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BARRIERS TO COMBINED HEAT AND POWER PRODUCTION IN THE CZECH AND SLOVAK REPUBLICS

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Abstract

Combined heat and power is well established in the Czech and Slovak Republic, especially in the district-heating sector. The current share in total electricity production is about 19% in the Czech Republic, and 11% in the Slovak Republic. Both governments aim to support CHP for reasons of energy efficiency improvement and, to some extent, mitigation of CO_2 emissions. However, different barriers hamper the further penetration of CHP. Therefore, this study aimed to support the Czech and Slovak government in the formulation of CHP policy The project has delivered three documents: a background document (this report) and national Action Plans for the promotion of CHP in the Czech and Slovak Republic, respectively (separate documents ECN-C--00-043/044). The Action Plans will provide policy makers in the Czech and Slovak government with concise information on potentials, priorities, and recommended policy actions.

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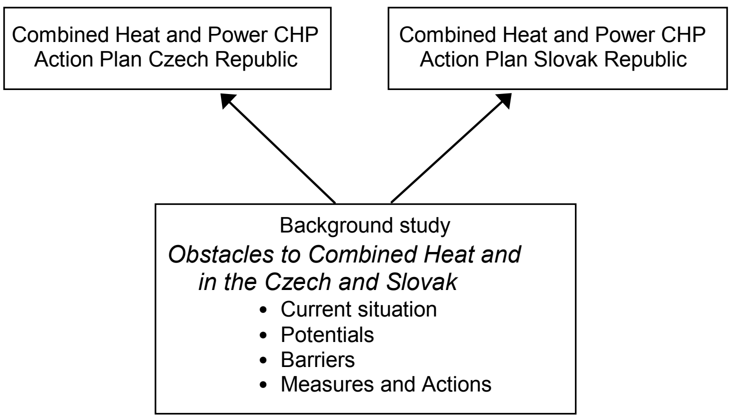
FOREWORD

Combined heat and power generation is well established in the Czech and Slovak Republic. The current share of CHP in the electricity and heat production is relatively high compared to the average in the European Union. Combined heat and power generation contribute to the three major goals of the national energy policy of both countries: overall competitiveness, security of supply and environmental protection. Therefore, the Slovak and Czech government aim to promote CHP. In both countries, however, it is necessary to develop specific policies addressing the impact of liberalisation of the energy markets on the prospects of production and investments in CHP.

The European Commission also promotes CHP. Therefore, the study 'Obstacles to the promotion of CHP in the Czech and Slovak Republics' was supported within the SAVE II Programme (SA/085NL) and was co-financed by the Dutch government, and the Czech Energy Agency. The Slovak Energy Agency provided in-kind support. The project consortium consisted of the following Slovak, Czech, Dutch and UK institutes: the Netherlands Energy Research Foundation ECN (project leader), SRC International CS s.r.o., March Consulting s.r.o., March Consulting Group (UK) and the Slovak Energy Agency. The study has resulted in the following documents:

1. The Combined Heat and Power (CHP) Action Plan addresses the promotion of CHP in the Czech Republic (report ECN-C-00-043) and the Slovak Republic (report ECN-C-00-044). The Action Plans provide policy makers in the Czech and Slovak government with essential information on potentials, targets, budgets and recommended policy instruments. The core of the Action Plan is the list of concrete policy actions to be taken.
2. The background document (this report, (ECN-C-00-042). The background document to the Action Plan contains detailed information on options and measures, potentials, barriers and policy instruments for promoting CHP. The main part is a detailed outline for a new CHP policy. Also, it includes recommendations for financing schemes to overcome the investment constraints in the Slovak and Czech Republic.



