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Some information about power generation system in Poland and potential for energy production from renewable sources - particularly biomass. dioxin emission preliminary data.

Depending on the quantity of energy purchased, particular consumer groups in Poland will have the access to the grid between the years of 1999 and 2005:

- till the end of 1998, the access to the grid obtained final consumers with the yearly purchase of electric energy of not less than 500 GWh (the largest 21 consumers with yearly total purchase of around 21.5 TWh),
- from 1 January 1999, the access to the grid obtained final consumers with the yearly purchase of not less than 100 GWh (83 consumers with yearly total of around 37 TWh),
- from 1 January 2000 - final consumers with the yearly purchase of not less than 40 GWh (180 consumers with yearly total of around 43.5 TWh),
- from 1 January 2002 - final consumers with the yearly purchase of not less than 10 GWh (610 consumers with yearly total of around 51.5 TWh),
- from 1 January 2004 - final consumers with the yearly purchase of not less than 1 GWh (3300 consumers with yearly total of around 60 TWh),
- from 5 December 2005 - all the consumers (around 14,5 million).

The Energy Law provides for careful and gradual introduction of the TPA principle, the process being conditioned that the necessary reliability of supply and quality of fuels and energy be maintained. The provisions of the Law make it clear that this principle is limited to the fuels extracted in Poland and the energy produced from them.

Table 3. Renewables energetic potential on the example of straw, hay and wood in Poland

Fuel	Total amount (mln ton)	Usage index (%)	Possible USE amounts (mln ton)
Grain straw	21.5	50	8.9
Rape straw	2.4	70	1.4
Hay	18.1	10	1.5
Wood	6.2	60	3.8
Total energetic potential in agriculture and forestry			15.6

Data from Witold Szwagrun
EC BREC/IEO - Institute for Renewable Energy, Warsaw, Poland
Association of Polish Energy Actors at Local and Regional Level

In order to unemployment reduction in Poland and rural areas activity improvement one can increase the share of renewable sources energy in total energy balance of the country.
Biomass substitution of primary fuel in energy production reduces its production costs and increases agricultural production efficiency and living standards of rural society.

Project Title	Technology	Capacity MW	Status	Sponsor
Koszalin wind farms	Wind		planned	
Walbrzyska	Biofuels		Planned	Elstar Oils
J&S Biofuel plants	Biodiesel		Planned	
Dipol Wind	Wind	22	Planned	Dipol Sp
Constanta Wind	Wind	NA	Planned	
Puck	Wind	22	Planned	EPA
Zagorze Wind	Wind	30	Operating	EPA, ELSAM
Darlow	Wind	0.66	Operating	
Nowogard	Wind	0.225	Operating	
Starbienino	Wind	0.25	Operating	
Stramnica	Wind	4.3	Operating	
Swarzewo	Wind	1.2	Operating	
Mloty	Hydroelectric	786	Planned	
Szczecin Idm	Waste to Energy	15	Planned	
Broniewek	Wind	90	Planned	
Barycz Landfill	Landfill Gas	0.498	Operating	
Barzowice	Wind	4.98	Operating	
Cisowo	Wind	18	Operating	
Biopawila Bio-Ethanol Plant	Biofuels		Planned	Biopawila
Malczyce Hydro Rehab	Hydroelectric	9	Planned	
Wysak Wind Farm	Wind	90	Construction	Wysak Petroleum, Projekt GmbH
Strabag Plasma Arc	Waste to Energy		Planned	Startech Environmental

Poland has very favorable technical and economical factors for renewable energy and has begun to experience a shift and political and public support away from traditional fossil fuels and toward the development of renewable energy resources. Poland has established a target of:**7.5 percent of energy production from renewable sources by 2010, and 14% by 2020.** However, these targets have not yet been enforced, discouraging large scale renewable development. Even so, the aggressive targets combined with strong economic growth provide a healthy investment atmosphere for renewable energy developers. Utilities are required to purchase electricity from renewable sources, although prices are not regulated by tariffs.
Biomass and wind appear to be the most promising renewable energy resources for development in Poland, with an estimated potential of about 4,000 MWe each. Both liquid and solid biomass are considered to be the main sources of renewable energy in Poland, for both electricity and thermal energy production. This is because biomass technologies and supply sources are relatively mature, and the investment costs are lower than for other maturing renewable energy technologies. Poland also has some of the best documented wind resources in Central and Eastern Europe with areas reaching up to 1,000 W/m2 in power density.
Biomass is the most promising source of renewable energy in Poland. The technical potential of biomass amount to **755 PJ/year** (1 TWh = 3,6 PJ (PetaJoule) and the greatest opportunities for biomass technology implementation has been recognized in forestry, wood processing and agriculture sectors.

