

8<sup>th</sup> Beacon Conference

## Waste-to-Energy

▶ State of the Art and latest News  
27-28 November 2013 in Malmoe, Sweden



# CEWEP Energy Efficiency Report III

## Overview on main Results

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## Main legal specifications and rules:

- **Waste Framework Directive 2008/98/EC (WFD)**
- **Reference Document on the Best Available Technique (August 2006) (BREF WI) for Waste Incineration**
- **EU Guidelines on the Interpretation of the R1 Energy Efficiency Formula ....(June 2011) (EU-R1 Guidelines)**
- **FDBR Guideline Edition 04/2000 for Acceptance Testing of Waste Incineration Plants with Grate Firing System**
- **Guideline VDI 3460, Part 2, Energy conversion in thermal solid waste treatment (2007)**





## **Data collection:**

**Annual CEWEP Questionnaires on Energy related measured data filled in by the responsible persons of WtE plants which attended to this Report**

**CEWEP Checklist based on the description of processing by yes /no answers filled in by the responsible persons of the WtE plants which attended to this Report**

**The received measured data of and information about the plants and their processing have been the basis for the determination of all energy specifications, NCVs and R1 energy efficiency factors**



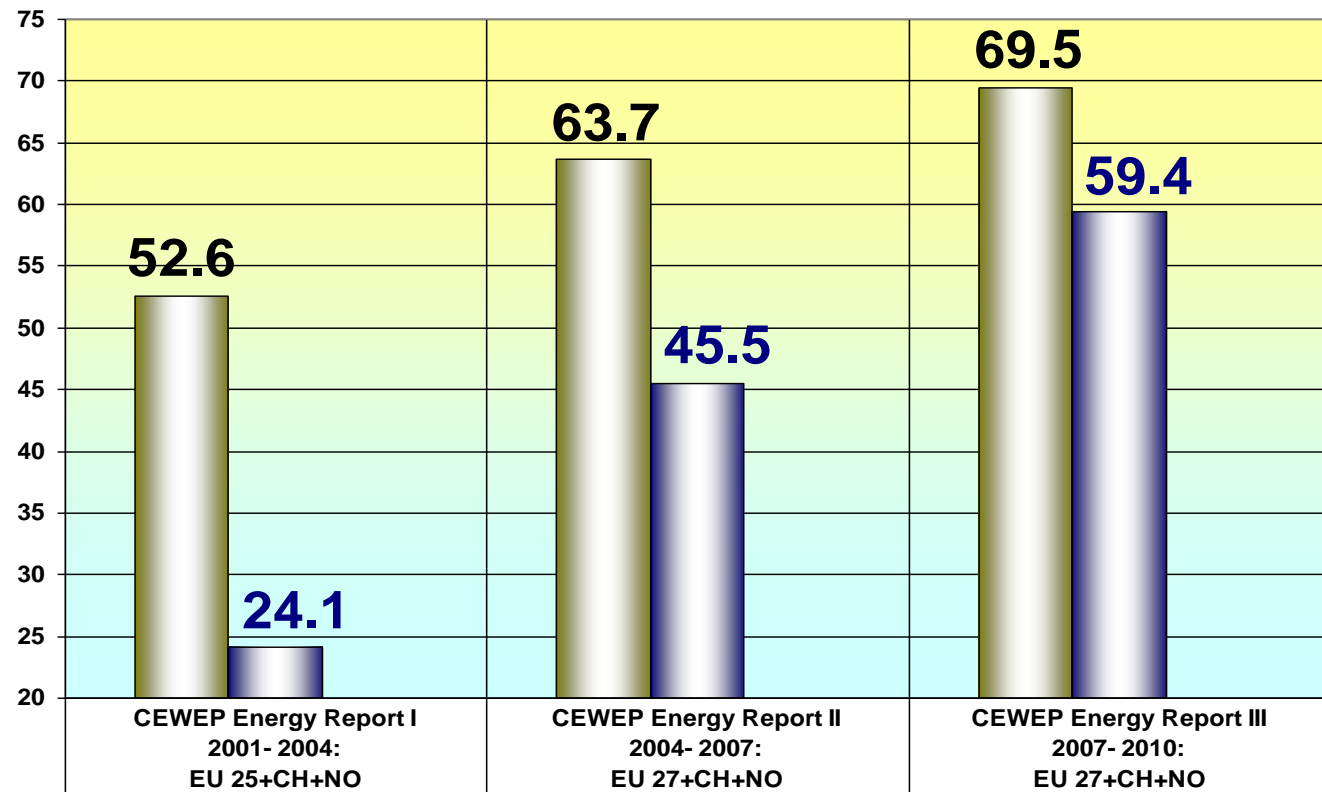
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## Growth of MSW incineration:

Municipal Solid Waste (MSW)  
[mio Mg/a]



□ mio Mg MSW incinerated	52.6	63.7	69.5
□ mio Mg MSW investigated	24.1	45.5	59.4
number of WtE plants	97	231	314

### **Analysis of growth of MSW quantity:**

**Increase of the amount of incinerated MSW from 52.6 to 63.7 mio Mg/a = 21% in about 4 years, equivalent to 5,3%/a and further on to 69.6 mio Mg/a = 11% in the following 4 years equivalent to 2.8%/a**

**The main reason for the increase during the first time period is due to the implementation of the EU Landfill Directive (1999/31/EC) and the Council Decision on Waste Acceptance Criteria (2003/33/EC)**