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ABBREVIATIONS

CCEG	Control Committee on Electricity and Gas
CEA	Czech Energy Agency
CEEC	Central and Eastern European Country
CHP	Combined Heat and Power Production
CR	Czech Republic
DH	District Heating
DHS	District Heating System
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EEA-SR	Energy Efficiency Act Slovak Republic
EKIS-CEA	Energy Consultancy and Information Centre of Czech Energy Agency
EMA-CR	Energy Management Act Czech Republic
EPL	Energy Performance on Location
ESB	Electricity Supply Board
ESCO	Energy Service Company
FGD	Flue-Gas Desulphurisation
GEF	Global Environmental Facility
IBRD	International Bank for Reconstruction and Development
IFI	International Financial Institution
MIT	Ministry of Industry and Trade
MoE	Ministry of Environment
MW_e	MW electrical
MWth	MW thermal
REB	Regulatory Energy Tax
SEA	Slovak Energy Agency
SEF	State Environmental Fund
SFZP	State Environmental Fund
SME	Small and Medium-sized Enterprises
SR	Slovak Republic
UK	United Kingdom
VÚMH	Research Institute of Municipal Economy

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SUMMARY

Combined heat and power is well established in the Czech and Slovak Republic, especially in the district-heating sector. The current share in total electricity production is about 19% in the Czech Republic and 11% in the Slovak Republic. In the Czech Republic, more than 50% of power generated by CHP plants is from public power plants and public CHP plants, and an additional more 40% from industrial CHP plants.

In recent years, in both countries, a few large-scale projects have been realised in the district-heating sector. Recently medium-scale CHP projects were realised in industry. The number of small-scale applications in both countries is small (about 500 in the Czech Republic and 80 in the Slovak Republic). Most small-scale applications are in small municipal district-heating systems, industry and the commercial sector (including biogas and landfill gas). Almost all small-scale projects received governmental subsidies.

Both governments aim to support CHP for reasons of energy efficiency improvement and, to some extent, mitigation of CO_2 emissions. Also, the accession to the EU is a motivation for the promotion of CHP in the Czech and Slovak Republics. However, no official policy and targets exist with regard to CHP, although some financial support is provided in the programmes of the national Energy Agencies. Different barriers exists that hamper the further penetration of CHP, among which the lacking policy and institutional framework, regulatory framework, pricing and tariffs, and barriers to financing of CHP projects. As a result, the developments in recent years have been rather slow, although a large technical potential exists.

This study therefore aims to support the Czech and Slovak government in the formulation of CHP policy to overcome the existing barriers. The study focused on the following three key applications of CHP:
1. Medium-scale CHP in municipal district heating systems (5 to 50 MW_e).
2. Medium-scale applications in industry (5 to 50 MW_e).
3. Small-scale applications in the residential and commercial sectors (50 kWe to 5 MW_e).

Recommendations for policy measures and actions are given for a number of key areas and questions. The questions are:
1. Policy framework. How to develop policies for the promotion of CHP?
2. Institutional framework. How to set up an optimal institutional framework for the promotion of CHP, e.g. the role of the Energy Agencies and stakeholders, and international corporation?
3. Regulatory framework. How to adapt energy and energy efficiency regulation not to discriminate against CHP? In both countries, energy legislation and energy efficiency legislation is being drafted at the moment.
4. Energy prices and tariffs. How to consider CHP in the price reforms and in the development of electricity and gas tariffs? How to deal with the future liberalisation of the energy markets?
5. Financing. What can the Czech and Slovak government do to improve financing of CHP projects?

The project has delivered three documents: a background document (this report) and concise national Action Plans for the promotion of CHP in the Czech Republic (ECN-C-00-043) and Slovak Republic (ECN-C-00-044), respectively. The Action Plans provide policy makers in the Czech and Slovak government with essential information on potentials, priorities, and recommended policy actions. They can be read as the summary of the background document. The project was supported from the SAVE II programme of the European Commission. The project

consortium consisted of the following Czech, Dutch and UK institutes: the Netherlands Energy Research Foundation ECN (co-ordinator), SRC International CS s.r.o., EnvirosMarch s.r.o., Enviros March UK, and the Slovak Energy Agency SEA with support of the Czech Energy Agency.

1. INTRODUCTION

1.1 Background

Combined heat and power is well established in the Czech and Slovak Republic, particularly in the district heating sector, where CHP plants have been the major heat source for new district heating networks in the Czech and Slovak Republics since the 1950s. The current share in total electricity production is about 19% in the Czech Republic and about 16% in the Slovak Republic (see this report). Large-scale district heating systems built in 50s and 60s used coal fired CHP plants as a major heat source. Lack of financial sources for investments in 70s and 80s and step by step switch from coal to natural gas in new district heating systems were major reasons for the increased implementation of heat only boiler plants which substantially reduced efficiency of district heating. Also many industrial companies operate their own large or medium sized CHP plants, most of which were built in 50s and 60s, too. After changes in 1989-1990, both republics started the economic transformation programmes, including the creation of conditions for gradual implementation of market mechanisms in the heat supply sector.

