Progress towards increasing the share of high-efficiency cogeneration based on useful heat demand in Hungary

(report under Article 10(2) of Directive 2004/8/EC of the European Parliament and of the Council containing the elements referred to in Article 6(3) thereof)

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1. Increase in combined heat and power production according to statistical data

There was a sharp increase in the amount of electricity produced from combined heat and power (CHP) during the period under review (2002-2007).

Table 1 shows the change in the amount of heat and electricity recovered from CHP units, the heat sold, energy source use and efficiency values from 2002 to 2007.

Table 1

Data on heat and electricity cogeneration from 2002 to 2007

	me.	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	***2007 /2002***
Gross electricity production*	*GWh*	5 450	6 123	6 568	7 333	8 109	8 706	*1.60*
Gross electricity production*	*TJ*	19618	22043	23646	26397	29191	31343	*1.60*
chain index		-	*1.12*	*1.07*	*1.12*	*1.11*	*1.07*	-
Net heat production*	*TJ*	47698	49586	47199	47970	46879	49222	*1.03*
chain index		-	*1.04*	*0.95*	*1.02*	*0.98*	*1.05*	-
of which sold to third parties	*TJ*	37756	37131	36043	34500	31827	35037	*0.93*
chain index		-	*0.98*	*0.97*	*0.96*	*0.92*	*1.10*	-
Recovered heat + electricity	*TJ*	67317	71629	70845	74367	76071	80565	*1.20*
chain index		-	*1.06*	*0.99*	*1.05*	*1.02*	*1.06*	-
Energy source use	*TJ***	84634	93612	89483	97353	100861	104396	*1.23*
chain index		-	*1.11*	*0.96*	*1.09*	*1.04*	*1.04*	-
Efficiency of CHP units	*%*	79.5	76.5	79.2	76.4	75.4	77.2	*0.97*
chain index		-	*0.96*	*1.03*	*0.96*	*0.99*	*1.02*	-

*As defined by the IEA (International Energy Agency).

** Calculated using the net calorific value (NCV).

Table 1 shows a sharp increase in the aggregated data for heat and electricity production. The increase was much higher for electricity than for heat production, which reflects a slight drop in the efficiency of CHP units, albeit with some fluctuation. Possible reasons for the fluctuation in efficiency include a change in CHP units, the introduction of new equipment, the renewal or suspension of existing equipment and fluctuations in useful heat demand.

Over a three-year period, electricity production was up 60%, while heat production rose by a mere 3%, owing to the positive trend in electricity prices compared with only a slight increase in heat demand.

2. Structure and change in fuel use in operational CHP units

Table 2 shows the amount of fuel used in CHP units (calculated according to heating value) and the percentage breakdown of fuel structure during the period under review.

Table 2

Energy sources used by CHP and their percentage breakdown

	me.	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	***2007/2002***
all types of coal	*TJ*	10 069	10 965	9 204	6 851	6 664	6 544	*0.65*
share of total inputs	*%*	11.9	11.7	10.3	7.0	6.6	6.3	
fuel oil	*TJ*	5 914	5 073	3 930	1 787	1 437	163	*0.03*
share of total inputs	*%*	7.0	5.4	4.4	1.8	1.4	0.2	
gasoil	*TJ*	21	43	64	16	34	4	*0.20*
share of total inputs	*%*	0.0	0.0	0.1	0.0	0.0	0.0	
natural gas*	*TJ*	60 559	66 172	69 216	78 983	80 546	85 647	*1.41*
share of total inputs	*%*	71.6	70.7	77.4	81.1	79.9	82.0	
blast-furnace and coke-oven gas	*TJ*	3 093	3 941	3 010	2 993	3 557	3 821	*1.24*
share of total inputs	*%*	3.7	4.2	3.4	3.1	3.5	3.7	
total renewables	*TJ*	907	951	1 073	1 170	1 780	3 533	*3.90*
share of total inputs	*%*	1.1	1.0	1.2	1.2	1.8	3.4	
other energy sources	*TJ*	4 071	6 468	2 984	5 554	6 843	4 684	*1.15*
share of total inputs	*%*	4.8	6.9	3.3	5.7	6.8	4.5	
Total fuel inputs	***TJ***	**84 634**	**93 612**	**89 483**	**97 353**	**100861**	**104396**	***1.23***

