Uncertainty assessment of Gross Inland Consumption of the energy balance 2006.

For assessing the cumulated overall uncertainty of the Gross Inland Consumption (GIC) five error types are taken into account. They are included hierarchically into the final equation following the sequence of their listening

1. **Statistical Differences**: They are only taken into account if supply and consumption side are of equal data quality. If one side is known or assumed as more complete eg due to higher or more complete number of respondents – normally this is the case for the supply side - no statistical difference is taken into account.

   It is always negative, because the philosophy behind AEB does not allow a statistical difference and higher reported quantities are interpreted as the more complete data-set. The "excessive" quantities are allocated iteratively to all sectors.

   In 2006 statistical differences are observed in Coal – **-931 TJ** or -0.55% - in Oil – **-1,064 TJ** or -0.17% and in Natural Gas – **-188 TJ** or -0.06% - auf.

2. **Measurement Errors**: Measurement errors include weighing errors and errors of flow meters. For the year 2006 for scales a relative accuracy of ± 1% und for flow meters of ±0.5% is assumed. The maximum errors in 2006 are for:

   Coal + 1,703 TJ / - 1,694 TJ,
   Oil + 6,085 TJ / - 6,075 TJ und
   Gas + 1,577 TJ / - 1,576 TJ

3. **Reporting errors (to a minor degree)**: This limitation is because big deviations on fuel and respondent level in time series are analysed and clarified. The potential range of reporting errors is checked by applying a Monte Carlo Analysis with the assumption that 5% of the reported quantities are deranged up to +/- 10%. The minima and maxima given in Tab. 1 are Worst-Case Scenarios out 1,000 simulation cycles. As reference survey the material and energy consumption survey is used, because this survey includes a high share of used quantities is covered by a high number of respondents. The reporting error is applied to primary fuels only that are calculated in the energy balance framework from supply data primarily. That are coal, oil and natural gas.

   For 2006 the maximum GIC interval due to potential reporting errors is +2.7% and -3,1% and gives the following picture in detail:

   Coal + 5.386 TJ / - 4.463 TJ,
   Oil + 19.246 TJ / - 16.007 TJ and
   Gas + 9.926 TJ / - 8.348 TJ

   On 95% statistical confidentiality the interval is +0.4% and -0.3% and gives the following absolute for

   Coal + 1.801 TJ / - 1.816 TJ,
   Oil + 6.437 TJ / - 6.512 TJ und
   Gas + 3.320 TJ / - 3.396 TJ

4. **Statistical Errors (on 95% confidential level)**: It is only taken into account with fuels calculated from the consumption side and surveyed with sample surveys only. At the moment this the case for final consumption of biofuels and heat for district heating. Because heat for district heating is of no relevance for the supply side based calcula-

tion of GIC this potential error is taken into account (in the same relation) for corresponding transformation input (for district heating) of biofuels

Table 2 shows the statistical error of the domestic energy survey 2004

Tab. 2: statistical error of the domestic energy survey 2004with 95% confidential level

Fuels	Overall sum	
	Quantities	rel. error
	in kg, kwh, m³	in %
Fuel wood	4,061,766,191	4.0
Pellets	201,779,961	16.4
Wood chips	294,571,501	18.1
Heat for district heating	7,103,511,378	4.5

In 2006 the confidence belt is for:

Fuel wood **± 2,475 TJ** (4.0%), Pellets **± 2,591 TJ** (16.4%),
Wood chips **± 1,619 TJ** (18.1%), Bark **± 1,215 TJ** (18.1%)
Transformation input of biofuels for district heating purposes **± 558 TJ** (4.5%)

5. **Uncertainty of Conversion factors:** This is taken into account for fuels with inhomogeneous material shares (municipial waste) or varying water content (wood based biofuels) only, of which the calorific value was not metered but calculated with default values

   For 2006 the following variations of the calorific values (kJ/kg) are assumed:

Municipial wastes	9.6 ± 0.4 (4%)[1]	→	**± 443 TJ**
Fuel wood	14.4 ± 1.4 (10%)	→	**+ 6,434 TJ** / **- 5,939 TJ**
Wood chips	12.8 ± 1.3 (10%)	→	**+ 1,057 TJ / - 733 TJ**
Bark	7.5 ± 0.8 (10%)	→	**+ 793 TJ / - 550 TJ**

The results for fuel classes and the overall GIC are given in Tab. 4. Sektoral uncertainties and uncertainties due to a modelled breakedown of GIC to other balance aggregates arenot included into this uncertainty assessment.

[1] Source: L. Morf, E. Ritter, P. Brunner: Goods- und Material Balance of a Waste Incineration Plant in Wels, TU Vienna 1999.

