

*Eco-profiles of the  
European Plastics Industry*

**ELECTRICITY (On-site)**

*A report by*

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*for*

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*Data last calculated*

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## IMPORTANT NOTE

Before using the data contained in this report, you are strongly recommended to look at the following documents:

### 1. Methodology

This provides information about the analysis technique used and gives advice on the meaning of the results.

### 2. Data sources

This gives information about the number of plants examined, the date when the data were collected and information about up-stream operations.

In addition, you can also download data sets for most of the upstream operations used in this report. All of these documents can be found at: [www.plasticseurope.org](http://www.plasticseurope.org).

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## ELECTRICITY PRODUCTION

All chemical plants use electricity. Frequently this is all derived from the public electricity supply. Sometimes, however, part of the electricity demand is satisfied by on-site generation. There are few plants that are totally self sufficient in electricity generation capacity and very few plants operate electricity-only generation plant.

The principle underlying the co-generation of electricity is simple. There is an inevitable thermodynamic inefficiency in converting thermal energy (heat) to electricity (work). In conventional power stations much of the rejected heat is lost from the system, which is why most public electricity facilities show generation efficiencies in the region of 30-40%. In a chemical plant there is always a demand for steam and so high pressure steam can be used to generate electricity with the lower pressure output satisfying some or all of the steam demand of the production plant.

In all eco-profile calculations site-specific electricity data have been used wherever possible. However, there are instances where on-site generated electricity is known to be used but details of the plant are not known. In a few other instances there are plants that import electricity from off-site, non-public sources. It is therefore essential to have a data set for industrial electricity production that can be used in these cases.

During the last decade or so details have been collected for over 100 different electricity plants and these have been used to produce an 'average'.

There are however a number of points to be borne in mind.

1. The commonest way of producing electricity is using the fossil fuels, coal, oil and gas. However, for economic reasons, many industrial boilers use low grade fuels so that the overall energy efficiency can be very variable. Conversely, some electrolysis plants generate hydrogen from which there is no immediate chemical demand. In these cases, the hydrogen is used as a very efficient fuel.
2. The feed water to co-generation plant can make a significant difference to overall efficiency. For example, if steam condensate is recovered or if the boiler feed water is pre-heated using waste heat from elsewhere, then steam and electricity production efficiency is boosted.
8. On-site electricity distribution usually leads to losses of the order of 2%. However, on sites that practice electrolysis and where rectification of the a.c. supply is necessary, losses can jump to 6-8%

## ECO-PROFILE OF ELECTRICITY

Table 1 shows the gross or cumulative energy to produce 1 MJ of electricity and Table 2 gives this same data expressed in terms of primary fuels. Table 3 shows the energy data expressed as masses of fuels. Table 4 shows the raw materials requirements and Table 5 shows the demand for water. Table 6 shows the gross air emissions and Table 7 shows the corresponding carbon dioxide equivalents of these air emissions. Table 8 shows the emissions to water. Table 9 shows the solid waste generated and Table 10 gives the solid waste in EU format.

*Table 1*

*Gross energy required to produce 1 MJ of electricity. (Totals may not agree because of rounding)*

Fuel type	Fuel prod'n & delivery energy (MJ)	Energy content of delivered fuel (MJ)	Energy use in transport (MJ)	Feedstock energy (MJ)	Total energy (MJ)
Electricity	-	-	-	-	-
Oil fuels	0.07	0.47	<0.01	-	0.54
Other fuels	0.06	1.62	0.01	-	1.69
Totals	0.13	2.09	0.01	-	2.23

*Table 2*

*Gross primary fuels required to produce 1 MJ of electricity. (Totals may not agree because of rounding)*