The current share in total electricity production is about 19% in the Czech Republic and about 11% in the Slovak Republic (see this report). In both countries, a large technical potential for CHP still remains. Both governments therefore aim to support CHP for reasons of energy efficiency improvement and, to some extent, mitigation of CO_2 emissions. Also, the accession to the EU is a motivation for the promotion of CHP in the Czech and Slovak Republics, because CHP plays an important role in the European Union's energy efficiency and climate change policy. The EU Strategy Paper proposes a target for the share of CHP in gross electricity production of 18% compared to the current share of 9% in the year 2010.

However, in both countries, a number of different barriers exists that hamper the further penetration of CHP. These include economic, financial, administrative and legal barriers. As a result, the developments in recent years have been small. The barriers are to be tackled if CHP should increase its market share significantly. A complicating factor in developing promotion policy for CHP is the transition to a liberalised electricity and gas market. In liberalised markets, new barriers for CHP could arise that are different to those that are currently important, and that require different policies. For an overview of the situation and prospects of CHP in CEE countries see the COGEN Europe 1999 Cogeneration Review1.

1.2 Objectives of the project

The main aim of the project is to develop new policies to overcome barriers to the implementation of CHP in the Czech and Slovak Republic. The specific objectives of this project are to:

- assess the potentials and key sectors for the implementation of CHP in the Republics both in future liberalised markets,
- identify the key barriers,
- prepare options for solutions to these problems and elaborate recommendation for policy actions,
- increase the insight in the impact of liberalisation of the energy market on CHP and support the Czech and Slovak Governments in the development of new policies,
- disseminate the results through newsletters, journals, and through seminars at the end of the project.

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[1] COGEN Europe. European Cogeneration Review 1999. COGEN Europe, Brussels, July 1999.

1.3 Action plans for the combined heat and power

The project has delivered three documents:
1. Background report with the results of the study for the Czech and Slovak Republic (this report).
2. Action Plan for the Promotion of Combined Heat and Power in the Czech Republic (separate report, ECN-C-00-043).
3. Action Plan for the Promotion of Combined Heat and Power in the Slovak Republic (separate report, ECN-C-00-044).

The main conclusions and recommended policy actions will be reported extensively in the background document and summarised in the two national Action Plans. In this way, the results of the study are far better accessible to policy makers. The Action Plans will provide policy makers in the Czech and Slovak government with essential information on potentials, targets, budgets and recommended policy instruments. The core of the Action Plans is the list of concrete policy actions, ready for implementation. The format of a policy document was applied, so that the documents can be used directly by policy makers as a starting point for official policy. The Action Plans have the following outline:
1. Summary current situation and potential for CHP.
2. Policy objectives and priorities.
3. Summary existing barriers for CHP.
4. Recommendations policy framework.
5. Recommendations institutional framework.
6. Recommendations regulatory framework.
7. Recommendations prices and tariffs.
8. Recommendations financing of CHP projects.
9. Summary of recommended actions.

1.4 Scope of the study

1.4.1 Definition of CHP

Combined heat and power involves the simultaneous production of thermal and electric energy from the same primary energy source2. For a given application, this can be achieved using different technologies. There exists no uniform definition of CHP with regard to the minimum efficiency levels. In this study, therefore, the following set of definition is adopted, which has been proposed by COGEN Europe3. The definition is based on the assumption that CHP should reduce carbon emissions and increase efficiency compared to separate best-practice heat and power production.

$$2\,P + 1.25\,H \geq 100 \quad \text{(for gas)}$$
$$2.5\,P + 1.25\,H \geq 100 \quad \text{(solid fuels)}$$
$$3\,P + 1.35\,H \geq 100 \quad \text{(biomass)}$$

With P: power and H: heat production.

An adequate definition is especially important in the Czech and Slovak Republic, where sometimes large power plants with limited heat extraction are considered CHP also, although they do not meet the efficiency criteria.