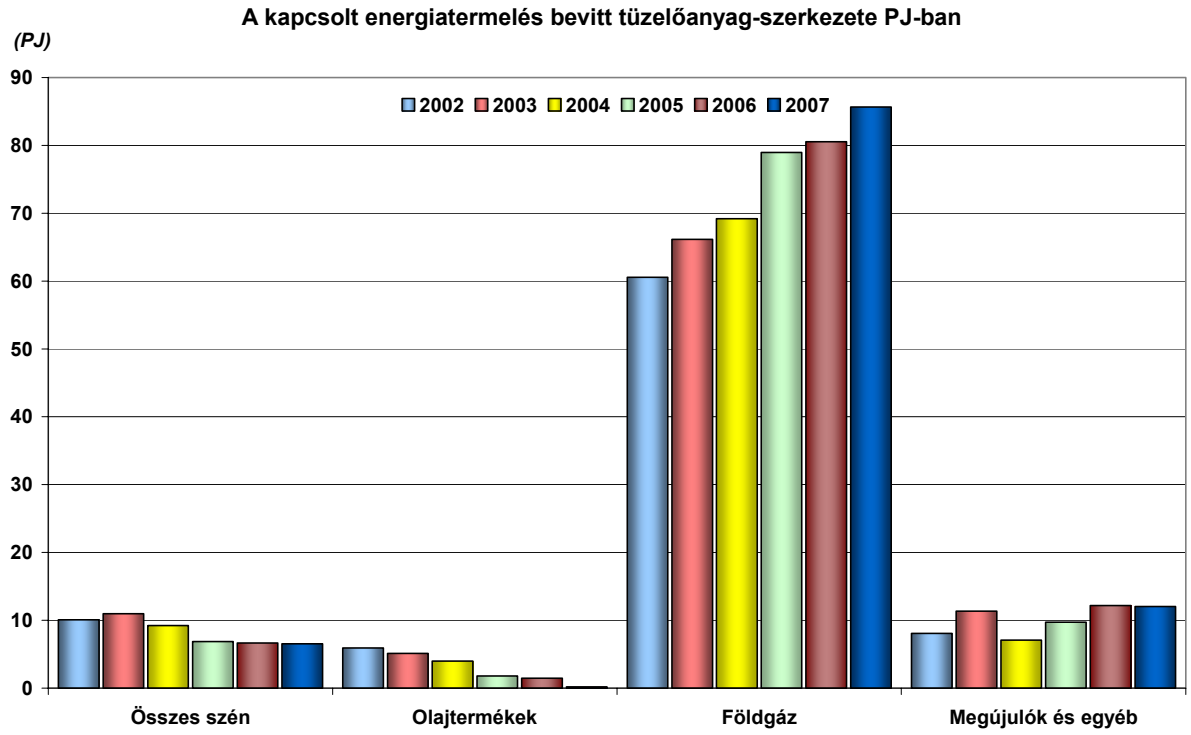
- Calculated using the net calorific value (NCV).
- Total renewables: biogas, biomass (biogas: produced from sewage sludge and animal products, gas from waste dumps).
- All types of coal: lignite, brown coal, hard coal.
- Other energy sources: municipal waste burned in incineration plants.

The increase in cogeneration that can be seen in Table 1 is also supported by a rise in the amount of fuel used in cogeneration.

The key element of the fuel structure is natural gas, which is of growing importance compared with petroleum products and coal types. It is also striking that renewable energy sources used in CHP plants rose slowly at first, increasing rapidly during the later years of the period under review. Thanks to a sharp crack-down on sulphur content, the use of fuel oil has fallen so low that it is practically irrelevant.