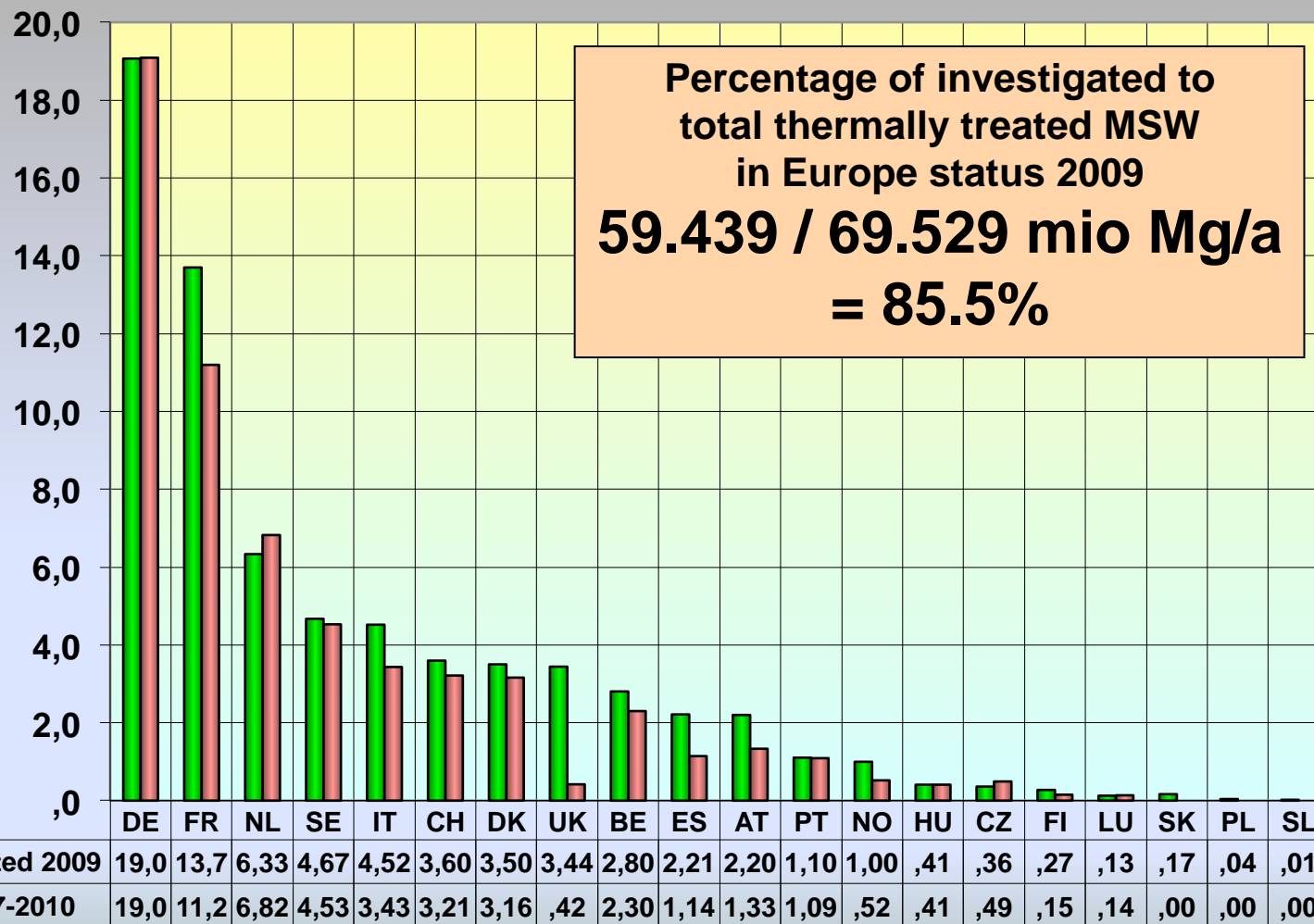


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**Waste-to-Energy**



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**Thermally treated MSW  
 [mio Mg/a]**

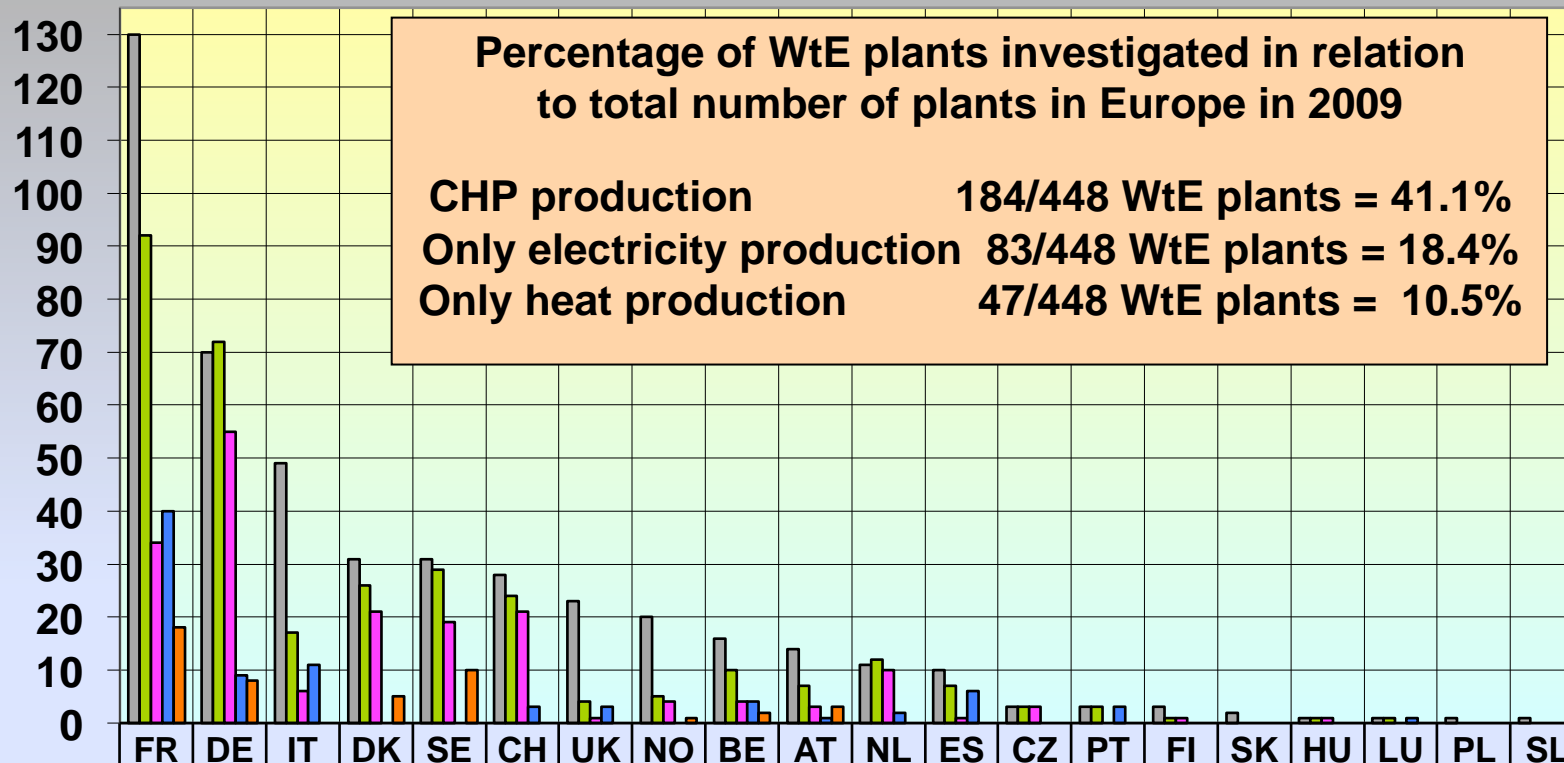


Percentage of investigated to total thermally treated MSW in Europe status 2009  
**59.439 / 69.529 mio Mg/a = 85.5%**

