

*Eco-profiles of the
European Plastics Industry*

STEAM (On-site)

A report by

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for

PlasticsEurope

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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.

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STEAM PRODUCTION

Steam is the principal carrier of thermal energy employed in almost all chemical processes. In all eco-profile calculations site-specific steam data have been used wherever possible. However, there are instances where details of the steam plant are not known and in yet other instances there are plants that import steam from off-site sources. It is therefore essential to have a data set for industrial steam production that can be used in these cases.

During the last decade or so details have been collected for over 200 different steam 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 steam 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.
2. In countries where there is a high proportion of hydro-power or nuclear power, steam may be generated using predominantly electricity.
3. Steam is often produced by waste incineration plant. Since the purpose of such plant in the chemical industry is primarily the efficient destruction of unwanted chemicals, steam production is only a secondary concern. As a result, the efficiency of such plant can often appear to be very low.
4. The feed water to steam 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 production efficiency is boosted.
5. It is important to remember that for centrally operated steam plants on a site, the overall site efficiency may be more important than the efficiency of the steam delivered to a single operation.
6. Many plants practise steam and electricity co-generation. Depending on priorities, some of these plants can appear to be very efficient while others appear very inefficient
7. In times of change, steam plants can become inefficient. Often a facility may have been set up at a time when it was feeding several production units. But if some of these production units cease operation, then the steam plant may well be operating below its optimum performance.

8. Steam distribution also leads to losses. These losses are commonly in the range of 2% to 5% of the steam fed into the system.

ECO-PROFILE OF STEAM

Table 1 shows the gross or cumulative energy to produce 1 kg of steam 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 kg of steam. (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	0.12	0.83	<0.01	-	0.95
Other fuels	0.11	2.88	0.01	-	3.00
Totals	0.23	3.71	0.01	-	3.95

Table 2

Gross primary fuels required to produce 1 kg of steam. (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	0.63	<0.01	-	0.64
Oil	0.07	0.83	0.01	-	0.91
Gas	0.14	2.05	<0.01	-	2.19
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	0.20	<0.01	-	0.20
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	0.23	3.71	0.01	-	3.95

Table 3

Gross primary fuels used to produce 1 kg of steam expressed as mass.

Fuel type	Input in mg
Crude oil	20000
Gas/condensate	42000
Coal	22000
Metallurgical coal	4
Lignite	<1
Peat	<1
Wood	<1

*Table 4
Gross raw materials required to produce 1
kg of steam.*

Raw material	Input in mg
Air	1
Barytes	<1
Bauxite	<1
Bentonite	<1
Biomass (including water)	38
Calcium sulphate (CaSO ₄)	<1
Chalk (CaCO ₃)	<1
Clay	<1
Cr	<1
Cu	<1
Dolomite	<1
Fe	10
Feldspar	<1
Ferromanganese	<1
Fluorspar	<1
Granite	<1
Gravel	<1
Hg	<1
Limestone (CaCO ₃)	2
N ₂	1
Ni	<1
O ₂	<1
Olivine	<1
Pb	<1
Phosphate as P ₂ O ₅	<1
Potassium chloride (KCl)	<1
Rutile	<1
S (bonded)	<1
S (elemental)	<1
Sand (SiO ₂)	<1
Shale	<1
Sodium chloride (NaCl)	<1
Talc	<1
Unspecified	<1
Zn	<1

*Table 5
Gross water consumption required for the production of 1 kg
of steam. (Totals may not agree because of rounding)*

Source	Use for processing (mg)	Use for cooling (mg)	Totals (mg)
Public supply	180	-	180
River canal	<1	<1	<1
Sea	<1	47	47
Well	<1	<1	<1
Unspecified	38000	480	38000
Totals	38000	530	38000

Table 6

Gross air emissions associated with the production of 1 kg of steam. (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)	31	67	<1	-	-	-	99
CO	54	88	5	-	-	-	150
CO2	12000	240000	960	-	<1	-	250000
SOX as SO2	56	1500	9	-	-	-	1600
H2S	<1	-	<1	-	-	-	<1
mercaptan	<1	-	<1	-	-	-	<1
NOX as NO2	40	640	8	-	-	-	680
NH3	<1	-	<1	-	-	-	<1
Cl2	<1	-	<1	-	-	-	<1
HCl	<1	13	<1	-	-	-	13
F2	<1	-	<1	-	-	-	<1
HF	<1	<1	<1	-	-	-	<1
hydrocarbons not specified	90	92	2	-	-	-	180
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	740	160	<1	-	-	-	890
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 kg of steam. (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	58000	250000	980	-	<1	-	310000
100 year equiv	29000	250000	980	-	<1	-	280000
500 year equiv	17000	240000	980	-	<1	-	260000

Table 8

Gross emissions to water arising from the production of 1 kg of steam. (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 acid as H+	<1	-	<1	-	<1
NO ₃ -	<1	-	<1	-	<1
Hg+compounds as Hg	<1	-	<1	-	<1
metals not specified elsewhere	<1	-	<1	-	<1
ammonium compounds as NH ₄ ⁺	<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	5	-	1	-	6
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
SO ₄ ⁻	<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
ClO ₃ ⁻	<1	-	<1	-	<1
BrO ₃ ⁻	<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 kg of steam. (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	250	-	<1	-	250
Mineral waste	<1	-	8	-	8
Slags & ash	31	1300	3	-	1300
Mixed industrial	240	-	<1	<1	240
Regulated chemicals	300	-	<1	-	300
Unregulated chemicals	230	-	<1	-	230
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	4400	-	<1	-	4400
Tailings	<1	-	<1	-	<1
Municipal solid waste	-8	-	-	-	-8
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 kg of steam. 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	8
010102 non-metal min'l excav'n waste	4400
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	290
010508 non-010504/010505 chloride mud	230
010599 unspecified drilling mud/waste	250
020107 wastes from forestry	<1
050107*oil industry acid tars	<1
050199 unspecified oil industry waste	9
050699 coal pyrolysis unsp'd waste	<1
060101*H2SO4/H2SO3 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*BaSO4 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	1300
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
100116*dangerous co-incin'n fly ash	<1
100199 unsp'd thermal process waste	<1

continued over

Table 10 - continued

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

100202 unprocessed iron/steel slag	3
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	240
Note: Negative values correspond to consumption of waste e.g. recycling or use in electricity generation.	