Figure 1 shows the rate and increasing importance of natural gas as an energy source.

Figure 1



A kapcsolt energiatermelés bevitt tüzelőanyag-szerkezete PJ-ban	Breakdown of co-generated fuel inputs in PJ
Összes szén	Total coal
Olajtermékek	Petroleum products
Földgáz	Natural gas
Megújulók és egyéb	Renewables and other

3. Change in amount of heat and electricity produced from CHP

3.1. Electricity

The change in the rate of co-generated electricity as a proportion of total electricity can be seen in Table 3. The rate of cogenerated electricity rose sharply.

There was also a higher increase in the rate of co-generated electricity than co-generated heat. Changes in these rates led to an increase in sigma values by the end of the period under review.

Table 3

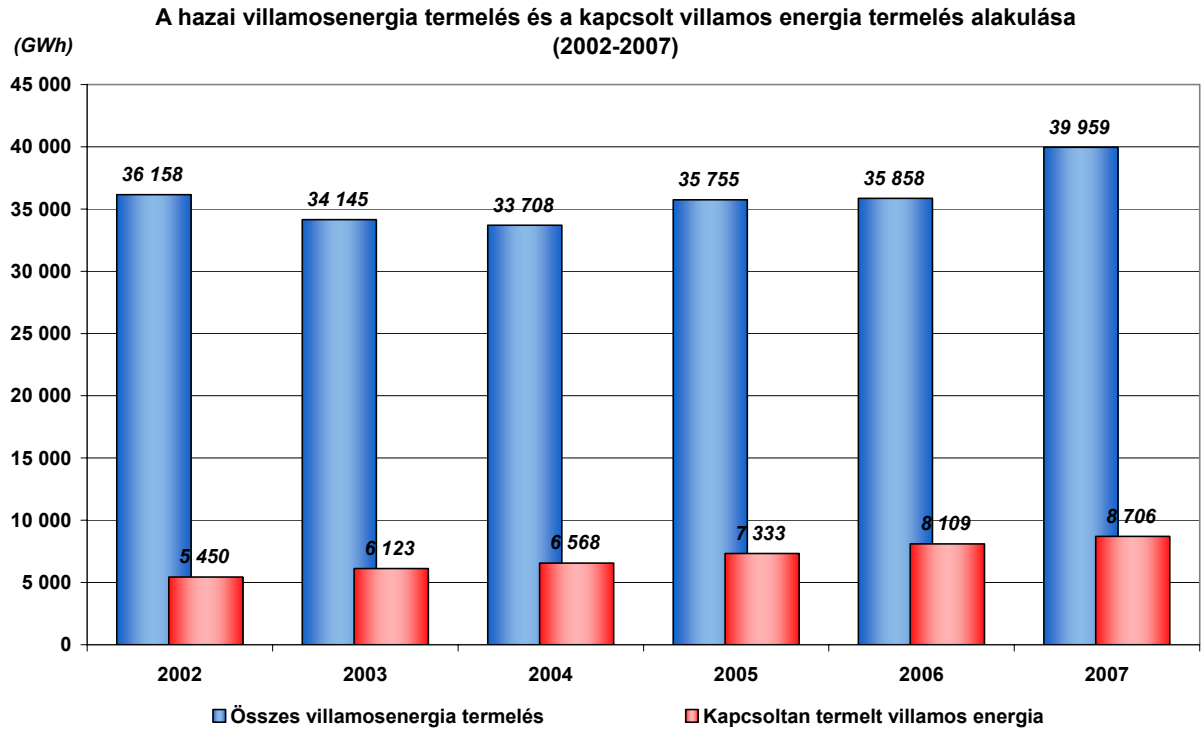
Breakdown of co-generated energy

		2002	2003	2004	2005	2006	2007	*2007 / 2002*
Total domestic electricity	*GWh*	36158	34145	33708	35755	35858	39959	*1.11*
of which: Co-generated electricity	*GWh*	5 450	6 123	6 568	7 333	8 109	8706	*1.60*
Co-generated / Total electricity production	*%*	15.1	17.9	19.5	20.5	22.6	21.8	*1.45*
Of co-generated production:								
rate of electricity production	*%*	29.1	30.8	33.4	35.5	38.4	38.9	*1.33*
rate of heat production	*%*	70.9	69.2	66.6	64.5	61.6	61.1	*0.86*
σ trend*		0.411	0.445	0.501	0.550	0.623	0.637	*1.55*