2 In this study, the term Combined Heat and power Production (CHP) is used. The term ‘cogeneration’ is not used, because the term is not widely used in the Czech and Slovak Republic and could lead to misunderstanding. Cogeneration refers for many in these countries only to small-scale CHP.

3 Simon Minett. Turning Policy Objective into Reality. COGEN Europe 6th Annual Conference, 14-15 October 1999. Brussels.

1.4.2 CHP applications

No conformity exists on the categorisation of the different applications of CHP. Table 1.1 shows a possible categorisation.

Table 1.1 *Categorisation of CHP applications*

Size	Sector	Capacity range	Technologies
Large-scale district heating	Public district heating	> 50 MW_e	Combined cycle Gas turbines with heat recovery Steam turbines
Medium-scale district heating	Municipal district heating	5-50 MW_e	Gas turbines with heat recovery Steam turbines
Large-scale	Industry	> 50 MW_e	Combined cycle Gas turbines with heat recovery Steam turbines
Medium-scale	Industry/larger building complexes	5-50 MW_e	Gas turbines with heat recovery
Small-scale	Residential and commercial sector Small industries	50 kWe-5 MW_e	Gas engine Diesel engines
Micro	Residential and commercial sector	< 50 kW_e	Stirling engines

The study will not specifically address large-scale CHP in district heating and industry (>50 MW_e), because the economic and financial conditions for large-scale applications are very different to medium and small-scale applications, and require a more project-based assessment. Also, the number of these large projects in the Czech and Slovak Republics is small. Also, micro-CHP will not be addressed at all. The technology is still in development and doesn't represent a significant potential in the Czech and Slovak Republics in the period to 2010, which is the scope of this study. The project will therefore focus on the following three applications of CHP:

1. Medium-scale CHP in municipal district heating systems (5 to 50 MW_e).
2. Medium-scale applications in industry (5 to 50 MW_e).
3. Small-scale applications in the residential and commercial sectors (50 kWe to 5 MW_e).

1.5 Content of the report

The situation with regard to CHP in the Czech and Slovak Republic is described in Chapter 2 and 3, respectively. A detailed assessment was made of the technical and economic potential of CHP (Chapter 4). In Chapter 5, the main barriers are identified. The regulatory framework for CHP, particularly with regards to prices and tariffs is discussed in Chapter 6. Recommendations for actions in these fields are identified also. In Chapter 7, financing of CHP projects is addressed.

Annex A and B provide background data for the current situation in the Czech and Slovak Republic and the potential for CHP. In both countries legislation has been drafted for the promotion of CHP within the framework of the Energy Management Act in the Czech Republic, and the Energy Efficiency Act in the Slovak Republic. The project team has reviewed the draft legislation (Annex C). Annex D provides an inventory of policy instruments that can be used for promotion of CHP in the EU. Finally, Annex E describes the possible future of CHP in the Netherlands and the United Kingdom.

2. CURRENT SITUATION IN THE CZECH REPUBLIC

2.1 Introduction

The current situation in the Czech and Slovak Republics with regard to CHP will be described in this and the next chapter. The description includes the current share of CHP in the electricity and heat market, the main applications, technologies etcetera. Furthermore, the current political, economic, legal and investment environment will be outlined. In both countries, the significant regional differences will be considered. The chapter also includes a description of recent trends.

The majority (about 70%) of the total primary energy consumption in the Czech Republic (equals to about 500 TWh/a) is used for heat production. Of this approximately two thirds are used for low potential heat (temperature under 90°C). This heat is mostly used for space heating and domestic tap water heating; a smaller portion is used for air-conditioning and for different processes. In the current situation, the majority of this low potential heat is produced from lignite, but massive gasification in recent years has decreased this portion.

District heating systems are widely used in the Czech Republic in municipal district heating as well as in industry. The major reasons why district heating developed in the Czech Republic are the following:

- District heating systems were based on the use of local low-grade fuels, which were burned at lower environmental impacts than if used in local heating in stoves.
- District heating was the easiest solution for heat supply to the new large living districts with concrete multi-storey apartments, which were built mostly in 60s-80s.
- Construction of large-scale district heating systems fitted well into construction planning.

