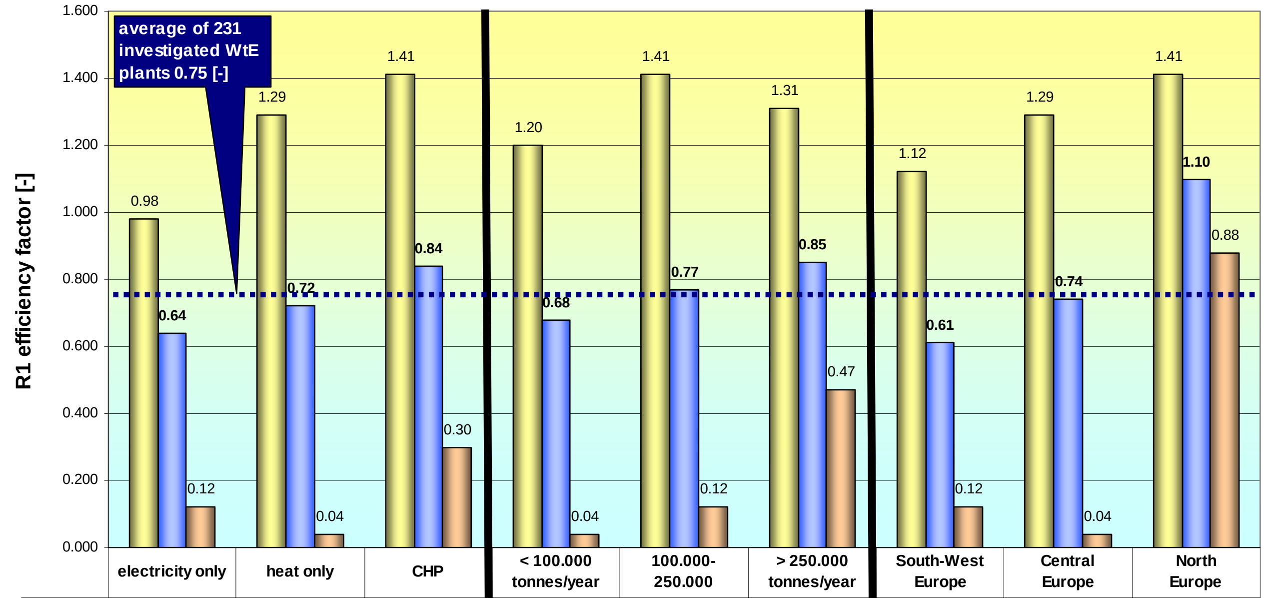
CEWEP Energy Report II
(Status 2004-2007)

Results of Specific Data for Energy, R1 Plant Efficiency factor and Net Calorific Value (NCV) of 231 European WtE Plants

March 2009

S u m m a r y



	electricity only	heat only	CHP	< 100.000 tonnes/year	100.000-250.000	> 250.000 tonnes/year	South-West Europe	Central Europe	North Europe
max	0.98	1.29	1.41	1.20	1.41	1.31	1.12	1.29	1.41
average	0.64	0.72	0.84	0.68	0.77	0.85	0.61	0.74	1.10
min	0.12	0.04	0.30	0.04	0.12	0.47	0.12	0.04	0.88

R1 energy efficiency factors calculated according to the Waste Framework Directive 2008/98/EC (Annex II, R1) of 231 investigated WtE plants divided into different categories according to the type of energy recovery, the size (throughput) and the geographical location as min., max. values and non weighted averages

The whole report is available on http://www.cewep.eu/studies/climate-protection/index.html

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Executive summary

Continuing the work started with its first CEWEP Energy Report on 97 European Waste-to-Energy (WtE) plants referring to the operation years 2001-2004, CEWEP now publishes a second CEWEP Energy Report on 231 European WtE plants referring to the operation years 2004-2007.