*σ: specific indicator of co-generated electricity (electricity produced [TJ] / heat energy produced [TJ])

Figure 2 demonstrates the importance of electricity cogeneration to domestic electricity production. A steady increase can be seen in both the absolute value and relative rate of electricity cogeneration.

Figure 2



A hazai villamosenergia termelés és a kapcsolt villamos energia termelés alakulása	Change in domestic electricity production and electricity cogeneration
Összes villamosenergia termelés	Total electricity production
Kapcsoltan termelt villamos energia	Co-generated electricity

3.2. Heat energy

Table 4 shows the data on heat production during the period under review.

Table 4

Change in net heat production by production type

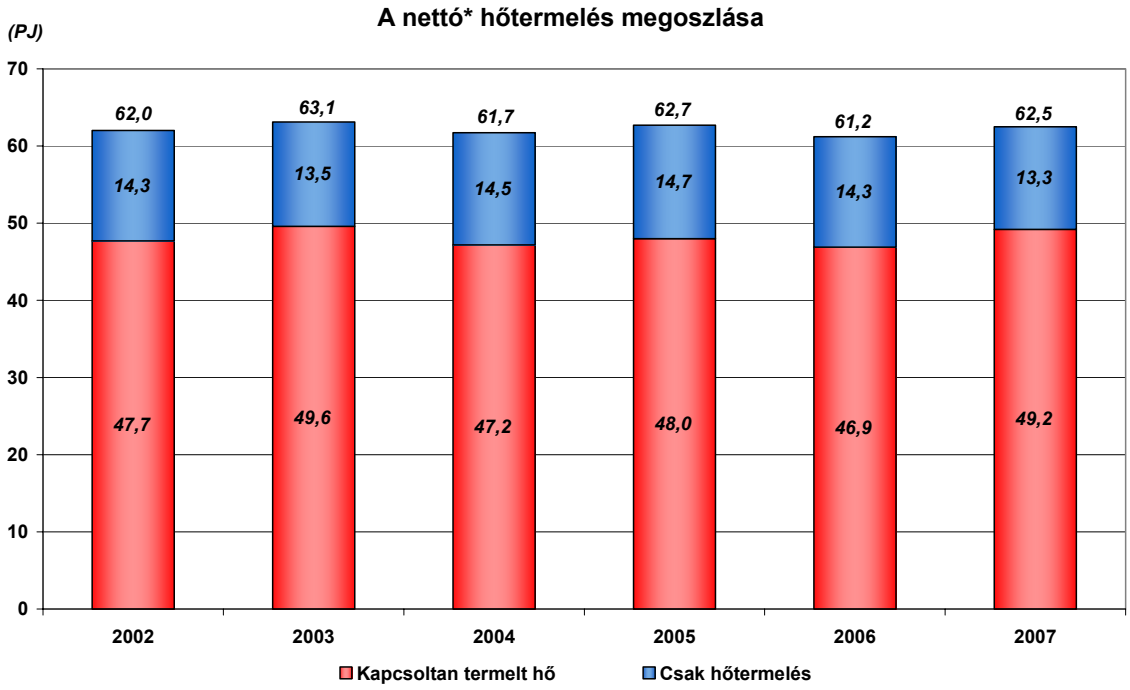
		2002	**2003**	**2004**	**2005**	**2006**	**2007**	***2007 / 2002***
Co-generated heat	*PJ*	47.7	49.6	47.2	48.0	46.9	49.2	*1.03*
chain index		-	*1.04*	*0.95*	*1.02*	*0.98*	*1.05*	-
Heat-only	*PJ*	14.3	13.5	14.5	14.7	14.3	13.3	*0.93*
chain index		-	*0.94*	*1.08*	*1.02*	*0.97*	*0.93*	-
Total heat production	*PJ*	62.0	63.1	61.7	62.7	61.2	62.5	*1.01*
chain index		-	*1.02*	*0.98*	*1.02*	*0.98*	*1.02*	-
Rate of heat co-generation	*%*	77.0	78.6	76.5	76.5	76.6	78.7	*1.02*
chain index		-	*1.02*	*0.97*	*1.00*	*1.00*	*1.03*	-

