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Combustion and industry expert panel

Biodiesel emission factors in energy production

Preliminary remarks

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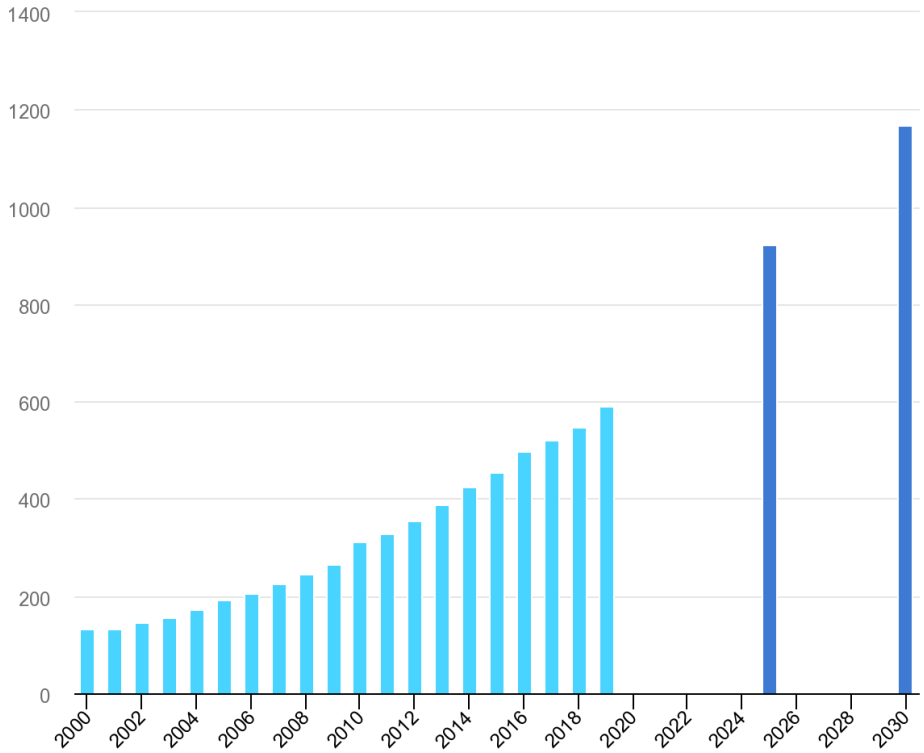
IEA Bioenergy power generation (TWh) in the Sustainable Development Scenario, 2000-2030



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Guidebook 2019

Actual Efs available for 1.A.1 Energy industries:

- ***Table 3-6 Tier 1 emission factors for source category 1.A.1.a using gas oil => assumed as Table 4-4***
- ***Table 3-18 Tier 2 emission factors for source category 1.A.1.a, gas turbines using gas oil***
- ***Table 3-19 Tier 2 emission factors for source category 1.A.1.a, reciprocating engines using gas oil***
- ***Table 4-4 Tier2 emission factors for source category 1.A.1.b, process furnaces using residual oil***

No Efs for biofuels

In the following we compare Efs for gasoil with some studies about biofuels for energy production

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Tier 1

Tier2 - Table 4-4 Tier2 emission factors for source category 1.A.1.b, process furnaces using residual oil

Table 3-6 Tier 1 emission factors for source category 1.A.1.a using gas oil

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	1.A.1.a	Public electricity and heat production			
Fuel	**Gas oil**				
Not applicable					
Not estimated	NH_3, PCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	65	g/GJ	22	195	US EPA (1998), chapter 1.3
CO	16.2	g/GJ	4	65	US EPA (1998), chapter 1.3
NMVOC	0.8	g/GJ	0.48	1.28	US EPA (1998), chapter 1.3
SOx	46.5	g/GJ	4.65	465	See Note
TSP	6.5	g/GJ	2	20	US EPA (1998), chapter 1.3
PM_{10}	3.2	g/GJ	1	10	US EPA (1998), chapter 1.3
$PM_{2.5}$	0.8	g/GJ	0.3	2.5	US EPA (1998), chapter 1.3
BC	33.5	% of $PM_{2.5}$	28.9	38	Hildemann et al., 1981 & Bond et al., 2006
Pb	4.07	mg/GJ	0.41	40	US EPA (1998), chapter 1.3
Cd	1.36	mg/GJ	0.14	15	US EPA (1998), chapter 1.3
Hg	1.36	mg/GJ	0.14	15	US EPA (1998), chapter 1.3
As	1.81	mg/GJ	0.18	20	US EPA (1998), chapter 1.3
Cr	1.36	mg/GJ	0.14	15	US EPA (1998), chapter 1.3
Cu	2.72	mg/GJ	0.27	30	US EPA (1998), chapter 1.3
Ni	1.36	mg/GJ	0.14	15	US EPA (1998), chapter 1.3
Se	6.79	mg/GJ	0.68	70	US EPA (1998), chapter 1.3
Zn	1.81	mg/GJ	0.18	20	US EPA (1998), chapter 1.3
PCDD/F	0.5	ng I-TEQ/GJ	0.25	1	UNEP, 2005
Indeno(1,2,3-cd)pyrene	6.92	µg/GJ	3.46	13.8	US EPA (1998), chapter 1.3

Note:

For conversion of the US EPA data the heating value as provided in the reference has been used (140 MMBTU/10^3 gal). This has been converted to NCV using a factor of 0.95. Furthermore, units have been converted using 1055.0559 J/BTU and 453.59237 g/lb.