Fuel type	Fuel prod'n & delivery energy (MJ)	Energy content of delivered fuel (MJ)	Fuel use in transport (MJ)	Feedstock energy (MJ)	Total energy (MJ)
Coal	0.01	0.36	<0.01	-	0.36
Oil	0.04	0.47	0.01	-	0.52
Gas	0.08	1.16	<0.01	-	1.24
Hydro	<0.01	-	<0.01	-	<0.01
Nuclear	<0.01	-	<0.01	-	<0.01
Lignite	<0.01	-	<0.01	-	<0.01
Wood	<0.01	-	<0.01	-	<0.01
Sulphur	<0.01	-	<0.01	-	<0.01
Biomass (solid)	<0.01	-	<0.01	-	<0.01
Hydrogen	<0.01	-	<0.01	-	<0.01
Recovered energy	<0.01	0.11	<0.01	-	0.11
Unspecified	<0.01	-	<0.01	-	<0.01
Peat	<0.01	-	<0.01	-	<0.01
Geothermal	<0.01	-	<0.01	-	<0.01
Solar	<0.01	-	<0.01	-	<0.01
Wave/tidal	<0.01	-	<0.01	-	<0.01
Biomass (liquid/gas)	<0.01	-	<0.01	-	<0.01
Industrial waste	<0.01	-	<0.01	-	<0.01
Municipal Waste	<0.01	-	<0.01	-	<0.01
Wind	<0.01	-	<0.01	-	<0.01
Totals	0.13	2.09	0.01	-	2.23

*Table 3*  
*Gross primary fuels used to*  
*produce 1 MJ of electricity*  
*expressed as mass.*

Fuel type	Input in mg
Crude oil	11000
Gas/condensate	23000
Coal	13000
Metallurgical coal	2
Lignite	<1
Peat	<1
Wood	<1

*Table 4*  
*Gross raw materials required to produce 1*  
*MJ of electricity.*

Raw material	Input in mg
Air	<1
Barytes	<1
Bauxite	<1
Bentonite	<1
Biomass (including water)	21
Calcium sulphate (CaSO <sub>4</sub> )	<1
Chalk (CaCO <sub>3</sub> )	<1
Clay	<1
Cr	<1
Cu	<1
Dolomite	<1
Fe	6
Feldspar	<1
Ferromanganese	<1
Fluorspar	<1
Granite	<1
Gravel	<1
Hg	<1
Limestone (CaCO <sub>3</sub> )	1
N <sub>2</sub>	<1
Ni	<1
O <sub>2</sub>	<1
Olivine	<1
Pb	<1
Phosphate as P <sub>2</sub> O <sub>5</sub>	<1
Potassium chloride (KCl)	<1
Rutile	<1
S (bonded)	<1
S (elemental)	<1
Sand (SiO <sub>2</sub> )	<1
Shale	<1
Sodium chloride (NaCl)	<1
Talc	<1
Unspecified	<1
Zn	<1

*Table 5*

*Gross water consumption required for the production of 1 MJ of electricity. (Totals may not agree because of rounding)*

Source	Use for processing (mg)	Use for cooling (mg)	Totals (mg)
Public supply	100	-	100
River canal	<1	<1	<1
Sea	<1	26	27
Well	<1	<1	<1
Unspecified	21000	270	22000
Totals	21000	300	22000

*Table 6*

*Gross air emissions associated with the production of 1 MJ of electricity. (Totals may not agree because of rounding)*

Emission	From fuel prod'n (mg)	From fuel use (mg)	From transport (mg)	From process (mg)	From biomass (mg)	From fugitive (mg)	Totals (mg)
dust (PM10)	18	38	<1	-	-	-	56
CO	30	49	3	-	-	-	82
CO2	6500	140000	540	-	<1	-	140000
SOX as SO2	32	870	5	-	-	-	910
H2S	<1	-	<1	-	-	-	<1
mercaptan	<1	-	<1	-	-	-	<1
NOX as NO2	22	360	4	-	-	-	390
NH3	<1	-	<1	-	-	-	<1
Cl2	<1	-	<1	-	-	-	<1
HCl	<1	7	<1	-	-	-	7
F2	<1	-	<1	-	-	-	<1
HF	<1	<1	<1	-	-	-	<1
hydrocarbons not specified	51	52	1	-	-	-	100
aldehyde (-CHO)	<1	-	<1	-	-	-	<1
organics	<1	-	<1	-	-	-	<1
Pb+compounds as Pb	<1	-	<1	-	-	-	<1
Hg+compounds as Hg	<1	-	<1	-	-	-	<1
metals not specified elsewhere	<1	<1	<1	-	-	-	<1
H2SO4	<1	-	<1	-	-	-	<1
N2O	<1	-	<1	-	-	-	<1
H2	<1	-	<1	-	-	-	<1
dichloroethane (DCE) C2H4Cl2	<1	-	<1	-	-	-	<1
vinyl chloride monomer (VCM)	<1	-	<1	-	-	-	<1
CFC/HCFC/HFC not specified	<1	-	<1	-	-	-	<1
organo-chlorine not specified	<1	-	<1	-	-	-	<1
HCN	<1	-	<1	-	-	-	<1
CH4	420	88	<1	-	-	-	500
aromatic HC not specified	<1	-	<1	-	-	-	<1
polycyclic hydrocarbons (PAH)	<1	-	<1	-	-	-	<1
NMVOC	<1	-	<1	-	-	-	<1
CS2	<1	-	<1	-	-	-	<1
methylene chloride CH2Cl2	<1	-	<1	-	-	-	<1
Cu+compounds as Cu	<1	-	<1	-	-	-	<1
Cd+compounds as Cd	<1	-	<1	-	-	-	<1
Zn+compounds as Zn	<1	-	<1	-	-	-	<1
Cr+compounds as Cr	<1	-	<1	-	-	-	<1
Ni+compounds as Ni	<1	-	<1	-	-	-	<1