The calculations were made assuming the same hypotheses as made in the first CEWEP Energy Report which was used as a reference when the Commission set the thresholds of the R1 formula in its proposal for the Waste Framework Directive. The formula used in the first report was slightly different from the one which is now in the Waste Framework Directive 2008/98/EC, but the results are quite comparable between the 2 reports in this respect.

However, the number of plants investigated has nearly tripled in this second report with a greater number of small plants and many plants from the South and the West part of EU and consequently this led to somewhat different results.

Energy data from 231 European WtE plants operated by CEWEP members from 16 countries of Europe (15 EU countries + CH) were collected and used for this report. The mixed municipal waste (MSW) incinerated by these investigated plants amounts to 45 million tonnes (t)/year in EU 27 and 45.5 million t/y (EU 27 + CH). These amounts represent a share of 76% of the incinerated MSW in EU 27 in 2006 and 71.5% of the incinerated MSW in EU 27+CH+NO during the same year.

The main objective of this report was to calculate the key figures Ep, Ew, Ef and Ei as basis for the R1 efficiency factor of these 231 installations according to the formula given in Annex II of the Waste Framework Directive 2008/98/EC and to determine whether they are Recovery operation (R1) or Disposal operation (D10). The criterion given in the Directive is R1 $\geq$ 0.60 for existing plants and $\geq$ 0.65 for plants permitted after 31/12/2008.

For the total of the 231 investigated European WtE plants, the R1 efficiency factor (calculated with the equivalence factors as given by the Directive) is 0.75 on average and therefore well exceeding the value of $\geq$ 0.60. The R1 efficiency factor of 169 WtE plants (73.2%) out of the total 231 investigated European plants is also well over 0.60.

The second task of the report was to check the possible effects of the main parameters of the energy efficiency performance of the plants as it is reflected by the R1 formula, with a view to gathering useful information for the guidance which the European Commission may elaborate as additional general conditions for the determination of R1.

With respect to the influencing parameters, the results of the investigation clearly show strong correlations between the values of R1 and the kind of energy recovery, the size of the plant and the European geographical location, respectively.

Type of energy recovery:
WtE plants “only electricity” producing are achieving the lowest R1 factor of 0.64 on average so that only 46 plants (61.3%) out of 75 are reaching R1 $\geq$ 0.60. Although WtE plants producing “only heat” achieve a R1 factor of 0.72, only 25 plants (61.0%) out of 41 are reaching R1 $\geq$ 0.60.

