

Summary

Annually NERI reports emission inventories based on the Danish energy statistics and on emission factors for different fuels and plants. Eltra (Independent transmission system operator in western Denmark) use emission factors for the annual Environmental Impact Statement for electricity. A considerable part of the electricity production in Denmark is based on decentralized CHP plants (Combined Heat and Power production) and thus well documented emission factors for these plants have been required.

Emission factors for CHP plants <25MW_e have been estimated. The following plant types are included in the work: municipal waste incineration plants, CHP plants combusting wood and straw, natural gas and biogas fuelled (reciprocating) engines and natural gas fuelled gas turbines. The estimated emission factors are based on existing emission measurements as well as on emission measurements carried out within the project. The following pollutants are included: SO₂, NO_x, NMVOC, CH₄, CO, N₂O, particulate matter, aldehyde, dioxin, HCl, HF, odour, metals, lube oil, 1,3-butadien and PAH. The number of emission data sets is comprehensive and detailed information about a number of emission measurements and the share of fuel consumption they represent are included in the tables in appendices. An extract of the emission factors is shown in Table 1.

Table 1 Extract of the emission factors for decentralized CHP plants, year 2000

Emission	Unit	Natural gas engines	Biogas engines	Gas turbines	Municipal waste incineration plants	CHP combusting straw	CHP combusting wood
NO _x	g/GJ	168	540	124	124	131	69
Unburned hydrocarbon (C-equivalent)	g/GJ	485	254	<2,3	<1,2	<0,93	<4,1
- CH ₄ 2)	g/GJ	520	323	1,5	<0,6	<0,5	<2,1
- NMVOC 2)	g/GJ	117	14	1,4	<1	<0,8	<3,4
CO	g/GJ	175	>273	6	<8	63	79
N ₂ O	g/GJ	1,3	0,5	2,2	<1,3	1,4	<0,8
TSP	g/GJ	0,76	2,63	0,10	<2,02	3,97	7,94
PM1	mg/GJ	143	132	38	1003	77	1033
PAH (benz[a]pyren equivalent)	mg/GJ	<0,023	<0,003	<0,005	<0,006	<0,154	<0,008
Formaldehyde	g/GJ	24	21,15	0,01	x	x	x
SO ₂	g/GJ	x	19	x	<24	47	<1,8
HCl	g/GJ	x	x	x	<4,4	46	<0,9
HF	g/GJ	x	x	x	<0,3	<0,2	<0,09
Cd	mg/GJ	x	x	x	<4,8	<0,8	<1
Hg	mg/GJ	x	x	x	<7,4	<0,6	<0,8
Pb	mg/GJ	x	x	x	<123	<6,2	<3,7
Dioxin	µg/GJ	x	x	x	0,157	0,022	0,001
Odour	OU/m ³	8229	18516	2027	x	x	x
Lube oil	g/GJ	12	x	x	x	x	x

Emission factors for subgroups of each plant type have been prepared. Thus emission factors for different natural gas engine types, different gas turbine and biogas engine manufactures are estimated. Further,

emission factors for municipal waste incineration plants equipped with different flue gas cleaning systems are worked out.

Emission factors for decentralized CHP plants have been compared to emission factors for power plants. The emission factors for CO and the unburned hydrocarbons CH₄ and NMVOC are considerably higher for decentralized CHP plants than for power plants. This is due to the relatively high gas engine emission factors for these pollutants. Emission factors for Cd and Pb are also considerably higher for decentralized CHP plants than for power plants and this is due to the relatively high municipal waste emission factors for these pollutants. The SO₂ emission factor is lower for decentralized CHP plants than for power plants. The NO_x emission factors for power plants and decentralized CHP plants respectively do not differ considerably but the emission factor for power plants is however somewhat lower than for decentralized CHP plants.

Based on the revised emission factors an emission inventory for decentralized CHP plants in Denmark has been prepared. Gas engines are the main emission source of NO_x, unburned hydrocarbons, CO, N₂O, aldehyde and PAH. Municipal waste incineration plants are the main emission source for particulate matter, SO₂, dioxin, HF and metals. Straw combusting plants are the main source of emission of HCl.

The emissions from CHP plants have been compared with the total Danish emissions. The Pb emission from decentralized CHP plants accounts for 38% of the overall Danish Pb emission. The emission of Cd, Hg and As also accounts for more than 15% of the overall Danish emission. Other pollutants for which CHP plants are a considerable emission source are CH₄ (6%) and NO_x (7%).

The emissions from decentralized CHP plants are also compared with stationary combustion plants in Denmark including public power, district heating, industrial combustion, residential combustion and combustion in commercial and institutional plants. It appears that 80% of the CH₄ from stationary combustion plants is emitted from decentralized CHP plants – primarily from gas engines. The Pb emission from decentralized CHP accounts for 53% of the total emission from stationary combustion plants.

New Danish legislation is expected to cause a decrease of some emission factors for municipal waste incineration plants, gas engines and gas turbines within the next few years.

The results of many heavy metal emission measurements have been below the detection limit. The calculation of emission factors is based on the assumption that the emission equals the emission detection limit in these cases. This may have caused an overestimate of some emission factors. The fact that many Pb emission measurements are below the detection limit causes a considerable uncertainty of the total Danish emission inventory for Pb.