**European Countries incinerating MSW**



Number of WtE plants [n]



	FR	DE	IT	DK	SE	CH	UK	NO	BE	AT	NL	ES	CZ	PT	FI	SK	HU	LU	PL	SL
■ Total n in 2009	130	70	49	31	31	28	23	20	16	14	11	10	3	3	3	2	1	1	1	1
■ Investigated 07-10	92	72	17	26	29	24	4	5	10	7	12	7	3	3	1	0	1	1	0	0
■ CHP	34	55	6	21	19	21	1	4	4	3	10	1	3	0	1	0	1	0	0	0
■ Only electricity	40	9	11	0	0	3	3	0	4	1	2	6	0	3	0	0	0	1	0	0
■ Only Heat	18	8	0	5	10	0	0	1	2	3	0	0	0	0	0	0	0	0	0	0

Country specific number of plants producing CHP, el, heat



### **NCV determination:**

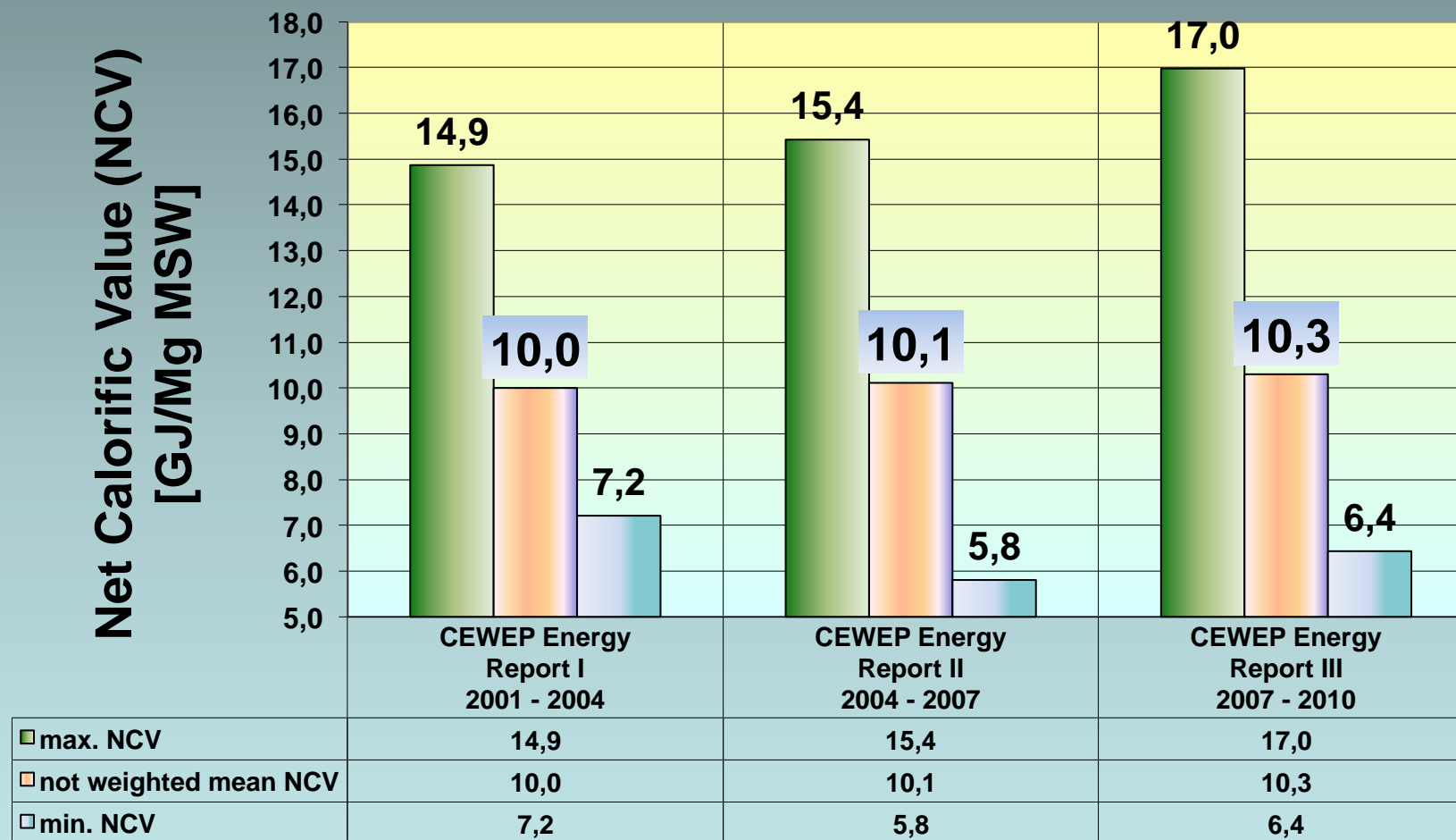
**The NCV was determined on initial energy balances as mentioned in the EU R1 Guidelines (2011) in combination with the NCV formula related to BREF WI (2005) Chapter 2.4.2.1. and FDBR Guideline (2000)**

**By this procedure not only measured data (e.g. steam quantity) as filled in by the operators in the annual CEWEP Energy Questionnaires have been taken into account. Also the influence of not or double counted energy flows on the NCV was implicated in correlation to the listed installations filled in by the operators in the CEWEP Checklist.**





## NCV results compared between CEWEP I, II, III:



## **NCV results related to classification:**

**The mean value of NCV has remained quite stable over the time period of about 8 years and has increased only a bit from 10.0 to 10.3 GJ/Mg MSW.**

**Quite interesting is the increase of the range between min and max NCV from 7.7 (Report I) to 10.6 GJ/Mg (Report III) (possible reasons can be inter alia pre-treatment of MSW, separate collection, different political requirements)**