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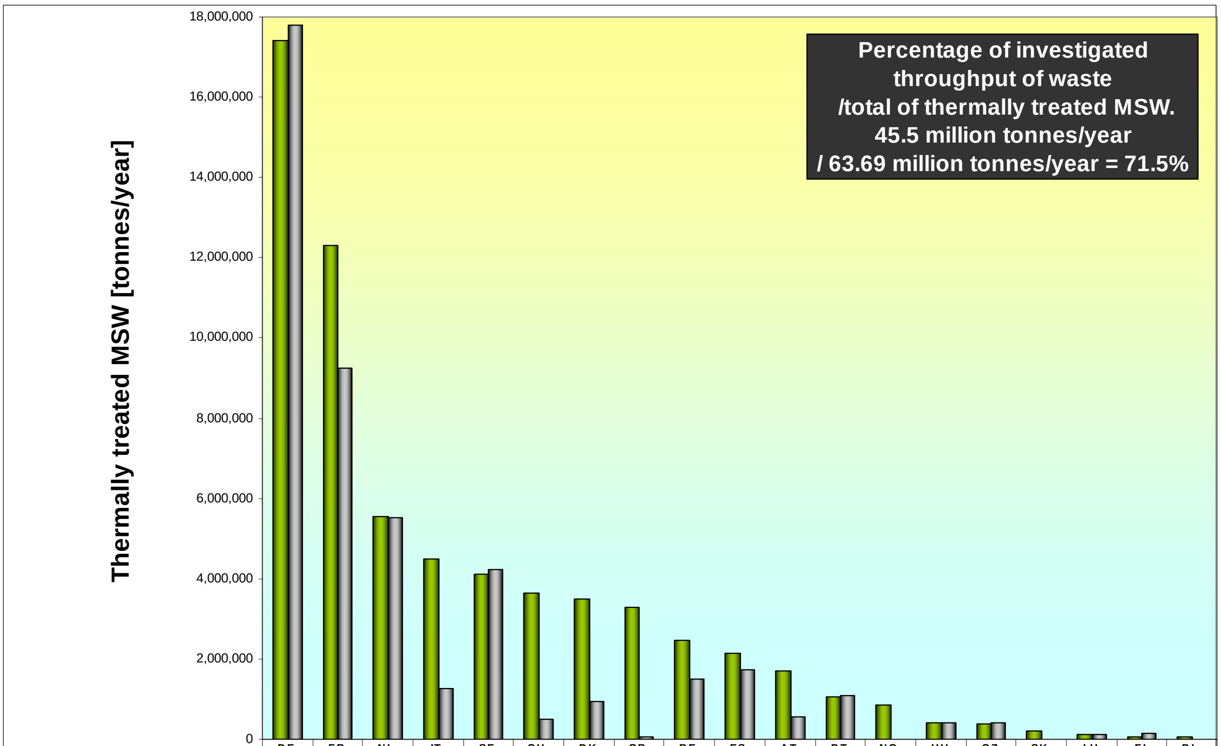
In this case, the import of the total electricity to treat the waste plays an important negative role. WtE plants "CHP" producing reach the highest R1 factor of 0.84 so that 98 plants (85.2%) out of 115 are reaching R1 ≥ 0.60.

Size (throughput) of the plant:
As expected, small sized WtE plants (< 100,000 t/a) have the lowest R1 factor of 0.68 on average, so that only 50 plants (54.3%) out of 92 are reaching R1 ≥ 0.60. Medium size WtE plants (100,000-250,000 t/a) are better with the R1 factor of 0.77 on average, so that 60 (77.9%) out of 77 plants are reaching R1 ≥ 0.60. Large sized WtE plants (> 250,000 t/a) are achieving the highest R1 factor of 0.85 on average so that 59 plants (95.2%) out of 62 are reaching R1 ≥ 0.60

Plant location (with respect to the European geographical region):
As expected, plants in South-West Europe achieve the lowest R1 factor of 0.61 on average, so that only 24 plants (40.7%) out of 59 are reaching R1 ≥ 0.60. Plants in Central Europe reach a higher R1 factor of 0.74 on average, so that 114 plants (80.9%) out of 141 are reaching R1 ≥ 0.60. Plants in Northern Europe have by far the highest R1 factor of 1.10 on average, so that all of the 31 plants (100%) are reaching R1 ≥ 0.60.