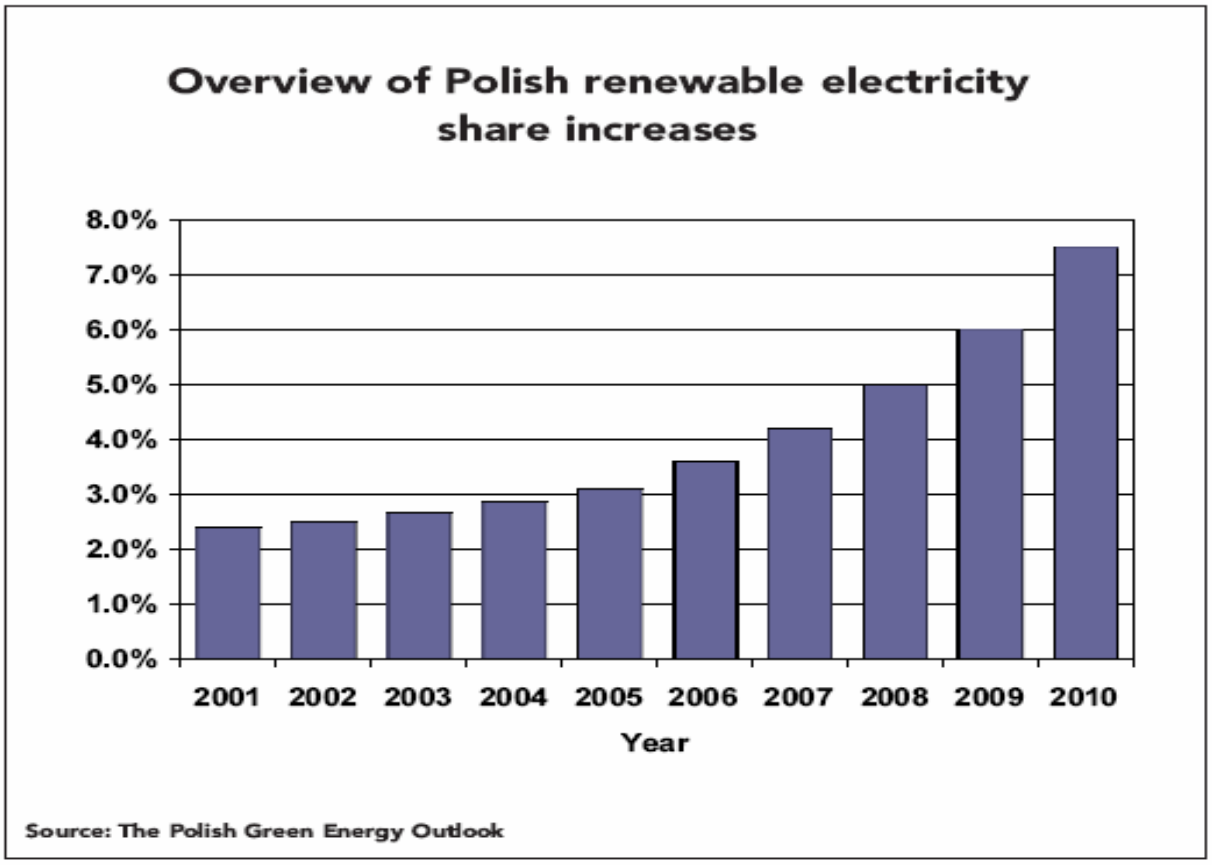
Data from Lech Pałasz
Department of Economic Policy and Market, Agricultural University of Szczecin, Poland