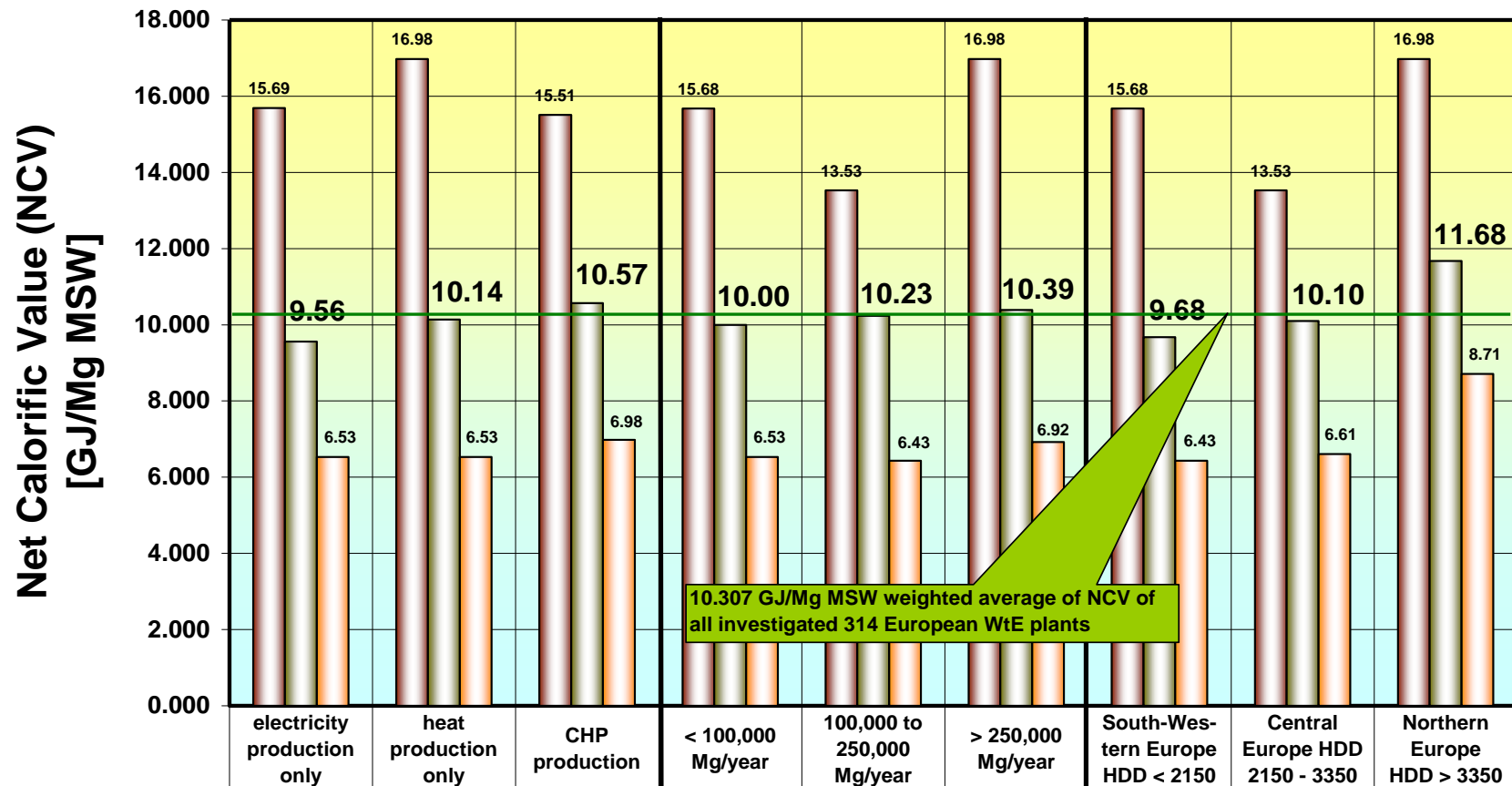


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## NCV results related to classification:



	electricity production only	heat production only	CHP production	< 100,000 Mg/year	100,000 to 250,000 Mg/year	> 250,000 Mg/year	South-Western Europe HDD < 2150	Central Europe HDD 2150 - 3350	Northern Europe HDD > 3350
□ R1 max [-]	15.690	16.980	15.510	15.680	13.530	16.980	15.680	13.530	16.980
□ R1 weight. average [-]	9.557	10.141	10.570	9.998	10.233	10.387	9.675	10.098	11.679
□ R1 min [-]	6.530	6.530	6.980	6.530	6.430	6.920	6.430	6.610	8.710

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specific heat and electricity produced and used depending on different classifications	unit	all investigated WtE plants	type of energy recovery of a plant		
			electricity production only	heat production only	CHP production
number of plants included	n	314	83	47	184
total throughput of plants	mio Mg/a	59.44	12.98	5.67	40.78
Total specific energy input (incl. import) as weighted averages	MWh input total abs. / Mg MSW	2.894	2.690	2.980	2.965
Specific electricity exported (Ep) as weighted averages	MWhel abs. /Mg MSW	0.336	0.476	0.000	0.338
	min / max MWhel abs. /Mg MSW	0.0 - 0.899	0.075 - 0.873	0.0	0.007 - 0.899
	% of MWhth input	11.61	17.70	0.00	11.40
Specific electricity self used (Ep) <sup>1)</sup> as weighted averages	MWhel abs. /Mg MSW	0.095	0.105	0.000	0.106
	min / max MWhel abs. /Mg MSW	0.0 - 0.286	0.0 - 0.251	0.0	0.0 - 0.286
	% of MWhth input	3.28	3.90	0.00	3.58
Specific electricity produced (Ep) as weighted averages	MWhel abs. /Mg MSW	0.431	0.581	0.000	0.444
	% of MWhth input	14.90	21.6	0.0	15.0
Specific heat exported (Ep) as weighted averages	MWhth abs. /Mg MSW	0.849	0.000	2.154	0.938
	min / max MWhth abs. /Mg MSW	0.0 - 3.333	0.0	0.520 - 3.333	0.004 - 3.267
	% of MWhth input	29.34	0.00	72.28	31.64
Specific heat self used (Ep) <sup>1)</sup> as weighted averages	MWhth abs. /Mg MSW	0.152	0.122	0.146	0.163
	min / max MWhth abs. /Mg MSW	0.014 - 0.389	0.014 - 0.389	0.014 - 0.350	0.020 - 0.387
	% of MWhth input	5.25	4.54	4.90	5.50
Specific heat produced (Ep) as weighted averages	MWhth abs. /Mg MSW	1.001	0.122	2.300	1.101
	% of MWhth input	34.59	4.54	77.18	37.13
Σ Specific heat and el produced (Ep) as weighted averages	MWhth+el abs. /Mg MSW	1.432	0.703	2.300	1.545
	% of MWhth input	49.5	26.1	77.2	52.1