Table 7

Carbon dioxide equivalents corresponding to the gross air emissions for the production of 1 MJ of electricity. (Totals may not agree because of rounding)

Type	From fuel prod'n (mg)	From fuel use (mg)	From transport (mg)	From process (mg)	From biomass (mg)	From fugitive (mg)	Totals (mg)
20 year equiv	33000	140000	550	-	<1	-	180000
100 year equiv	16000	140000	550	-	<1	-	160000
500 year equiv	9700	140000	550	-	<1	-	150000

Table 8

Gross emissions to water arising from the production of 1 MJ of electricity. (Totals may not agree because of rounding).

Emission	From fuel prod'n (mg)	From fuel use (mg)	From transport (mg)	From process (mg)	Totals (mg)
COD	<1	-	<1	-	<1
BOD	<1	-	<1	-	<1
Pb+compounds as Pb	<1	-	<1	-	<1
Fe+compounds as Fe	<1	-	<1	-	<1
Na+compounds as Na	<1	-	<1	-	<1
acid as H+	<1	-	<1	-	<1
NO3-	<1	-	<1	-	<1
Hg+compounds as Hg	<1	-	<1	-	<1
metals not specified elsewhere	<1	-	<1	-	<1
ammonium compounds as NH4+	<1	-	<1	-	<1
Cl-	<1	-	<1	-	<1
CN-	<1	-	<1	-	<1
F-	<1	-	<1	-	<1
S+sulphides as S	<1	-	<1	-	<1
dissolved organics (non- suspended solids	<1	-	<1	-	<1
detergent/oil	3	-	<1	-	3
hydrocarbons not specified	<1	-	<1	-	<1
organo-chlorine not specified	<1	-	<1	-	<1
dissolved chlorine	<1	-	<1	-	<1
phenols	<1	-	<1	-	<1
dissolved solids not specified	<1	-	<1	-	<1
P+compounds as P	<1	-	<1	-	<1
other nitrogen as N	<1	-	<1	-	<1
other organics not specified	<1	-	<1	-	<1
SO4--	<1	-	<1	-	<1
dichloroethane (DCE)	<1	-	<1	-	<1
vinyl chloride monomer (VCM)	<1	-	<1	-	<1
K+compounds as K	<1	-	<1	-	<1
Ca+compounds as Ca	<1	-	<1	-	<1
Mg+compounds as Mg	<1	-	<1	-	<1
Cr+compounds as Cr	<1	-	<1	-	<1
ClO3--	<1	-	<1	-	<1
BrO3--	<1	-	<1	-	<1
TOC	<1	-	<1	-	<1
AOX	<1	-	<1	-	<1
Al+compounds as Al	<1	-	<1	-	<1
Zn+compounds as Zn	<1	-	<1	-	<1
Cu+compounds as Cu	<1	-	<1	-	<1
Ni+compounds as Ni	<1	-	<1	-	<1



Table 9

*Gross solid waste associated with the production of 1 MJ of electricity. (Totals may not agree because of rounding)*