Large district heating networks were usually equipped with lignite-fired CHP plants with poor efficiency of combined heat and power production in most cases. The low general energy efficiency of district heating systems is caused by:

- low thermodynamic efficiency of power and heat production due to obsolete technologies,
- low energy efficiency of energy transport due to big losses,
- high specific heat consumption in buildings due to high thermal losses and overheating of buildings,
- low energy efficiency of end-use processes due to obsolete technologies.

Small district heating networks and industrial heating systems were mainly equipped with lignite-fired heat only boiler plants. Most of such boiler plants are currently being converted from coal to natural gas. With the large progress in gasification in the Czech Republic, many small district heating systems were rehabilitated in the last ten years. This rehabilitation mostly aimed at the refurbishment of old (usually steam) boiler plants and their conversion to hot-water boiler plants. In some boiler plants that supply district-heating systems, combined-cycle CHP plants have been installed. Based on the experiences with actual projects, combined heat and power production can bring energy savings of up to 40% and substantial reductions of emissions of pollutants, especially when natural gas is used instead of coal. Thanks to subsidies granted by the Czech Energy Agency to small-scale CHP installations, some small-scale CHP plants with gas engines were also installed.

2.2 Share of CHP

2.2.1 Share of CHP on installed capacity

Of the total installed capacity in power plants, the share of CHP is about 40%. The current structure of power generation according to the installed capacity in the Czech Republic is given in the following table.

Table 2.1 *Current structure of power generation in the Czech Republic*

Total installed power capacity of the Czech Republic	14 597 MW
of which:	
Installed capacity of hydro power and nuclear power plants	3 719 MW
Condensing steam power plants	4 940 MW
Other power plants and CHP plants	5 938 MW

The overview of the installed power capacity of CHP plants divided according to regions of the Czech Republic is given in the following table (see also Figure 2.2).

Table 2.2 *Installed power capacity of CHP plants according to regions*

Region [1997]	Installed capacity [MW_e]
Capital Prague	159
Central Bohemia	738
South Bohemia	142
West Bohemia	467
North Bohemia	1,941
East Bohemia	766
South Moravia	438
North Moravia	1,287
Czech Republic total	5,938

Source: Czech Statistical Office.

Figure 2.1 shows the share of CHP in total electricity generation in the Czech Republic, some selected countries and in the EU combined.