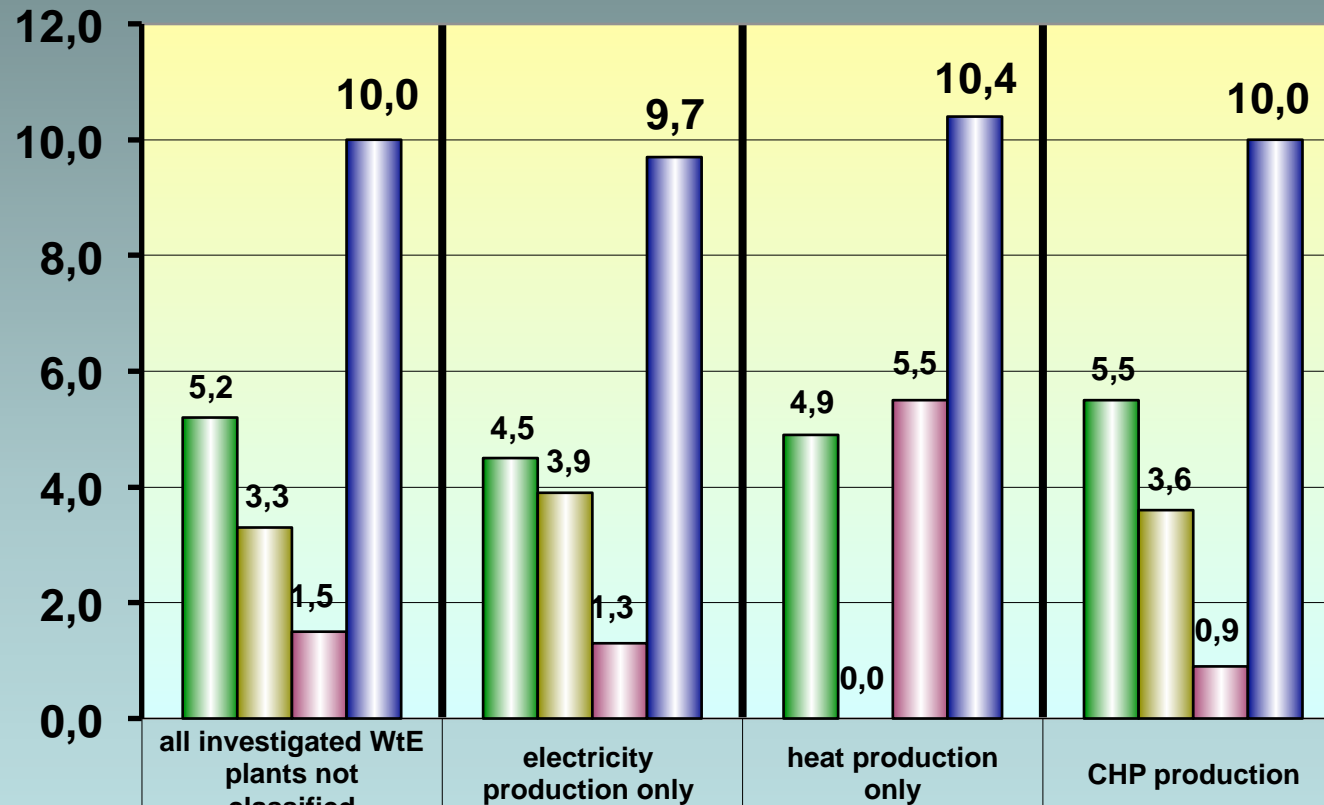


<sup>1)</sup> amount of self used electricity and heat based on the EU Guidelines on the R1 energy efficiency formula in Annex II of Directive 2008/98/EC (June 2011) - not legally binding



## Rates of process specific energy demand:

Energy demand /energy input  
incl. imported in absolute [%]



□ MWhth Ep/MWh input	5,2	4,5	4,9	5,5
□ MWhel Ep/MWh input	3,3	3,9	0,0	3,6
□ MWh (Ef+Ei(th+el))/MWh input	1,5	1,3	5,5	0,9
□ MWh (Ep+Ef+Eiall)/MWh input	10,0	9,7	10,4	10,0

## Process relevant energy demand:

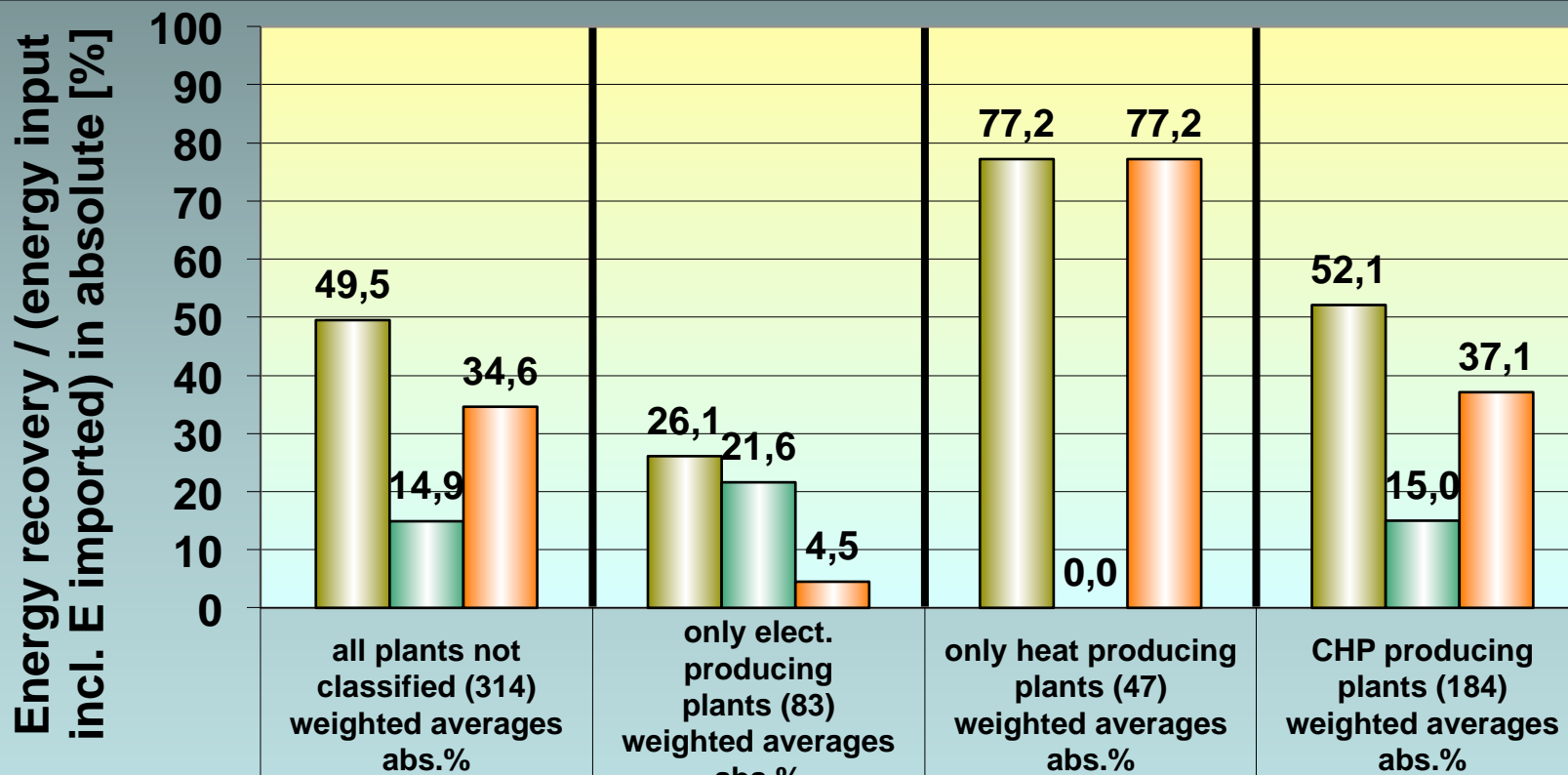
The absolute specific demand of electricity is in the range of 0.092 and 0.286 with an average of 0.097 MWh e/Mg MSW (about 3.5% from input), whereas for only heat producing WtE plants the electricity got to be imported

