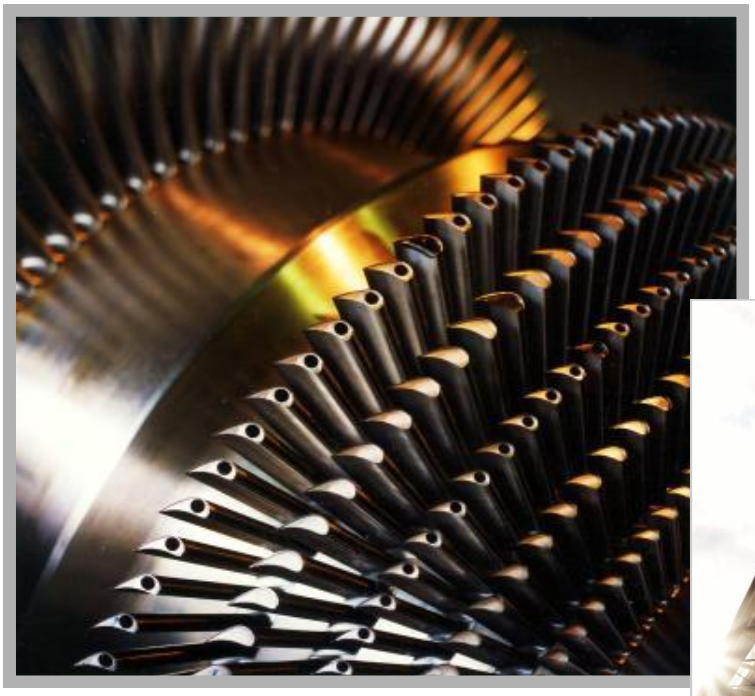
CEWEP Energy Report III

(Status 2007-2010)

Results of Specific Data for Energy,
R1 Plant Efficiency Factor and NCV of
314 European Waste-to-Energy (WtE) Plants

Executive Summary



$$R1 = \frac{Ep - (Ef + Ei)}{0.97 * (Ew + Ef)}$$

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Executive summary

As a continuation of the work started by CEWEP into the energy efficiency of European Waste-to-Energy (WtE) plants: CEWEP Energy Report I (97 WtE plants (2001-2004)), CEWEP Energy Report II (231 WtE plants (2004-2007)), CEWEP now publishes the CEWEP Energy Report III (314 WtE plants (2007-2010)), abbreviated to Report in the following text.

Energy data from 314 European WtE plants operated by CEWEP members from 17 European countries (15 EU countries +CH+NO) has been collected and used for this Report.

The Municipal Solid Waste (MSW) incinerated by the plants investigated amounts to 59.4 million (mio) Mg/a in 15 Member States of EU 27 +CH+NO = 17 European States and represents a share of 85.5% of the total incinerated MSW of 20 European countries in EU 27 +CH+NO in 2009.