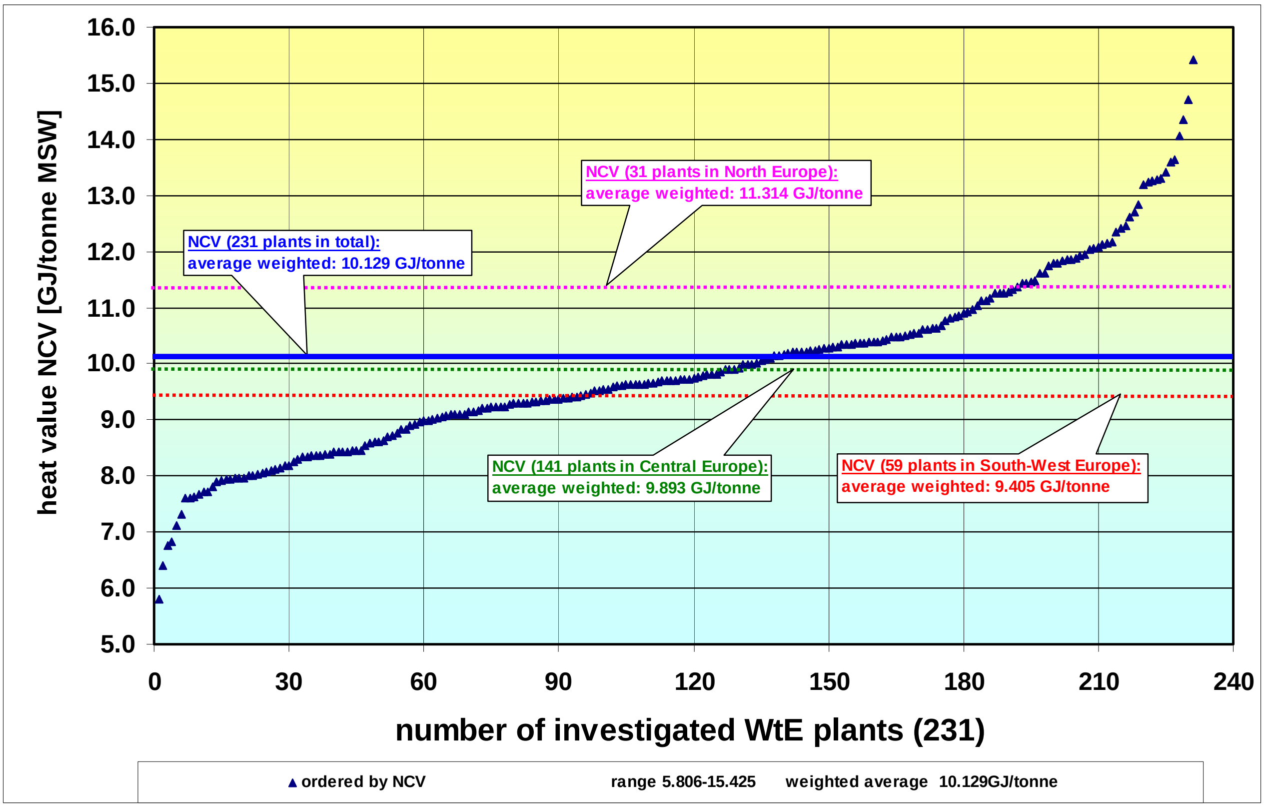
These results corroborate the statements of the BREF Waste Incineration.



	DE	FR	NL	IT	SE	CH	DK	GB	BE	ES	AT	PT	NO	HU	CZ	SK	LU	FI	PL
Total MSW incinerated in 2006	17,403,8	12,300,0	5,541,79	4,500,0	4,099,8	3,640,2	3,489,0	3,284,0	2,462,61	2,136,27	1,700,00	1,067,95	849,755	405,317	392,878	194,010	125,000	49,000	48,500
MSW in CEWEP Report 2004-2007	17,804,9	9,254,4	5,527,5	1,254,82	4,220,0	510,447	935,466	46,087	1,505,91	1,725,65	561,272	1,079,90	0	405,317	412,752	0	123,650	150,000	0

Thermally treated municipal solid waste (MSW) in Waste-to-Energy (WtE) plants as total in 2006 compared with the throughput of the 231 investigated WtE plants included in the CEWEP Energy Report II (status 2004-2007)

Net Calorific Value (NCV) calculated by using the BREF Waste Incineration NCV-formula



Specific production and import of electricity and heat for all 231 WtE plants classified according to the type of energy recovery, the size (throughput) and the geographical location as weighted averages in MWh abs/t and percentages (%) of total energy input