Emission	From fuel prod'n (mg)	From fuel use (mg)	From transport (mg)	From process (mg)	Totals (mg)
Plastic containers	<1	-	<1	-	<1
Paper	<1	-	<1	-	<1
Plastics	<1	-	<1	-	<1
Metals	<1	-	<1	-	<1
Putrescibles	<1	-	<1	-	<1
Unspecified refuse	140	-	<1	-	140
Mineral waste	<1	-	5	-	5
Slags & ash	18	710	2	-	730
Mixed industrial	140	-	<1	<1	140
Regulated chemicals	170	-	<1	-	170
Unregulated chemicals	130	-	<1	-	130
Construction waste	<1	-	<1	-	<1
Waste to incinerator	<1	-	<1	-	<1
Inert chemical	<1	-	<1	-	<1
Wood waste	<1	-	<1	-	<1
Wooden pallets	<1	-	<1	-	<1
Waste to recycling	<1	-	<1	-	<1
Waste returned to mine	2500	-	<1	-	2500
Tailings	<1	-	<1	-	<1
Municipal solid waste	-4	-	-	-	-4
Note: Negative values correspond to consumption of waste e.g. recycling or use in electricity generation.					

Table 10

Gross solid waste in EU format associated with the production of 1 MJ of electricity. Entries marked with an asterisk (\*) are considered hazardous as defined by EU Directive 91/689/EEC

Emission	Totals (mg)
010101 metallic min'l excav'n waste	4
010102 non-metal min'l excav'n waste	2500
010306 non 010304/010305 tailings	<1
010308 non-010307 powdery wastes	<1
010399 unspecified met. min'l wastes	<1
010408 non-010407 gravel/crushed rock	<1
010411 non-010407 potash/rock salt	<1
010499 unsp'd non-met. waste	<1
010505*oil-bearing drilling mud/waste	160
010508 non-010504/010505 chloride mud	130
010599 unspecified drilling mud/waste	140
020107 wastes from forestry	<1
050107*oil industry acid tars	<1
050199 unspecified oil industry waste	5
050699 coal pyrolysis unsp'd waste	<1
060101*H <sub>2</sub> SO <sub>4</sub> /H <sub>2</sub> SO <sub>3</sub> MFSU waste	<1
060102*HCl MFSU waste	<1
060204*NaOH/KOH MFSU waste	<1
060313*h. metal salt/sol'n MFSU waste	<1
060314 other salt/sol'n MFSU waste	<1
060399 unsp'd salt/sol'n MFSU waste	<1
060404*Hg MFSU waste	<1
060405*other h. metal MFSU waste	<1
060499 unsp'd metallic MFSU waste	<1
060602*dangerous sulphide MFSU waste	<1
060603 non-060602 sulphide MFSU waste	<1
060701*halogen electrol. asbestos waste	<1
060703*BaSO <sub>4</sub> sludge with Hg	<1
060704*halogen pr. acids and sol'ns	<1
060799 unsp'd halogen pr. waste	<1
070107*hal'd still bottoms/residues	<1
070108*other still bottoms/residues	<1
070111*org. chem. dan. eff. sludge	<1
070199 unsp'd organic chem. waste	<1
070207*polymer ind. hal'd still waste	<1
070208*polymer ind. other still waste	<1
070213 polymer ind. waste plastic	<1
070214*polymer ind. dan. additives	<1
070299 unsp'd polymer ind. waste	<1
080199 unspecified paint/varnish waste	<1
100101 non-100104 ash, slag & dust	730
100102 coal fly ash	<1
100105 FGD Ca-based reac. solid waste	<1
100114*dangerous co-incin'n ash/slag	<1
100115 non-100115 co-incin'n ash/slag	<1

continued over .....

*Table 10 - continued*

*Gross solid waste in EU format associated with the production of 1 MJ of electricity. Entries marked with an asterisk (\*) are considered hazardous as defined by EU Directive 91/689/EEC*

100116*dangerous co-incin'n fly ash	<1
100199 unsp'd thermal process waste	<1
100202 unprocessed iron/steel slag	2
100210 iron/steel mill scales	<1
100399 unspecified aluminium waste	<1
100501 primary/secondary zinc slags	<1
100504 zinc pr. other dust	<1
100511 non-100511 Zn pr. skimmings	<1
101304 lime calcin'n/hydration waste	<1
150103 wooden packaging	<1
170107 non-170106 con'e/brick/tile mix	<1
190199 unspecified incin'n/pyro waste	<1
190905 sat./spent ion exchange resins	<1
200101 paper and cardboard	<1
200108 biodeg. kitchen/canteen waste	<1
200138 non-200137 wood	<1
200139 plastics	<1
200140 metals	<1
200199 other separately coll. frac'ns	<1
200301 mixed municipal waste	<1
200399 unspecified municipal wastes	130
Note: Negative values correspond to consumption of waste e.g. recycling or	