The absolute specific demand of heat shows a very wide range between 0.014 and 0.389 with a weighted average of 0.158 MWh th/Mg MSW (about 5.5% from input), depending on the kind of used technology as well as the temperature flow in the flue gas cleaning system





## Rates of specific energy recovery:

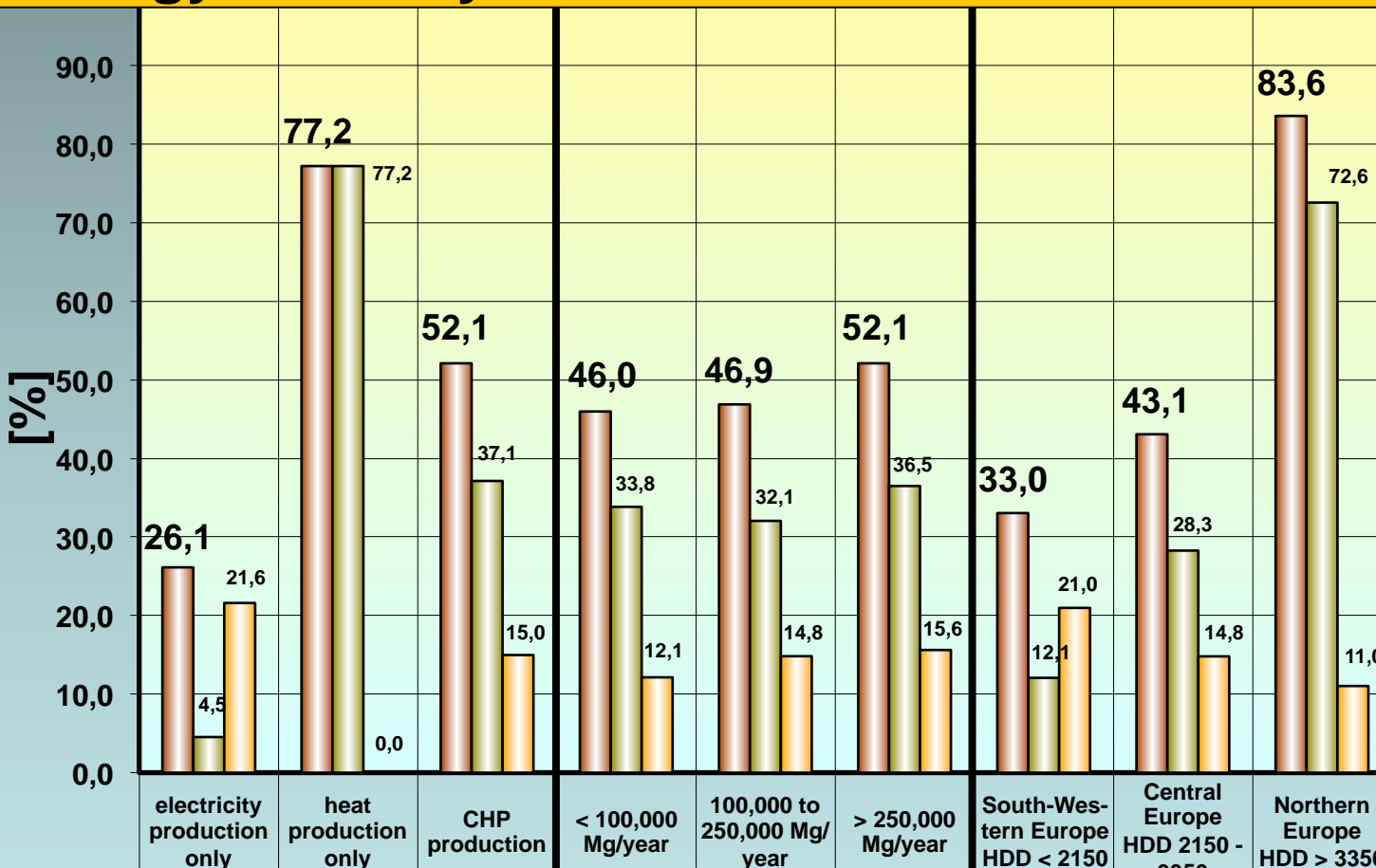


■ MWhth+el prod/MWh input	49,5	26,1	77,2	52,1
■ MWhel prod/MWh input	14,9	21,6	0,0	15,0
■ MWhth prod/MWh input	34,6	4,5	77,2	37,1



## Energy recovery rates related to classification:

energy recovery/(energy input incl. imported energy) in absolute [%]



■ MWth+el prod/MWh input	26,1	77,2	52,1	46,0	46,9	52,1	33,0	43,1	83,6
■ MWth prod/MWh input	4,5	77,2	37,1	33,8	32,1	36,5	12,1	28,3	72,6
■ MWhel prod/MWh input	21,6	0,0	15,0	12,1	14,8	15,6	21,0	14,8	11,0