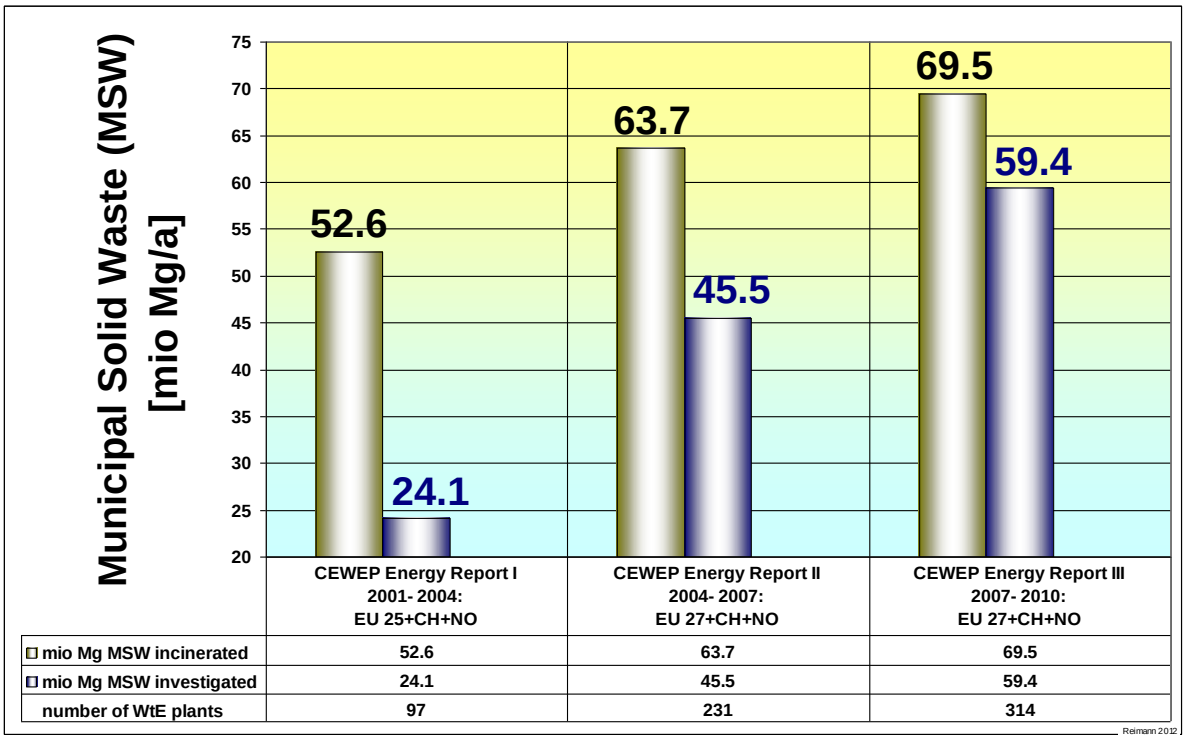

Figure 1: Growth of total and investigated amount of incinerated MSW in Europe and investigated in the CEWEP Energy Reports I, II and III (Status 2001 - 2010)

The increase in the amount of incinerated MSW from 52.6 to 63.7 mio Mg/a is 21% in about a 4 year period (equivalent to 5.3%/a), is due to the implementation of the EU Landfill Directive (1999/31/EC) [1] and the Council Decision on Waste Acceptance Criteria (2003/33/EC) [2].

In the next 4 year period (2007-2010) the amount of waste incinerated grew to 69.5 mio Mg/a (9.1%), representing a growth of 2.3%/a.

The main objective of this Report was to calculate the key figures 'Ep' annual energy produced as heat or electricity, 'Ew' annual energy contained in the treated waste, 'Ef' annual energy input to the system from fuels contributing to the production of steam and 'Ei' annual energy imported excluding Ew and Ef, which forms the R1 efficiency factor according to the formula given in Annex II of the Waste Framework Directive (WFD) (Directive 2008/98/EC) [3] for the 314 installations and to determine if they are Recovery (R1) or Disposal operations (D10).

The criterion given in the WFD Directive has to be proven using the R1 energy efficiency factor (R1 factor), which for existing plants has to be R1 $\geq$ 0.60 and for plants permitted after 31/12/2008 R1 $\geq$ 0.65.

Another objective of this Report was to check the possible effects of the main parameters of energy efficiency performance in the R1 formula, with a view to gathering information for the determination

of a possible climate factor, as an additional condition for the R1 criterion, which is currently being discussed by the European Commission.

The calculations in this Report were made assuming the same hypothesis as made in the CEWEP Energy Report I [4], which was used as a reference when the Commission set the thresholds for the R1 formula in the proposal for the WFD.

In the CEWEP Energy Report II [5] the individual and also the mean values for R1 for all 231 investigated WtE plants were higher compared to the current Report, because for the period 2004-2007 the amount of energy for heating up circulated boiler water and combustion air taken into consideration was larger, calculated according to the draft R1 Guidelines document which was available at that time. This Report was made using the stricter interpretation set out in the final version of the R1 Guidelines [6].

Better R1 results have been achieved in comparison with Report II (231 WtE plants), even though more plants from South-Western and Central Europe, often smaller and with less opportunity to export heat, are included in this Report (314 WtE plants). This is due to the optimization efforts made in the plants that participated in Report II.