Poland - Country Summary Table

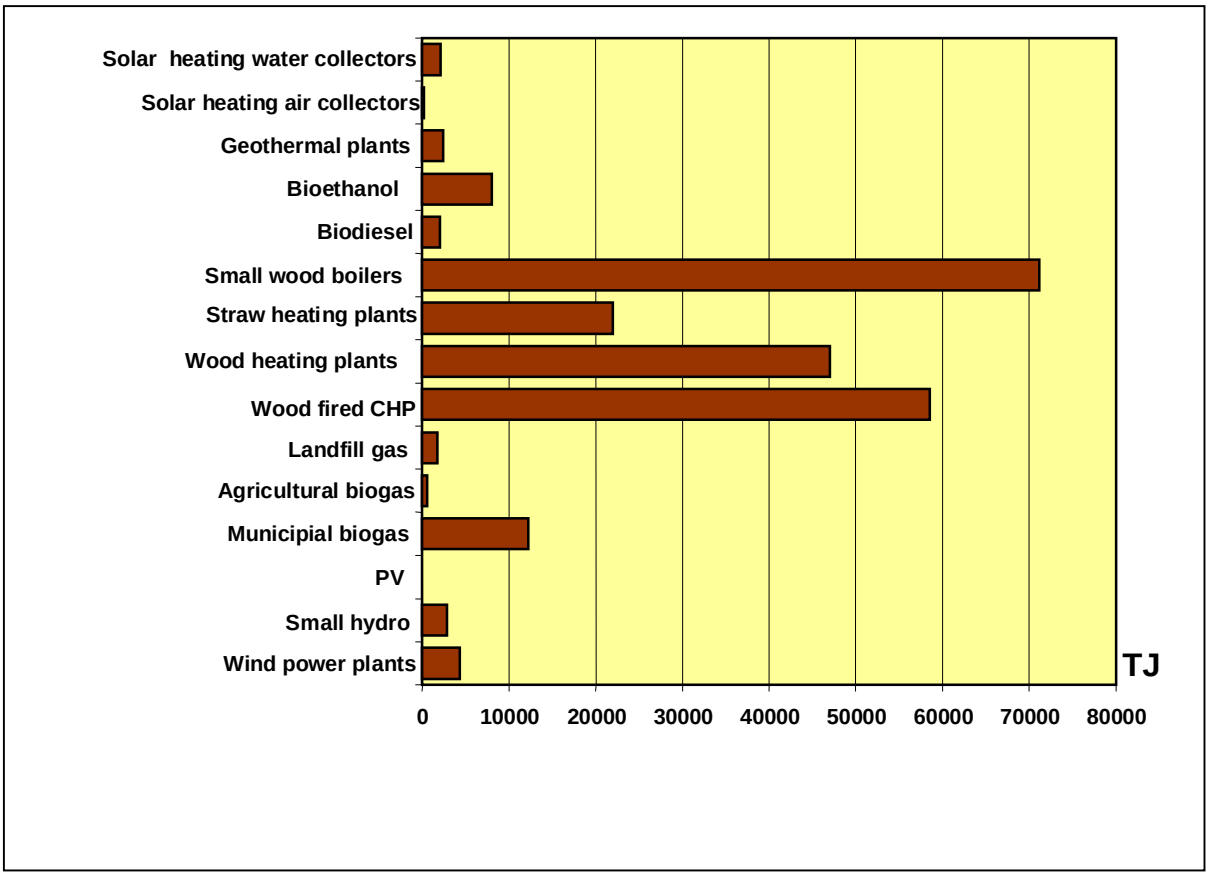
Demographical Information	
Population, millions (2003)	38.3
Land area, km^2 (2002)	312690
Macroeconomic Information (2003)	
GDP, billion US$	209.5
Real GDP growth rate, percent	3.70
Foreign direct investment (net), million US$	3,950
Electricity sector	
Electricity tariff, US¢/kWh (2002)	8.8
Collection rate, percent (2002)	90
Load utilization factor, percent (2000)	NA
Curent Feed-In (Euro)	0.090
Renewable Target (2012)	9%
Electricity disposition, billion kWh (2003)	
Generation	141.25
Consumption	121.26
Exports	15.10
Imports	5.00
Generation capacity, GW (2003)	
Nuclear	0.0
Thermal	28.4
Hydro	0.9
Other renewables	2
Total	29.3

Sources: European Bank for Reconstruction and Development, U.S. Energy Information Administration, Food and Agriculture Organization of the United Nations.