Based on the data in Table 4, we can make the following observations for the period under review:

- There was only a slight change in total heat production, which was weather-related; overall it can be said to have stagnated.
- The amount of co-generated heat had risen only slightly by the end of the period under review; it virtually stagnated.
- There was a slight fall in the amount of heat-only production. This fall was not reflected in total heat production due to the high rate of co-generated heat.
- Co-generated heat accounts for a very high proportion of total heat production, and there was hardly any change in this proportion over the years. No significant increase is expected over the next few years.

Figure 3 shows that both combined heat and power and heat-only production stagnated during the period under review. As a result, there was no significant change in total heat production.

Figure 3



A nettó* hőtermelés megoszlása	Breakdown of net* heat production
Kapcsoltan termelt hő	Co-generated heat
Csak hőtermelés	Heat-only production

*As defined by the IEA (International Energy Agency).

4. Change in cogeneration installed capacity

4.1. By unit type

It can be seen from Table 5 that the installed capacity of operational CHP units rose sharply during the period under review. It should also be noted that the rate of increase accelerated during the second half of this period.

There were three cases where the change was particularly marked:

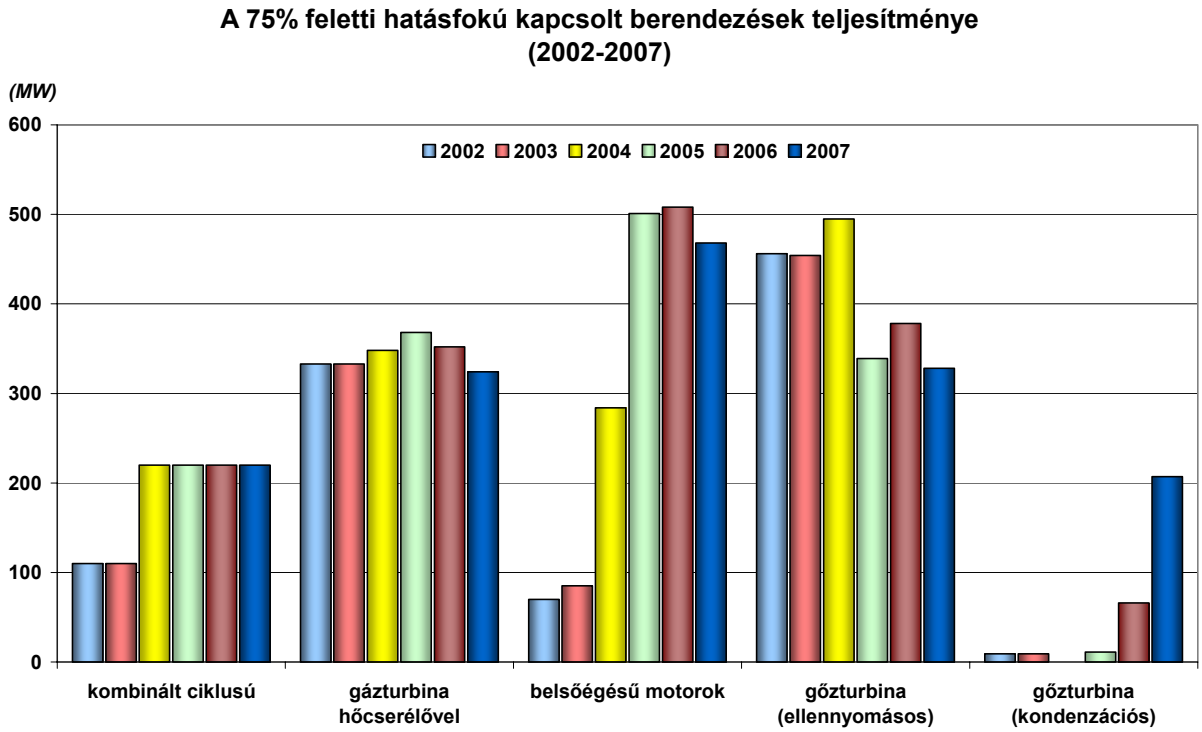
- For combined-cycle CHP units, lower-efficiency units were replaced with higher-efficiency units.
- The increase in capacity of internal combustion engine CHP units was especially high.
- The increase in capacity of condensing steam turbine CHP units was also especially high.