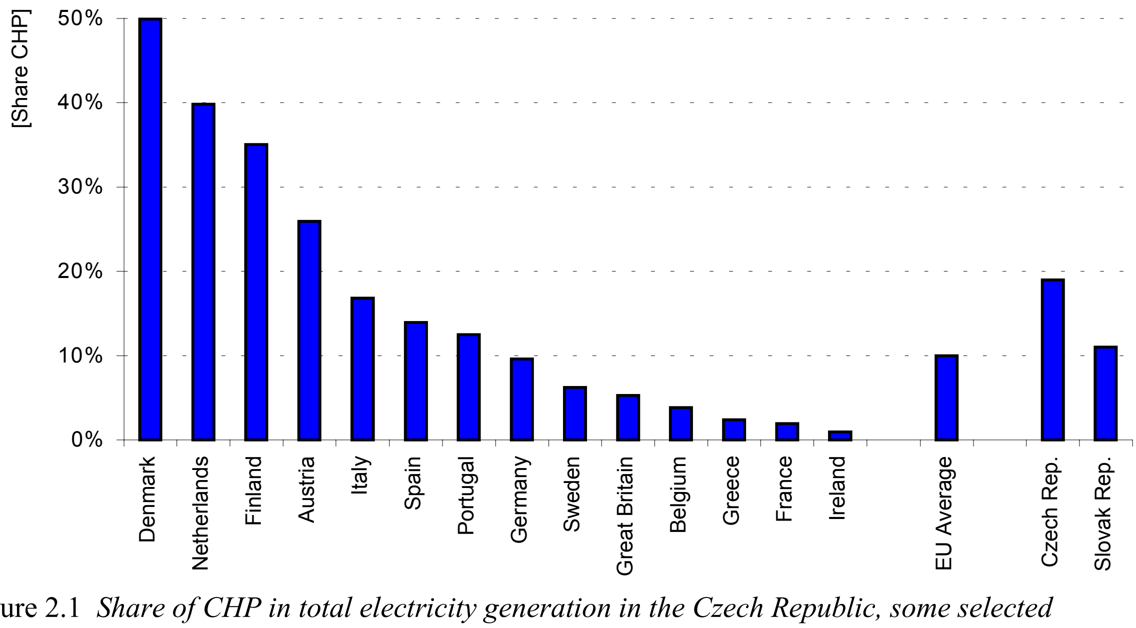

Figure 2.1 *Share of CHP in total electricity generation in the Czech Republic, some selected countries and in the EU (Source: COGEN Europe and own analysis)*

Figure 2.2 *Map of the Czech Republic with regions and districts and regional capitals*

The following CHP applications can be found in the Czech Republic:
- six big power plants with heat extraction,
- more than 20 big public CHP plants in biggest densely populated cities,
- many big industrial CHP plants in biggest industrial centres (e.g. Ostrava, Plzen, Mladá Boleslav, Kladno, Litvínov, Sokolov etcetera),
- 40 small-scale industry CHP plants with unit installed capacity of 1 to 20 MW_e,
- few hundred small-scale CHP plants (unit output up to 1 MW_e).

Table 2.3 *Installed power capacity of CHP sources according to groups of sources (1997)*

CHP source-sector	Installed capacity [MW]	Installed capacity [%]
Large thermal power plants	2,978	50.2
Public CHP plants	1,011	17.0
Industrial CHP plants	1,909	32.2
Small-scale CHP plants	40	0.7
Total	5,938	100.0

Source: Czech Statistical Office.

More than 65% of the installed power capacity exists of public power plants and public CHP plants. Additional over 30% is capacity in industry. The share of small-scale CHP capacity is very small.

2.2.2 Share of CHP on total power and heat production

The total power and heat generation in the Czech Republic is as follows (in 1997). The total heat production in power sector and district heating networks in the Czech Republic is about 700,000 TJ. Of the total heat produced roughly 520,000 TJ of heat (74%) is supplied to end-users.

Table 2.4 *Breakdown power and heat generation in the Czech Republic (1997)*

	Power [GWh/year]	Heat [TJ/year]
Hydro and nuclear plants	14,650	0
Individual boilers and stoves	0	170,000
Other sources	37,425[1]	229,123
CHP plants	12,425	121,369
Total	64,500	520,492

[1] Including six big power plants.

More than 50% of power generated by CHP plants comes from public power plants and public CHP plants, additional more 40% from industrial CHP plants. The share of small-scale CHP plants is still rather low - about 5%.

Table 2.5 *Power and heat production in CHP plants and structure by type of CHP plant (1997)*

CHP sources	Electricity production		Heat production	
	[GWh/year]	[%]	[TJ/year]	[%]
Large thermal power plants	2,799	22.5	7,950	6.6
Public CHP plants	3,659	29.5	50,729	41.8
Industrial CHP	5,267	42.4	59,690	49.1
Small-scale CHP	700	5.6	3,000	2.5
Total	12,400	100.0	121	100.0

Source: Czech Statistical Office.

The share of power and heat generation in CHP plants by regions of the Czech Republic is given in Figure 2.3.

