/ha.a]	16	20	18	45	45	35	15	45	120
Type of P fertiliser		TSP	TSP	TSP	TSP	TSP	TSP	TSP	TSP	TSP
K fertiliser	[kg K_2O/ha.a]	12	15	13	80	90	44	12	48	80
Lime	[kg CaO/ha.a]	271	271	271	271	271	271	271	271	271

Stage / Input	Units	Feedstock country of origin								
		Australia	**Canada**	**Finland**	**France**	**Germany**	**Poland**	**Ukraine**	**United Kingdom**	**USA**
Pesticides	[kg/ha.a]	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Diesel fuel consumption	[litres/ha.a]	66	66	66	66	66	66	66	66	66
Stage 2 – Drying and storage										
Moisture removed	% by weight	0	3	3	3	3	3	3	3	3
Fuel for heating	[MJ/t OSR]	0	318	318	318	318	318	318	318	318
Electricity	[MJ/t OSR]	0	35	35	35	35	35	35	35	35
Stage 3 – Feedstock Transport										
Transport distance	[km]	300	3000	100	300	300	300	1700	100	100
Fuel consumption	[MJ/t-km]	0.38	0.19	1.53	1.53	1.53	1.53	0	1.53	1.46
Fuel type		Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel

Stage / Input	Units	Feedstock country of origin								
		Australia	Canada	Finland	France	Germany	Poland	Ukraine	United Kingdom	USA
Stage 4 – Feedstock Transport										
Transport distance	[km]	18000	0	0	0	0	0	2300	0	0
Fuel consumption	[MJ/t-km]	0.2	N/A	N/A	N/A	N/A	N/A	0.2	N/A	N/A
Fuel type		HFO	N/A	N/A	N/A	N/A	N/A	HFO	N/A	N/A
Stage 5 – Conversion										
Plant yield	[t rapeseed oil/t oilseed rape]	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Natural gas	[MJ/t rapeseed oil]	1986	1986	1986	1986	1986	1986	1986	1986	1986
Electricity imported	[MJ/t rapeseed oil]	337	337	337	337	337	337	337	337	337

Stage / Input	**Units**	**Feedstock country of origin**								
		Australia	**Canada**	**Finland**	**France**	**Germany**	**Poland**	**Ukraine**	**United Kingdom**	**USA**
Co-product 1: Rape meal – sold as animal feed		Substitutes US soy meal (soybeans crushed in EU)								
Quantity of rape meal	[t rape meal/t rapeseed oil]	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32
Credit for co-product 1	[kgCO_2e/t rape meal]	-504	-504	-504	-504	-504	-504	-504	-504	-504
Stage 6 – Feedstock Transport										
Transport distance	[km]	500	5200	0	450	650	1500	0	0	1500
Fuel consumption	[MJ/t-km]	0.2	0.2	0	0.2	0.2	0.2	0	0	0.19
Fuel type		HFO	HFO	N/A	HFO	HFO	HFO	N/A	N/A	Diesel
Stage 7 – Feedstock Transport										
Transport distance	[km]	0	0	0	0	0	0	0	0	7000

Stage / Input	Units	Feedstock country of origin								
		Australia	**Canada**	**Finland**	**France**	**Germany**	**Poland**	**Ukraine**	**United Kingdom**	**USA**
Fuel consumption	[MJ/t-km]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.20
Fuel type		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	HFO
Stage 8 – Conversion										
Plant yield	[t biodiesel/t rapeseed oil]	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Natural gas	[MJ/t biodiesel]	1690	1690	1690	1690	1690	1690	1690	1690	1690
Electricity imported	[MJ/t biodiesel]	335	335	335	335	335	335	335	335	335
Methanol	kg/t biodiesel	113	113	113	113	113	113	113	113	113
Potassium hydroxide	kg/t biodiesel	26	26	26	26	26	26	26	26	26
Co-products										

Stage / Input	Units	Feedstock country of origin								
		Australia	Canada	Finland	France	Germany	Poland	Ukraine	United Kingdom	USA
Co-product 1	Crude glycerine	Allocation – by market value								
Quantity of crude glycerine	[t glycerine/t biodiesel]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Market value of glycerine	[£/t glycerine]	345	345	345	345	345	345	345	345	345
Co-product 2:	Potassium sulphate	Allocation – by market value								
Quantity of potassium sulphate	[t potassium sulphate/t biodiesel]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Market value of potassium sulphate	[£/t potassium sulphate]	75	75	75	75	75	75	75	75	75
Primary product: biodiesel										
Market value of biodiesel	[£/t	340	340	340	340	340	340	340	340	340

Stage / Input	Units	Feedstock country of origin								
		Australia	**Canada**	**Finland**	**France**	**Germany**	**Poland**	**Ukraine**	**United Kingdom**	**USA**
	biodiesel]									
Allocation factor	%	90	90	90	90	90	90	90	90	90
Stage 9 – Liquid fuel transport and storage										
Transport distance	[km]	0	0	2000	0	0	0	0	0	0
Fuel consumption	[MJ/t-km]	0	0	0.2	0	0	0	0	0	0
Fuel Type		N/A	N/A	HFO	N/A	N/A	N/A	N/A	N/A	N/A

Reason for changes

- Addition of a new OSR to biodiesel ME fuel chain for feedstock from USA.
- Addition of a new soy to biodiesel ME fuel chain for feedstock from Canada.