Table 5

Installed electrical capacity in operational CHP units, by type

1: CHP with efficiency greater than 75%		**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	***2007/ 2002***
Combined cycle (efficiency ≥ 80%)	*[MW]*	110	110	220	220	220	220	*2.00*
chain index		-	*1.00*	*2.00*	*1.00*	*1.00*	*1.00*	-
Gas turbine with heat recovery	*[MW]*	333	333	348	368	352	324	*0.97*
chain index		-	*1.00*	*1.04*	*1.06*	*0.96*	*0.92*	-
Internal combustion engine	*[MW]*	70	85	284	501	508	468	*6.68*
chain index		-	*1.21*	*3.34*	*1.77*	*1.01*	*0.92*	-
Steam: backpressure turbine	*[MW]*	456	454	495	339	378	328	*0.72*
chain index		-	*1.00*	*1.09*	*0.68*	*1.12*	*0.87*	-
Steam: condensing turbine (efficiency ≥ 80%)	*[MW]*	9	9	0	11	66	207	*23.11*
chain index		-	*1.01*	*0.00*		*5.86*	*3.15*	-
Total	*[MW]*	**978**	**991**	**1347**	**1438**	**1524**	**1547**	***1.58***
chain index		**-**	*1.01*	*1.36*	*1.07*	*1.06*	*1.02*	**-**
2: CHP with efficiency lower than 75%		**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	***2007/ 2002***
Combined cycle (efficiency < 80%)	*[MW]*	214	214	214	240	132	144	*0.67*
chain index		-	*1.00*	*1.00*	*1.12*	*0.55*	*1.09*	-
Gas turbine with heat recovery	*[MW]*	14	14	14	0	17	183	*13.06*
chain index		-	*1.00*	*1.00*	*0.00*		*10.74*	-
Internal combustion engine	*[MW]*	32	47	19	6	18	21	*0.65*
chain index		-	*1.45*	*0.40*	*0.30*	*3.22*	*1.16*	-
Steam: backpressure turbine	*[MW]*	57	81	22	35	8	64	*1.12*
chain index		-	*1.43*	*0.27*	*1.61*	*0.22*	*8.49*	-
Steam: condensing turbine (efficiency < 80%)	*[MW]*	139	70	160	154	277	278	*2.01*
chain index		-	*0.51*	*2.28*	*0.96*	*1.81*	*1.00*	-
Total	*[MW]*	**456**	**426**	**428**	**433**	**452**	**690**	***1.51***
chain index		-	*0.94*	*1.00*	*1.01*	*1.04*	*1.53*	-
Total 1 + 2	*[MW]*	**1 433**	**1417**	**1775**	**1872**	**1975**	**2 237**	***1.56***
chain index		-	*0.99*	*1.25*	*1.05*	*1.06*	*1.13*	-
Internal combustion engines	*[units]*	**87**	**138**	**212**	**262**	**303**	**306**	***3.52***
chain index		-	*1.59*	*1.54*	*1.24*	*1.16*	*1.01*	-

Figure 4



A 75% feletti hatásfokú kapcsolt berendezések teljesítménye (2002-2007)	Capacity of cogeneration units with efficiency above 75% (2002-2007)
kombinált ciklusú	combined cycle
gázturbina hőcserélővel	gas turbine with heat recovery
belsőégésű motorok	internal combustion engine
gőzturbina (ellennyomásos)	steam: backpressure turbine
gőzturbina (kondenzációs)	steam: condensing turbine

4.2. CHP broken down by economic sector

There was a steady increase in the installed electrical capacity of public CHP plants during the period under review, as shown in Table 6.1.