Energy produced and used (Ep) and imported energy (Ef + Ei) as heat and electricity according to all and to different classifications	unit	all investi-gated WtE plants	type of energy recovery of a plant (weighted averages)			size (throughput) of a plant (weighted averages)			geographical European region of a plant (weighted averages)		
			only electricity production	only heat production	CHP production	< 100,000 tonnes/year	100,000 to 250,000 tonnes/year	> 250,000 tonnes/year	South-West Europe	Central Europe	North Europe
number of plants included	n	231	75	41	115	92	77	62	59	141	31
total throughput of plants	million t/year	45.52	12.72	4.57	28.23	5.34	12.77	27.41	8.08	32.13	5.31
Total specific energy input (incl. import) as weighted averages	MWh abs. / t	2.876	2.664	3.056	2.922	2.845	2.810	2.886	2.670	2.805	3.483
Specific electricity produced (Ep) as weighted averages	MWh abs. / t	0.413	0.551	0.000	0.416	0.305	0.386	0.445	0.441	0.418	0.334
	% of total specific energy input	*14.4*	*20.7*	*0.0*	*14.2*	*10.7*	*13.7*	*15.4*	*16.5*	*14.9*	*9.6*
Specific heat produced and used (Ep) as weighted averages	MWh abs. / t	1.202	0.400	2.486	1.341	1.098	1.059	1.273	0.582	1.067	2.889
	% of total specific energy input	*41.8*	*15.0*	*81.3*	*45.9*	*38.6*	*37.7*	*44.1*	*21.8*	*38.0*	*82.9*
Specific energy imported (Ef+Ei) as weighted averages	MWh abs. / t	0.062	0.040	0.141	0.055	0.076	0.056	0.053	0.058	0.066	0.048
	% of total specific energy input	*2.2*	*1.5*	*4.6*	*1.9*	*2.7*	*2.0*	*1.8*	*2.2*	*2.4*	*1.4*

R1 efficiency factors for all 231 WtE plants and plants classified according to the type of energy recovery, the size (throughput) and the geographical location as min., non weighted averages and max. values with the number of plants reaching/not reaching R1 = 0.60

R1 depending on different classifications	unit	all investi-gated WtE plants	type of energy recovery of a plant (weighted averages)			size (throughput) of a plant (weighted averages)			geographical European region of a plant (weighted averages)		
			only electricity production	only heat production	CHP production	< 100,000 tonnes/year	100,000 to 250,000 tonnes/year	> 250,000 tonnes/year	South-West Europe	Central Europe	North Europe
number of plants included	n	**231**	75	41	115	92	77	62	59	141	31
total throughput of plants	million t/a	**45.52**	12.72	4.57	28.23	5.34	12.77	27.41	8.08	32.13	5.31
R1 result (averages)	[-]	**0.75**	**0.64**	**0.72**	**0.84**	**0.68**	**0.77**	**0.85**	**0.61**	**0.74**	**1.10**
R1 result (min-max)	[-]	0.04-1.41	0.12-0.98	0.04-1.29	0.30-1.41	0.04-1.20	0.12-1.41	0.47-1.31	0.12-1.12	0.04-1.29	0.88-1.41
number of plants: R1 at least 0.60	n *(%)*	**169 *(73.2)***	46 *(61.3)*	25 *(61.0)*	98 *(85.2)*	50 *(54.3)*	60 *(77.9)*	59 *(95.2)*	24 *(40.7)*	114 *(80.9)*	31 *(100)*
number of plants: R1 under 0.60	n *(%)*	**62 *(26.8)***	29 *(38.7)*	16 *(39.0)*	17 *(14.8)*	42 *(45.7)*	17 *(22.1)*	3 *(4.8)*	35 *(59.3)*	27 *(19.1)*	0 *(0)*

R1 calculation in accordance to the Directive 2008/98/EC (WFD), Annex II, with equivalence factors: for electricity produced and imported 1 MWh el = 2.6 MWhel equ; for heat produced and commercially used 1 MWh th = 1.1 MWhthe equ and according to BREF WI for imported fuel 1 MWh fuel = 1.0 MW fuel equ. The heat used by the plant to treat the waste includes all uses of steam, particularly steam to the deaerator and to the air heater.

Due to the equivalence factors, the influence of produced electricity is increased in comparison to the table above.