By: Renewable Development Initiative – Poland 2006.
http://www.mos.gov.pl/sipw/technologie_srodowiskowe/road_map.pdf
http://www.ebrdrenewables.com/sites/renew/countries/Poland/profile.aspx#biomass



The majority of current biomass use is as heat for and small and medium scale boilers in industrial settings. Common fuel is wood pieces, sawdust, and wood shavings. Combined heat and power (CHP) plants using organic waste from pulp and paper operations, and straw and wood fired heating plants are also in operation.
Biogas production from landfill gas and municipal waste is also available. In 2002 there were about 25 landfill gas installations producing 22.3 GWh of electricity and 100 TJ of heat. Biogas production from municipal waste resulted in about 38 GWh of electricity and 450 TJ of heat.
About 47 percent of the land area of Poland, about 14 million ha, consists of arable and agricultural lands. Nearly 9 million ha is forested, about 28 percent. It is estimated that the total forest cover in Poland will reach 32 percent in the next 15 years.
The area with the most development in recent years has been energy generation from fuel wood, forestry residues, agricultural residues and surpluses. These have taken the form of individual and industrial heating plants, district heating and even CHP plants, in where biomass is replacing or reducing the use of coal. Considering the age and the decreased efficiency of many of the existing plants due to age or lack of maintenance, rehabilitation and conversion to a biomass boiler may be a possible alternative.



Breakdown of Renewable Energy Source

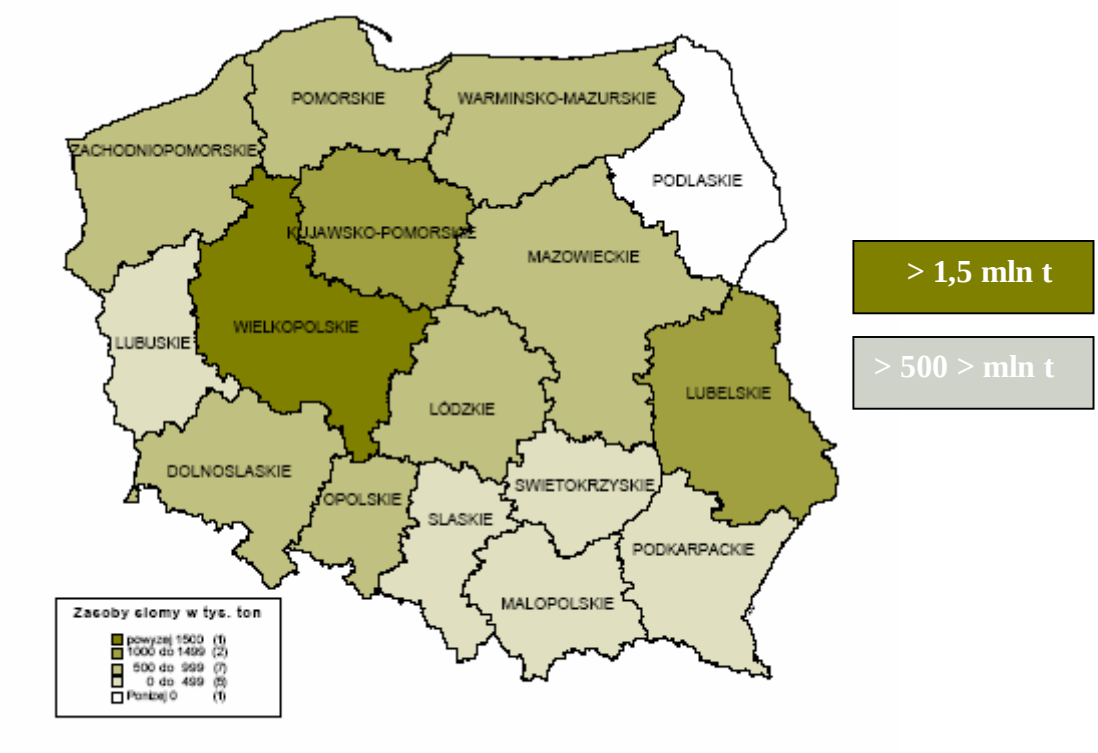
Source: Magdalena Rogulska, Polish Biomass Association – POLBIOM, Warsaw