The factor for SO_x assumes no SO_2 abatement and is based on 0.1 % mass sulphur content.

The TSP, PM_{10} and $PM_{2.5}$ emission factors represent filterable PM emissions. Note that condensable PM emission factors are also provided in US EPA (1998), Chapter 1.3.

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Tier 2 emission factors for reciprocating engines using gas oil

Table 3-19 Tier 2 emission factors for source category 1.A.1.a, reciprocating engines using gas oil

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.1.a	Public electricity and heat production			
Fuel	Gas Oil				
SNAP (if applicable)	010105	Public power - Stationary engines			
Technologies/Practices	Large stationary CI reciprocating engines				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NH_3				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	942	g/GJ	500	1380	Nielsen et al., 2010
CO	130	g/GJ	30	230	Nielsen et al., 2010
NMVOC	37.1	g/GJ	18.5	55.6	US EPA (1996), chapter 3.4
SOx	46.5	g/GJ	4.65	465	See Note
TSP	28.1	g/GJ	14.1	56.2	US EPA (1996), chapter 3.4
PM_{10}	22.4	g/GJ	11.2	44.8	US EPA (1996), chapter 3.4
$PM_{2.5}$	21.7	g/GJ	10.8	43.4	US EPA (1996), chapter 3.4
BC	78	% of $PM_{2.5}$	63	93	Hernandez et al., 2004
Pb	4.07	mg/GJ	0.41	40.7	US EPA (2010), chapter 1.3
Cd	1.36	mg/GJ	0.14	13.6	US EPA (2010), chapter 1.3
Hg	1.36	mg/GJ	0.14	13.6	US EPA (2010), chapter 1.3
As	1.81	mg/GJ	0.18	18.1	US EPA (2010), chapter 1.3
Cr	1.36	mg/GJ	0.14	13.6	US EPA (2010), chapter 1.3
Cu	2.72	mg/GJ	0.27	27.1	US EPA (2010), chapter 1.3
Ni	1.36	mg/GJ	0.14	13.6	US EPA (2010), chapter 1.3
Se	6.79	mg/GJ	0.68	67.9	US EPA (2010), chapter 1.3
Zn	1.81	mg/GJ	0.18	18.1	US EPA (2010), chapter 1.3
PCDD/F	0.99	ng I-TEQ/GJ	0.1	10	Nielsen et al., 2010
HCB	0.22	µg/GJ	0.022	2.2	Nielsen et al., 2010
PCBs	0.13	ng I-TEQ/GJ	0.013	1.3	Nielsen et al., 2010
Benzo(a)pyrene	0.116	mg/GJ	0.0582	0.116	US EPA (1996), chapter 3.4 ("Less than" value based on method detection limits)
Benzo(b)fluoranthene	0.502	mg/GJ	0.251	0.754	US EPA (1996), chapter 3.4
Benzo(k)fluoranthene	0.0987	mg/GJ	0.0493	0.0987	US EPA (1996), chapter 3.4 ("Less than" value based on method detection limits)
Indeno(1,2,3-cd)pyrene	0.187	mg/GJ	0.0937	0.187	US EPA (1996), chapter 3.4 ("Less than" value based on method detection limits)

Notes:

For conversion of the US EPA data the values have been converted to NCV using a factor of 0.95. Furthermore, units have been converted using 1055.0559 J/BTU and 453.59237 g/lb.

The factor for SO_x assumes no SO_2 abatement and is based on 0.1 % mass sulphur content using EF calculation from subsection 3.4.2.2 of the present chapter.The TSP, PM_{10} and $PM_{2.5}$ emission factors represent filterable PM emissions. Note that a condensable PM emission factor is also provided in US EPA (1996), Chapter 3.4.

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Some researches about emissions

- Miller (2008), C. Andrew Miller, Characterizing Emissions from the Combustion of Biofuels, .S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/069, 2008.
- Komarian (2013), L. N. Komariah, S. Arita, Novia, S. S. Wirawan, and M. Yazid, Journal of Renewable and Sustainable Energy 5, 052005 (2013); doi: 10.1063/1.4822036
- ERG (2007), Eastern Research Group, Emission Factors for Priority Biofuels in Minnesota, Minnesota Pollution Control Agency, June 30, 2007

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Emission factors comparison

	Miller (2008)			Komariah(2013)		ERG (2007)		Guidebook	
	boiler			fire tube boiler				Gasoil	
g/GJ	Gasoil	Soy	Animal	Gasoil	Palm	Biodiesel boiler	Biodiesel engines	Tier 1	Tier 2 engines
NOx	42,65	47,72	48,58	1361,1	1820,2	46,86	2295,78	65	942
CO	0,74	1,23	1,35	48,3	39,2	23,65	184,87	167,2	130
SO2	13,2	1,99	1,35					46,5	46,5
PM tot	5,2	1,1	1,25			0,86	47,29	6,5	28,1

Some preliminary consideration:

- Lack of information about biodiesel in GB and also for gasoil in boilers
- In general NOx, PM and CO emissions seems greater for biodiesel
- Some focus can be useful for future development of biodiesel toward carbon neutrality target