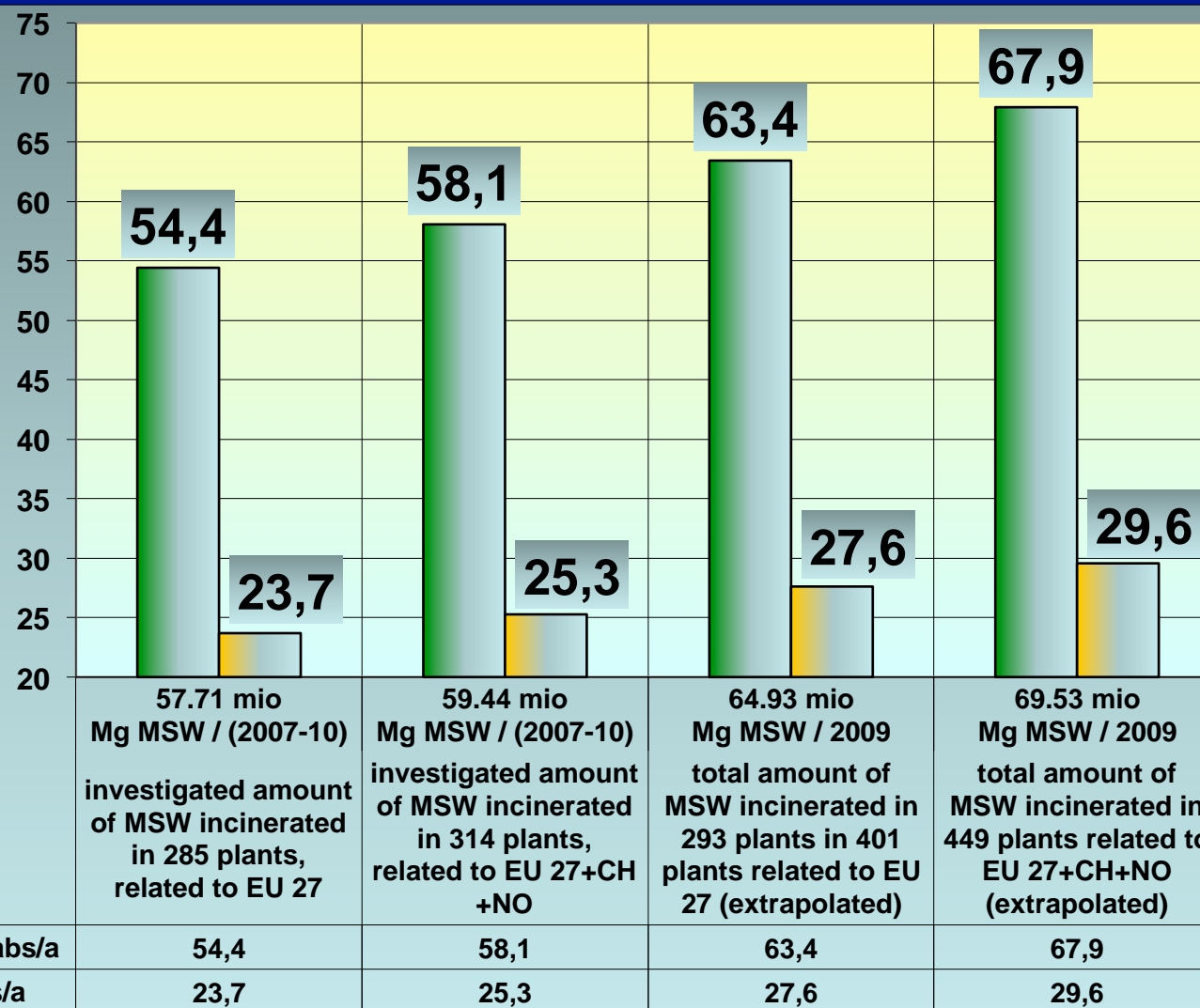


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**Produced energy net as  
 heat and electricity  
 [mio MWh/a]**

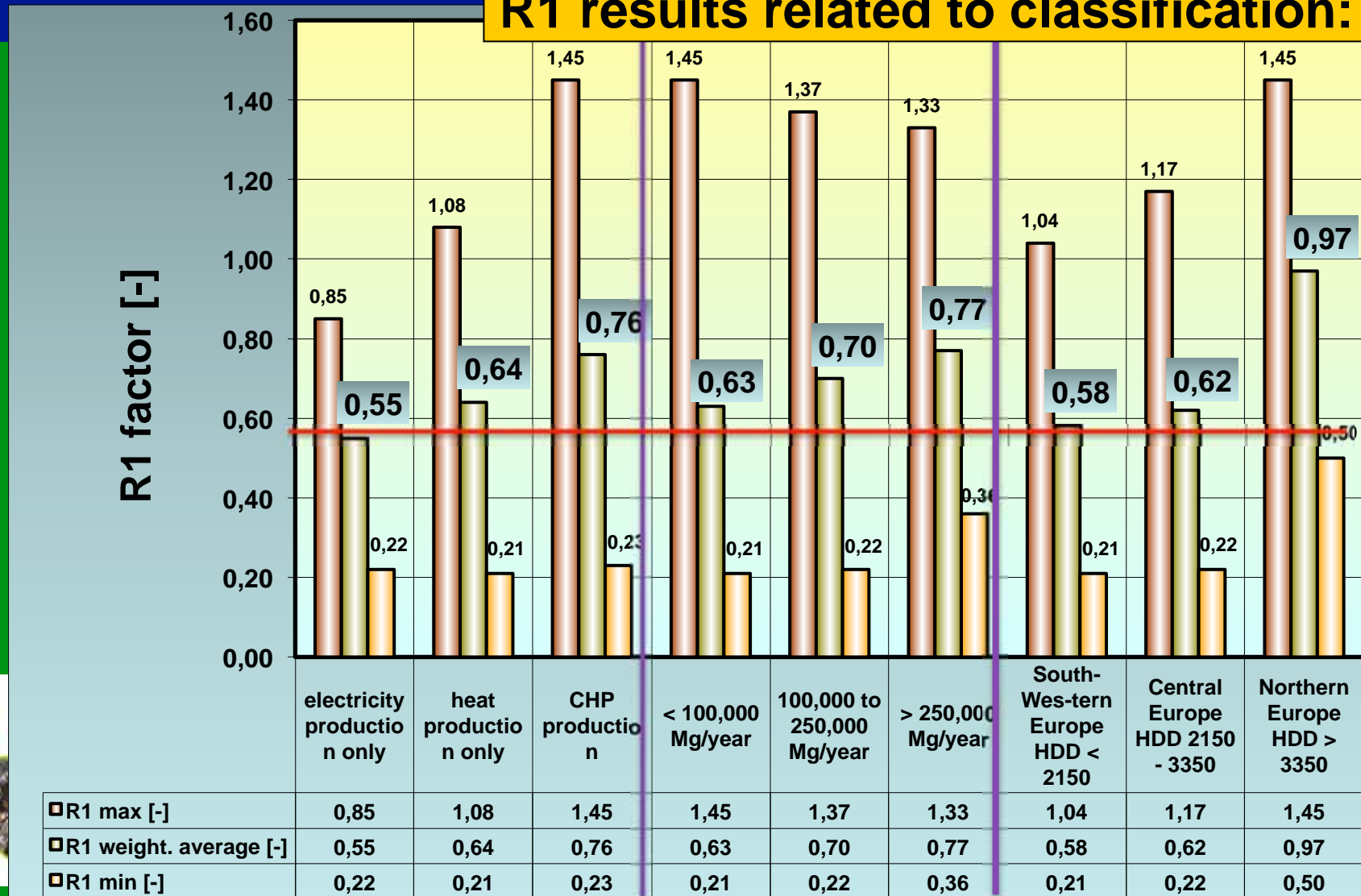


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## R1 results related to classification:

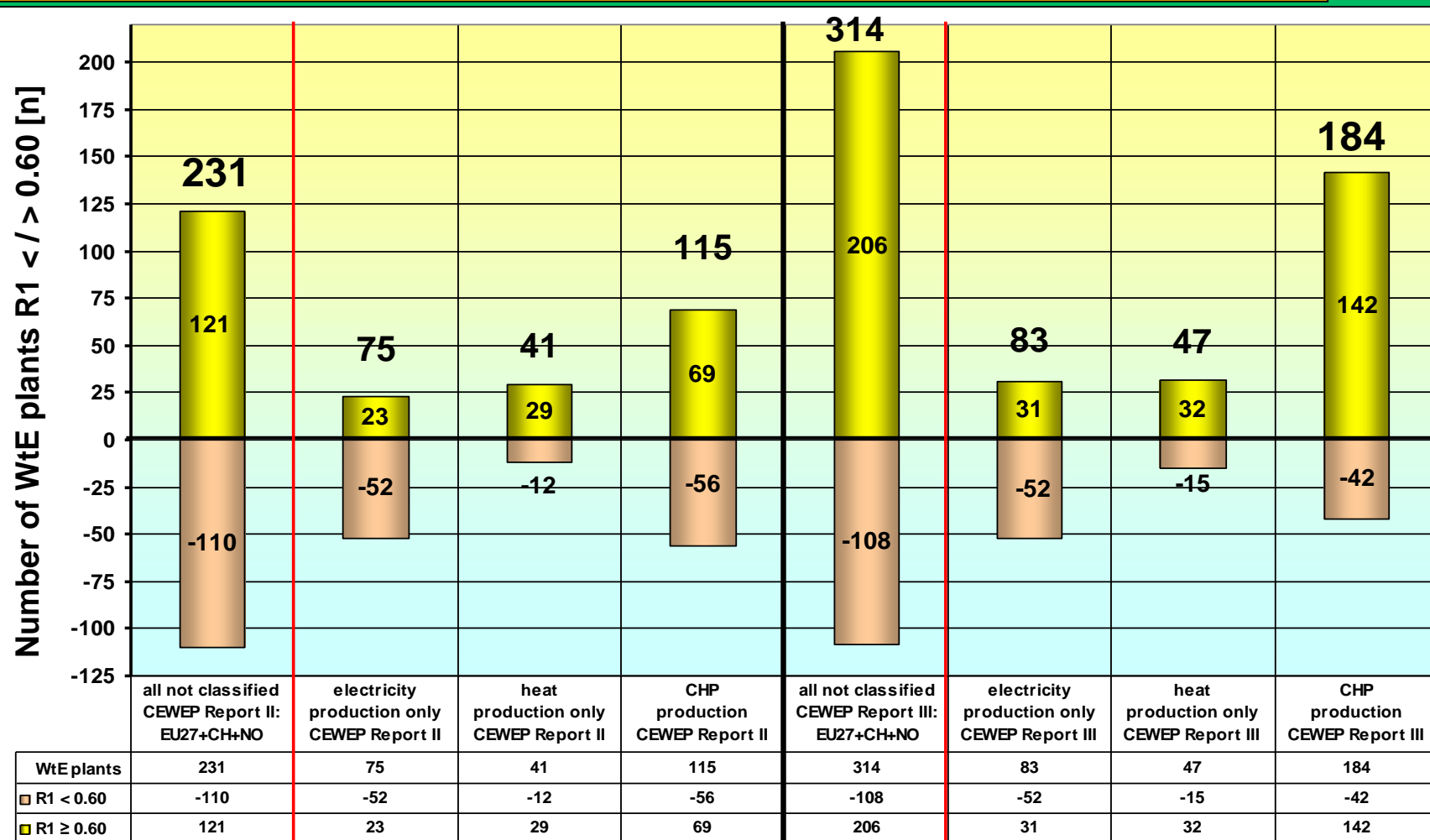


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## Change of R1 results from CEWEP Report II to III:



## **R1 results compared between CEWEP II and III:**

**The R1 efficiency factors of the investigated EU WtE plants are better in the recent Report III than in the Report II even if in this Report II a higher amount of self used heat has been considered (based on the previous Draft of the EU R1 Guidelines)**

**In the Report II 52% of all investigate EU WtE plants have met  $R1 > 0.60$ ; in Report III, based on the final, more stringent EU R1 Guidelines these are 63%,**

**Most problematic are plants only electricity producing with only 37% of the plants meeting  $R1 > 0.60$ .**





## **General appraisal of the results:**

**Most of the figures in the CEWEP Energy Report III are weighted averages based on a multitude of available information for not and classified investigated groupings under different aspects (kind of energy recovery, throughput, geographical region)**

**The mean data in the CEWEP Energy Report III are representing under these conditions not only a trend but realistic, process relevant results with high accuracy**



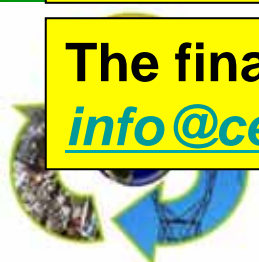


## Final remarks:

The R1 energy efficiency results do not include the so called R1 climate factor, which at this time is discussed in the EU Commission. Therefore its influence cannot be predicted.

*“R1 values calculated in the report for individual plants might contain differences due to the NCV calculation and the own heat use of the plant. For these data the CEWEP calculations are based on assumptions (average approach, ratios) and not on specific measurements in the particular plant. Therefore the report does not replace individual calculations by the operators when applying for the R1 certificate.”*

The final CEWEP Energy Report III is available under [info@cewep.eu](mailto:info@cewep.eu) or [www.cewep.eu/CEWEP Energy Efficiency...](http://www.cewep.eu/CEWEP_Energy_Efficiency...)



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**Thank you for your attention**