Another alternative is the expanded use of biogas. Energy production projects from biogas generated from wastewater treatment plants, agricultural and livestock activities and landfills are currently being implemented.
In addition, biofuels is an area that appears to be developing, especially for the agriculture community. It has been a political priority of the Polish government to develop the use of biofuels. Biofuel has recently been utilized in conjunction with #2 fuel oil, for heating purposes. A 1997 biofuels law provides tax incentives for the use of #2 fuel oil / bio-fuel mixtures. In 2001, approximately 209 tons of bio-fuel was utilized for heating

by Gierulski Krzysztof
EC BALTIC RENEWABLE ENERGY CENTRE
Polish National Energy Conservation Agency

Poland Biomass Resource Data

Biomass resource type	Total production	Production density
Percent of total land area covered by		
Forests	8%	
Shrublands, savanna, and grasslands	0%	
Cropland and crop/natural vegetation mosaic	90%	
Urban and built-up areas	1%	
Sparse or barren vegetation; snow and ice	0%	
Wetlands and water bodies	2%	
Primary crop production, tonne	(avg. 1999-2001, tonne)	(tonne /1000 Ha)
Total primary crops (rank among COO)	83,836,385 (3)	2,754 (6)
Top 10 primary crops		
Potatoes	21,520,127	707
Sugar Beets	12,899,332	424
Wheat	8,982,393	295
Maize for Forage & Silage	6,333,333	208
Vegetables and Roots, Fodder	5,193,333	171
Rye	4,701,436	154
Mixed Grain	3,689,795	121
Barley	3,174,738	104
Leguminous (misc), Forage & Silage	3,064,000	101
Triticale	2,243,369	74
Animal units, number	(number)	(number / 1000 Ha)
Cattle	6,273,900	206
Poultry	49,772,000	1,635
Pigs	18,380,802	604
Equivalent animal units	14,123,941	464
Annual roundwood production	(1996-98, 000 m^3)	(m^3 / Ha)
Total	21772	715.2
Fuel	1492	49.0
Industrial	20280	666.2
Wood-based panels	3024	99.3
	(1996-98, 000 metric tons)	(metric tons / Ha)
Paper and paperboard	1828	60.0
Recovered paper	703	23.1



Territorial distribution of straw available for energy production in different provinces

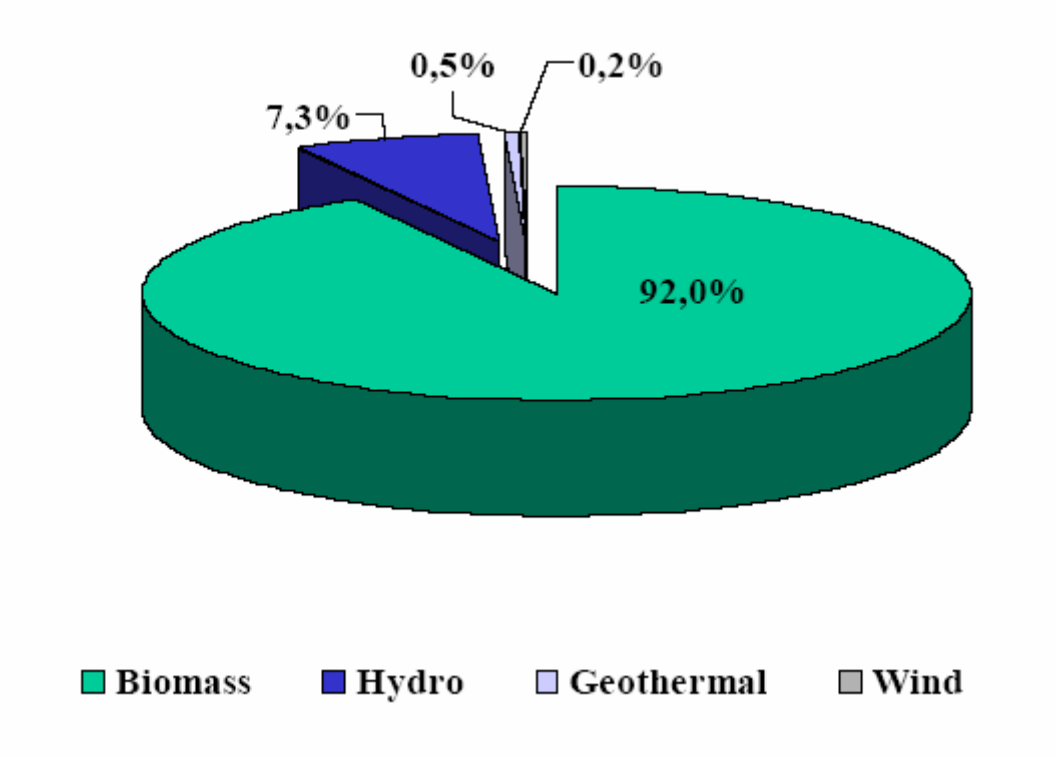
Recently, Poland has seen a considerable increase in interest in utilisation of renewable energy sources. The current share of green energy in the total energy balance in Poland is around 2.5% and is growing steadily. The process has been accelerated by actions at central government level and political support for the whole renewable energy sector. This includes the adoption by the