There was also an increase in the installed heat capacity of public CHP plants, although it was much smaller and not a steady increase, as can be seen in Table 6.2.

Conversely, for autoproducer CHP plants there was a sharper fall in installed heat capacity than installed electrical capacity.

Close examination of the above data reveals that autoproducer CHP plants are being overtaken by public CHP plants, as a result of external fund-raising.

Table 6.1

Installed electrical capacity in CHP units, by sector [MW]

Sector	2002	2003	2004	2005	2006	2007
Public supply	**1 251**	**1 224**	**1 584**	**1 657**	**1 839**	**2 088**
Autoproducers	**183**	**192**	**190**	**215**	**137**	**149**
Chemical industry	39	31	49	13	15	13
Manufacture of non-metallic mineral products	10	12	10	0	0	0
Manufacture of food products, beverages and tobacco	98	97	65	71	80	84
Paper and printing industry	17	16	14	16	16	16
Metal products, machinery, equipment	0	0	0	0	8	12
Other industrial branches	2	25	3	2	12	20
Services	17	11	49	112	5	2
TOTAL	**1 434**	**1 416**	**1 775**	**1 872**	**1 976**	**2 237**

Table 6.2

Installed heat capacity in CHP units, by sector [MW]

Sector	2002	2003	2004	2005	2006	2007
Public supply	**3 304**	**3 193**	**3 775**	**3 440**	**3 743**	**3 955**
Autoproducers	**1 037**	**1 007**	**920**	**753**	**629**	**502**
Chemical industry	350	273	358	113	100	35
Manufacture of non-metallic mineral products	51	55	51	0	0	0
Manufacture of food products, beverages and tobacco	517	516	393	426	428	352
Paper and printing industry	67	63	53	72	72	68
Metal products, machinery, equipment	1	0	1	0	8	15
Other industrial branches	3	84	3	7	14	29
Services	49	16	61	136	7	4
TOTAL	**4 341**	**4 200**	**4 694**	**4 193**	**4 373**	**4 457**

Closer scrutiny also reveals that a large proportion of newly commissioned CHP units are combined-cycle gas turbine (CCGT) units, which have a more favourable sigma factor. This is one reason why the increase in installed electrical capacity was much higher than the increase in installed heat capacity during the period under review.

5. Summary

- According to the data set out above, there was a sharp increase in cogeneration during the period under review (2002-2007). The increase in electricity production was much higher than the increase in heat production.
- The key element in the fuel structure of CHP energy production is natural gas, while the use of renewable energy sources rose slowly at first and sharply in later years.
- The increase in co-generated electricity as a proportion of total electricity production is particularly striking. Total heat production stagnated during the period under review. This is because, although there was a slight increase in co-generated heat, there was a broadly similar fall in heat-only production. Since it is already at a very high level, the proportion of total heat produced from co-generated heat is unlikely to increase in the future.
- There was a sharp increase in the installed capacity of operational CHP units during the period under review. The introduction of more efficient combined-cycle gas turbine CHP units was particularly striking, as was the increase in installed capacity of internal combustion engine and steam condensing turbine CHP units.
- When broken down by economic sector, we can see a steady increase in the installed electrical capacity of public CHP plants, with a much smaller and no steady increase in installed heat capacity. For autoproducer CHP plants, there was a fall in both installed electrical and heat capacity. The fall in heat capacity was more marked.

The statistical data were provided by Energia Központ Nonprofit Kft.