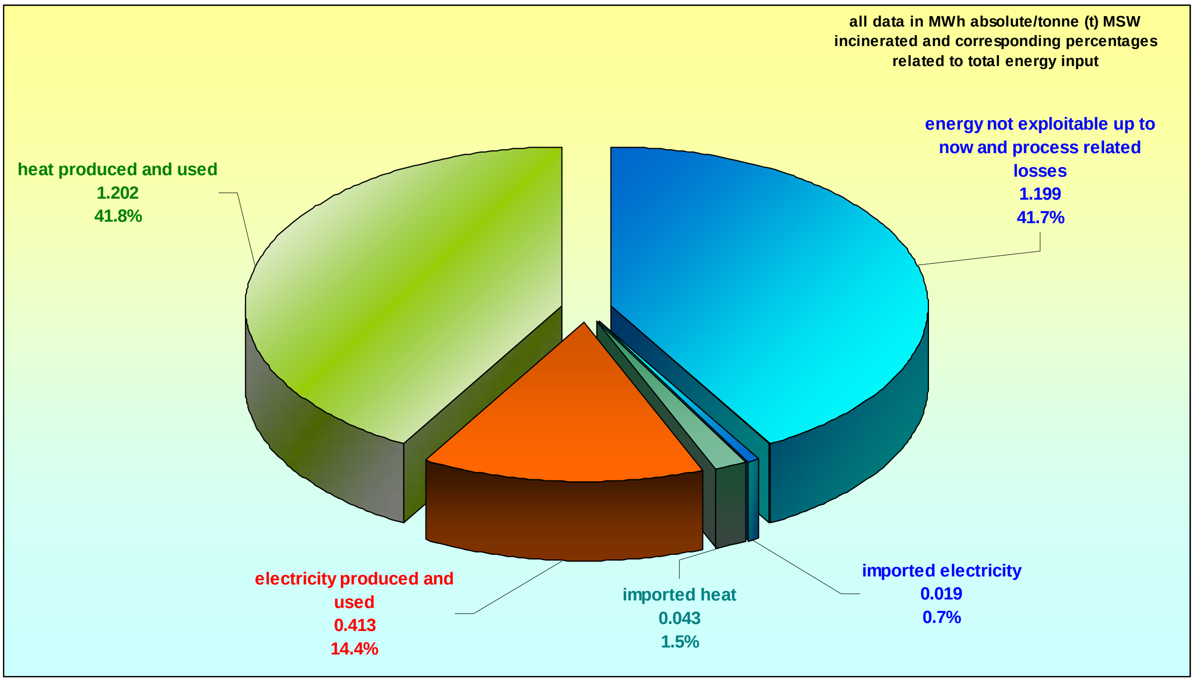
It is evident that for small sized plants, only producing electricity and located in South-West Europe with R1 averages between 0.61-0.68 it is very difficult to reach R1=0.60.

Middle sized plants in Middle Europe producing heat respectively CHP have a better basis to reach R1=0.60 with R1 averages between 0.72-0.77(0.84).

Highest R1 factors >> 0.60 are reachable in large sized plants in North Europe which are CHP producing with R1 averages between 0.84-1.10.

In conclusion, the results of the investigation clearly show strong correlations between the values of R1 and the type of energy recovery, the size of the plant and the geographical location respectively.

Optimisation possibilities to increase the energy utilisation and efficiency in the future



To reduce the amount of energy that is currently not exploitable (41.7%) it is necessary to improve the access to the grid as well as the infrastructure in order to increase the utilisation of steam, district heating or district cooling, as this is by far the most effective means.

However, this is not possible everywhere since it depends essentially on the presence of customers for heat, and the length of the heat (cooling) demand period (climate zone) as well as the local energy market conditions (prices).

It is recommended that the authorities involved in decision making on the location of new WtE plants take a proactive approach in searching for sites which have the possibility to supply a large proportion of the energy from WtE in the form of heat, i.e. either in the form of steam to adjacent industry or in the form of heat for district heating & cooling networks

CEWEP, March 2009