Polish parliament in 2001 of a National Renewable Energy Strategy – the first such policy document in Central and Eastern Europe.
Grzegorz Wisniewski leads the Centre of Excellence RECEPOL (Renewable Energy Centre of Excellence and Competence in Poland) which is based at the EC Baltic Renewable Energy Centre (EC BREC). Both belong to the Institute for Building Mechanisation and Electrification of Agriculture (IBMER) in Warsaw. RECEPOL organises a sub-network on biomass/bioenergy research and is a significant focus of work in Poland's plans for boosting RES capacity (http://www.ecbrec.pl). Research activities at RECEPOL include a variety of activities in the renewable energy sector. The centre undertakes interdisciplinary studies on the use of bioenergy from forestry and agriculture, and standardising the methods for analyses of biofuels properties.

To hit Poland's RES targets, considerable increases in capacity for small biomass boilers (8 000 MW capacity), wood-fired heating plant (4 000 MW), wood-fired CHP (1 500 MW) and straw-fired heating plants (1 000 MW) are envisaged by 2010. The projected share of electrical power produced by various RES is shown in Figure 1.The Polish government expects 4% of power generation to be derived from co-firing biomass with coal by 2010 – equivalent to 10-12 million m3of biomass fuel. Current logging operations in Poland yield around 2.5 million m3. Fortunately, the potential for bioenergy is very large in Poland with almost 60% of its land devoted to agricultural production and over 29% currently forest or

woodland. Therefore, there are significant biomass feeds available from agricultural surpluses/wastes, plus opportunities for specific energy cropping. In addition, there is good technical potential for up to 26 PJ (PJ = 1015J) of biogas production from livestock farms.

RES research in new member states
http://ec.europa.eu/research/energy/nn/nn_pu/renews/003/article_2271_en.htm



DIOXIN (PCDDs + PCDFs) EMISSIONS FROM HARD COAL BURNING IN POLISH INDUSTRIAL AND LOCAL, SMALL POWER PLANTS

FLUIDIZED BED HARD COAL ONLY COMBUSTION

Dioxin in stack gases ng-TEQ/m^3	Coal mass combusted t/h	Stack gas emission m^3/h	Dioxin Emission factor **µgTEQ / t** of coal	Dioxin Emission factor µgTEQ / TJ
0,0012	16	330000	0,025	0,93
0,0015	9	200000	0,033	1,22

Average emission factor 0,029 µg-TEQ/t. Relative error ± 20%

PULVERIZED HARD COAL ONLY COMBUSTION

Dioxin in stack gases ng-TEQ/m^3	Coal mass combusted t/h	Stack gas emission m^3/h	Dioxin Emission factor **µgTEQ / t** of coal	Dioxin Emission factor µgTEQ / TJ
0,0012	28	400000	0,017	0,81
0,002	35	750000	0,043	2,05
0,0025	20	385000	0,048	2,29
0,0032	85	900000	0,034	1,62