Tab. 1: Results of a Monte Carlo Analysis of all relevant fuels of Material and Energy Input Survey 2006 assuming that 5% of the reported quantities are disturbed within a range of+/- 10% after 1000 simulation cycles on 100% and 95% security level

		TJ 100%		TJ 95%		Abweichung 100%		Abweichung 95%	
Fuel type	Eported Value	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Gasoline	**595**	592	600	593	597	-0.6%	0.8%	-0.3%	0.3%
Bio-/sewage sludge-/landfillgas	**215**	204	226	212	217	-5.3%	4.8%	-1.3%	1.2%
Brauncoalbriqettes	**0**	0	0	0	0	-10.7%	9.1%	-0.6%	0.0%
Lignite	**15,624**	15,035	16,208	15,280	15,831	-3.9%	3.6%	-2.2%	1.3%
Dieselkraft	**14,674**	14,604	14,742	14,647	14,704	-0.5%	0.5%	-0.2%	0.2%
Natural gas	**165,200**	162,831	168,565	164,391	166,093	-1.5%	2.0%	-0.5%	0.5%
LPG	**1,512**	1,495	1,529	1,503	1,519	-1.1%	1.2%	-0.6%	0.5%
Fuel oil, light	**5,855**	5,815	5,904	5,831	5,879	-0.7%	0.8%	-0.4%	0.4%
Fuel oil, medium	**343**	328	360	340	345	-4.6%	4.7%	-0.8%	0.7%
Fuel oil, heavy	**23,189**	22,268	24,174	22,983	23,398	-4.1%	4.1%	-0.9%	0.9%
Coke oven coke	**60,677**	57,057	64,665	59,195	61,926	-6.3%	6.2%	-2.5%	2.0%
Gas oil for heating purposes	**753**	746	764	748	757	-0.9%	1.4%	-0.7%	0.6%
Kerosene	**9**	9	9	9	9	-3.5%	2.8%	-1.6%	1.4%
Biodiesel	**0**	0	0	0	0	-5.0%	4.0%	-2.1%	2.1%
Hard coal	**51,245**	49,861	52,789	50,515	52,114	-2.8%	2.9%	-1.4%	1.7%
Overall sum	**339,891**	**330,844**	**350,534**	**336,250**	**343,488**	**-2.7%**	**3.0%**	**-1.1%**	**1.0%**

Following the given description the Worst Case Intervall looks like as follows:

$$\sum_{i=1}^{n}(x_i - s_i)*(1-a_i)*(1-b_-)*(1-c_i)*(1-d_i) \leq \sum_{i=1}^{n} x_i \leq \sum_{i=1}^{n}(x_i*(1+a_i)*(1+b_+)*(1+c_i)*(1+d_i)$$

i =all fuels of the EB, xi = CIG of the fuel i in TJ, si = statistical difference of the fuel i in TJ, ai =Measurement error of the fuel i in %, b+/- = Reportig error in %, ci = Statistial Error of the fuel i in %, di = Variation of the calorific value of the fuel i in %

Table 4: Cumulated uncertainty of GIC 2006 Worst Case

	Coal		Oil		Gas		Renewables		Overall fuels	
	minus	plus	minus	plus	minus	plus	minus	plus	minus	plus
CIG in TJ	170,293		608,522		315,391		323,384		1,442,251	
Stat. Difference in TJ	-931	0	-1,064	0	-188	0	0	0	-2,183	0
Measurement Error in TJ	-1,694	1,703	-6,075	6,085	-1,576	1,577	0	0	-9,344	9,365
Reporting Error in TJ	-4,463	5,386	-16,007	19,246	-8,348	9,926	0	0	-28,818	34,557
Stat. Error in TJ	0	0	0	0	0	0	-8,459	8,459	-8,459	8,459
Variance of CV in TJ	0	0	0	0	0	0	-7,665	8,727	-7,665	8,727
Sum	-7,087	7,089	-23,146	25,331	-10,112	11,503	-16,124	17,186	-56,468	61,108
CIG-extreme value in TJ	163,206	177,382	585,376	633,853	305,279	326,894	307,260	340,570	1,385,783	1,503,359
Tolerance	*-4.2%*	*4.2%*	*-3.8%*	*4.2%*	*-3.2%*	*3.6%*	*-5.0%*	*5.3%*	*-3.9%*	*4.2%*

Table 5: Cumulated uncertainty of GIC 2006 on 95% confidential level (with statistical and reporting error)

	Coal		Oil		Gas		Renewables		Overall fuels	
	minus	plus	minus	plus	minus	plus	minus	plus	minus	plus
CIG in TJ	170,293		608,522		315,391		323,384		1,442,251	
Stat. Difference in TJ	-931	0	-1,064	0	-188	0	0	0	-2,183	0
Measurement Error in TJ	-1,694	1,703	-6,075	6,085	-1,576	1,577	0	0	-9,344	9,365
Reporting Error in TJ	-1,816	1,801	-6,512	6,437	-3,396	3,320	0	0	-11,723	11,558
Stat. Error in TJ	0	0	0	0	0	0	-8,459	8,459	-8,459	8,459
Variance of CV in TJ	0	0	0	0	0	0	-7,665	8,727	-7,665	8,727
Sum	-4,440	3,504	-13,651	12,522	-5,160	4,897	-16,124	17,186	-39,374	38,108
CIG-extreme value in TJ	165,853	173,797	594,871	621,044	310,231	320,288	307,260	340,570	1,402,877	1,480,359
Tolerance	*-2.6%*	*2.1%*	*-2.2%*	*2.1%*	*-1.6%*	*1.6%*	*-5.0%*	*5.3%*	*-2.7%*	*2.6%*