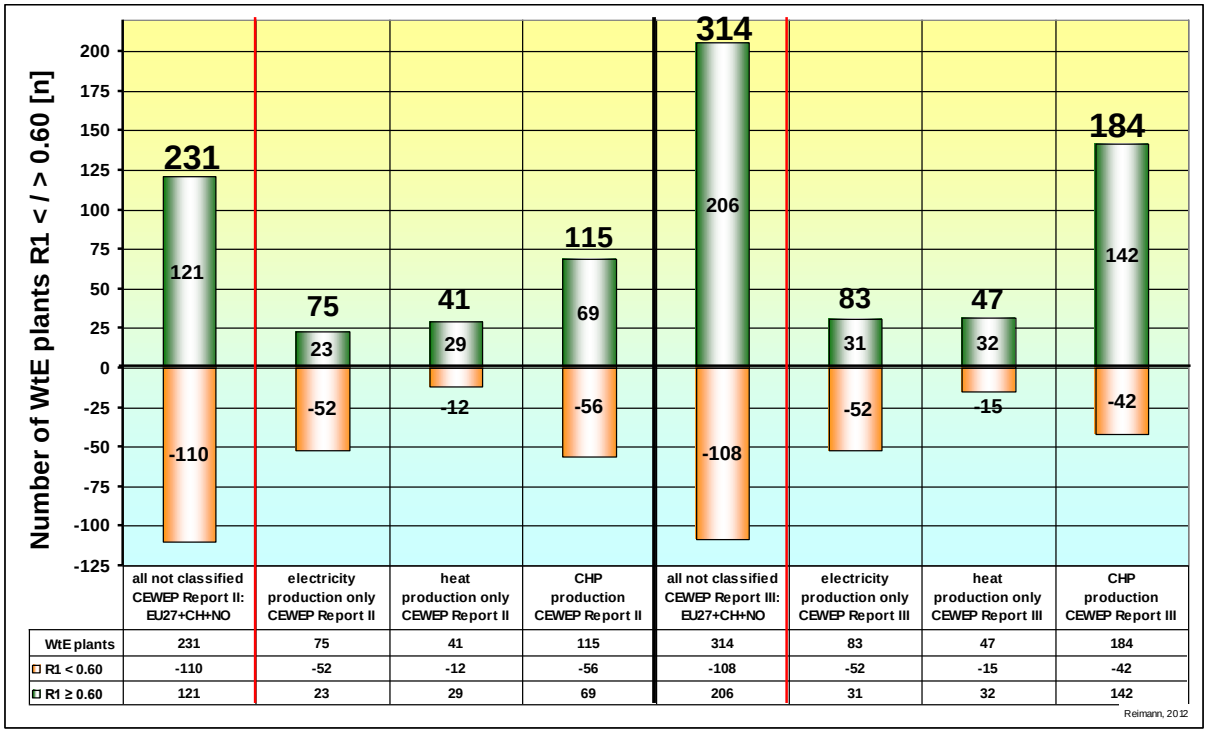

Figure 2: Comparison of R1 factors of investigated European WtE plants divided into all, electricity only, heat only and Combined Heat and Power (CHP) production in the CEWEP Energy Reports II and III

For all the 314 investigated European WtE plants, the R1 factor is on average R1 = 0.69 (min 0.21 and max 1.37). The R1 factor ≥0.60, which is the criterion established for existing plants in the WFD to obtain recovery status, is met by 206 WtE plants (65.6%) out of the total 314 investigated.

The results of this investigation clearly show strong correlations between the values of R1 and the parameters: type of energy recovery, size of the plant and European geographical location, respectively.

Type of energy recovery:
WtE plants "producing electricity only" have the lowest R1 factor of 0.55, as a non-weighted average, so that only 31 (37.3%) out of 83 plants reach R1 ≥ 0.60.
Although WtE plants "producing heat only" have a higher R1 factor of 0.64, as a non-weighted average, only 32 (68.1%) out of 47 plants reach R1 ≥ 0.60. In this case, the import of the total amount of electricity to treat the waste has a negative influence.

WtE plants "CHP producing" achieve the highest R1 factor of 0.76, as a non-weighted average, so that 142 (77.2%) out of 184 plants reach R1 ≥ 0.60.

Size (throughput) of the plant:
Small sized WtE plants (< 100,000 Mg/a) have the lowest R1 factor of 0.63, as a non-weighted average, so that only 59 (50.0%) out of 118 plants reach R1 ≥ 0.60.

Medium sized WtE plants (100,000 – 250,000 Mg/a) have a higher R1 factor of 0.70, as a non-weighted average, so that 85 (68.5%) out of 124 plants reach R1 ≥ 0.60..

Large sized WtE plants (> 250,000 Mg/a) achieve the highest R1 factor of 0.77 as a non-weighted average so that 62 (86.1%) out of 72 plants reach R1 ≥ 0.60.

Plant location (in European geographical regions):
Plants in South-Western Europe have the lowest R1 factor of 0.58, as a non-weighted average, so that only 27 (49.1%) out of 55 plants reach R1 ≥ 0.60.

Plants in Central Europe have a higher R1 factor of 0.62, as a non-weighted average, so that 110 (58.5%) out of 188 plants reach R1 ≥ 0.60.

Plants in Northern Europe have the highest R1 factor of 0.97, as non-weighted average, so that 69 (97.2%) out of 71 plants reach R1 ≥ 0.60.

The results can be summarized, based on the mean R1 results, as follows:

- **Very low results in general with R1 < 0.60 are found in small sized plants (throughput < 100,000Mg/a), located in South-Western Europe producing electricity only;**

  For plants producing electricity only it is very difficult to meet R1 as only 37.3% meet R1 ≥ 0.60;
- **The highest R1 results are related to large sized plants (throughput >250,000Mg/a), located in Northern Europe with CHP production;**
- **In the Energy Report II, 52% of all investigated WtE plants met R1 ≥ 0.60, whereas in this Report, although the assessment criteria are more stringent according to the final version of the R1 Guidelines, 65.6% of the WtE plants now meet R1 ≥ 0.60 primarily due to the optimization carried out by the plants that participated in the Energy Report II.**

The amount of MSW being recovered in the 206 investigated European WtE plants reaching R1 ≥ 0.60 is 46.39 mio Mg MSW/a equivalent to 78.1% of the corresponding 59.4 mio Mg MSW investigated from this Report.

The R1 factors calculated for individual plants as basis for the weighted averages and mean values in this Report may contain differences due to the NCV calculation and the self used heat of the plants (Ew and Ep). For these data the CEWEP calculations are based on the general formula, but also on assumptions (average approach, ratios) and not on specific measurements in the particular plant. Therefore the results in this Report do not replace individual calculations made by the operators when applying for R1 certification.

The R1 energy efficiency results do not include the R1 "climate factor" (R1cl), which is currently discussed at the EU level. If a R1cl factor would be adopted, it would increase the R1 level for the plants in South-Western Europe and some plants in Central Europe, but its ultimate influence cannot yet be predicted.

The results found in this Report are in correlation to the data in the BREF Waste Incineration [7].