Average emission factor 0,036 µg-TEQ/t. Relative error ± 10%

GRID FURNACE HARD COAL ONLY COMBUSTION

Dioxin in stack gases ng-TEQ/m^3	Coal mass combusted t/h	Stack gas emission m^3/h	Dioxin Emission factor **µgTEQ / t** of coal	Dioxin Emission factor µgTEQ / TJ
0,001	17	388000	0,023	1,05
0,0014	30	650000	0,030	1,36
0,0022	12	360000	0,066	3,00
0,0042	5	120000	0,101	4,59

Average emission factor 0,055 µg-TEQ/t. Relative error ± 10%
Data from measurements in 1998-2001

OLD, SMALL GRID FURNACE for local house heating ONLY HARD COAL

Dioxin in stack gases ng-TEQ/m^3	Coal mass combusted t/h	Stack gas emission m^3/h	Dioxin Emission factor **µgTEQ / t** of coal	Dioxin Emission factor µgTEQ / TJ
9,2	0,05	1500	276	13800
4,1	0,02	700	144	7200

Average emission factor 210µg-TEQ/t. Relative error ± 50%
Possibly, some wastes were co-incinerated

OLD GRID FURNACE (Built in 1950) ONLY HARD COAL

Dioxin in stack gases ng-TEQ/m^3	Coal mass combusted t/h	Stack gas emission m^3/h	Dioxin Emission factor **µgTEQ / t** of coal	Dioxin Emission factor µgTEQ / TJ
0,125	0,3	8700	3,625	186
0,080	0,5	13500	2,160	111

Average emission factor 2,893 µg-TEQ/t. Relative error ± 20%

GRID FURNACE (Built in 1985) ONLY HARD COAL

Dioxin in stack gases ng-TEQ/m^3	Coal mass combusted t/h	Stack gas emission m^3/h	Dioxin Emission factor **µgTEQ / t** of coal	Dioxin Emission factor µgTEQ / TJ
0,024	2,2	26000	0,284	11,4
0,090	0,86	11250	1,177	47,1

Average emission factor 0,731 µg-TEQ/t. Relative error ± 20%

INDUSTRIAL FLUIDIZED BED ONLY HARD COAL

Dioxin in stack gases ng-TEQ/m^3	Coal mass combusted t/h	Stack gas emission m^3/h	Dioxin Emission factor **µgTEQ / t** of coal	Dioxin Emission factor µgTEQ / TJ
0,074	8,4	285000	2,510	109
0,166	3,9	154500	6,580	286

Average emission factor 4,55 µg-TEQ/t. Relative error ± 50% from only two measurements
Data from measurements in 2000-2005

Data Source: Adam Grochowalski
http://www.dioksyny.pl/kierunkibadan/towartowiedziec/oznaczaniedioksynwpowietrzuispalinachang/ - in English

also: *Survey of Dioxin Sources in the Baltic Region (COWI, Denmark)*
http://www.cowi.dk/NR/rdonlyres/71E17C1F-5B11-41D7-92B7-F7845C8A98FD/0/SurveyofDioxinSourcesintheBalticRegionExtendedSummary.pdf

Unpublished data from preliminary dioxin emission measurements in 2006 year.

Biomass :
wood chips (W-ch)
animal meal (A-me)

routine co-firing in electric generation power plants in Poland

FLUIDIZED BED: HARD COAL + BIOMASS COMBUSTION

Dioxin in stack gases **ng-TEQ/ m^3/h**	**Coal mass** combusted **t/h**	**Biomass** combusted **t/h**	Stack gas emission **m^3/h**	Dioxin emission factor **µgTEQ/t coal**	Dioxin emission factor **µgTEQ / TJ**
0,0024	27	0	860000	0,076	3,17
0,017	25	W-ch 1,8	880000	0,598	24,9
0,025	24 **	W-ch 2,8	890000	0,927	38,6
0,0015	18	0	620000	0,052	1,96
0,080	16,8	A-me 1,2	620000	2,952	111
0,064	15,5 **	A-me 2,5	620000	2,560	96,6

** Pilot test

Relative error ± 50% from only two measurements from both installations
Data from measurements in 2005