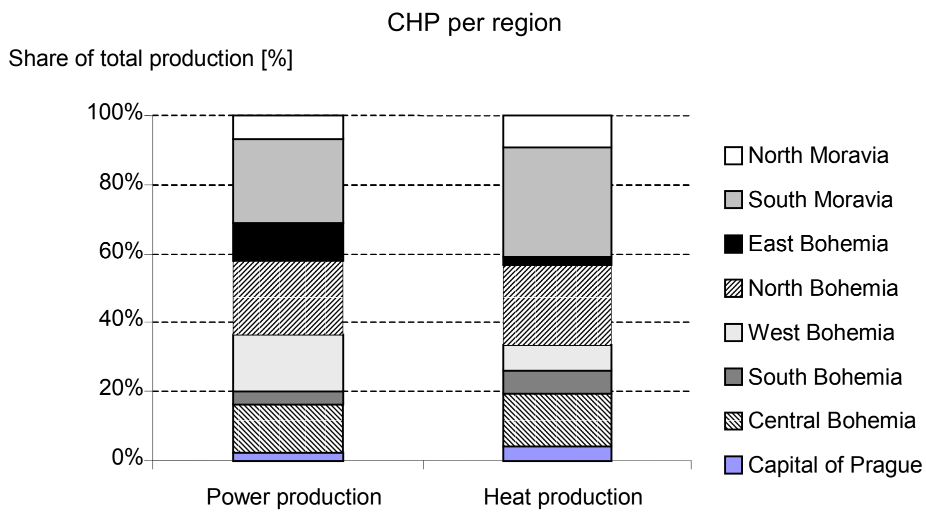

Figure 2.3 *Power and heat generation in CHP plants by regions*

2.2.3 Utilisation of renewables in CHP production

Biomass

In the Czech Republic, the energy use of biomass has been concentrated till now only on combustion in heat only boiler plants. Heat from biomass-fired boiler plants is used for district heating systems, some of them in rural municipal district heating systems. The wider use of biomass (wood) is found in local heat sources, operated mainly by inhabitants in single family houses. Although there some installations of biomass gasification CHP plants were planned, so far no biomass gasification CHP plant or classical cycle CHP unit using only biomass has been installed in the Czech Republic.

Biogas

Biogas is utilised in CHP units installed mainly in sewage treatment plants. There are also few installations operated in agriculture. The exact figures on the total installed capacity and yearly production are not available. The total number of installed biogas CHP units is estimated to be 30-35 with the total installed power capacity of 6-10 MW_e.

Landfill gas

Solid municipal waste, which is dumped into waste dumps (landfills), is the major source of landfill gas. According to the research undertaken by VÚMH in 1994 about 310 kg of solid municipal waste is annually produced in the Czech Republic annually per capita in the Czech Republic. Of this amount about 25-35% is of organic origin. The landfill gas of the average heating value of 17-20 GJth/m3 (about half compare to natural gas) can be made use for energy purposes in several ways. Most effective is a direct burning for various technological purposes, or for water heating in case of nearby consumption. In the case of large landfills, CHP also could be used for heat and power production in gas engines. This usually is proposed for landfills with the capacity over 1 mil. tonnes of waste. The usual problem to deal with is utilisation of heat. There is only one installation for landfill gas utilisation in CHP unit in the Czech Republic in the Chabry waste dump (near to Prague). Two CHP units are installed here with the electric output of 2 × 826 kW. All generated electricity is sold to the low voltage grid, but only a small amount of heat can be utilised in the plant itself. As a result, both the CHP units and the heat consumption will be relocated to a machinery plant where all heat will be utilised for space and water heating. Landfill gas will be supplied to Avia by a gas pipeline. The project would not be viable without subsidies.

The competition of natural gas and the penetration of other, more effective industrial methods prevailing the formation of landfill gas creation (e.g. smell-well method, which ensures that direct oxidation is going on in the waste field.) reduce the number of applications of landfill gas. Moreover, the new biological methods (with use of micro-organisms) are more effective and less capital intensive.

2.3 Existing CHP schemes

In the Czech Republic the following types of CHP technologies are installed:

1. conventional plants
2. combined cycle
3. small-scale (gas engine).

The conventional CHP plants are systems with steam extraction in combination with a condensing steam turbine for hot water production or a backpressure steam turbine for process steam production. As a result, condensing systems are applied in district heat system and the backpressure variant is used by the industry. The condensing type is widely used in the Czech Republic while the backpressure variant is hardly in use. The second category conventional plants are gas turbine systems equipped with heat recovery boilers, which have been installed since 1990. The technological design of large-scale CHP plants was predominantly influenced by the primary energy source used. Therefore coal-fired CHP plants with steam turbines dominate. The energy sources in industry were initially mostly developed as CHP plants with a steam distribution network. Only in the 60s to 80s, due to concentrated construction of housing, development of hot water based district-heating systems started. They are supplied by heat from the sources of the public power sector but also from industrial CHP plants.

Combined cycle CHP plants are relative new in the Czech Republic. In this plant, a gas turbine cycle is combined with a heat recovery boiler and a steam turbine. One of the largest installations of this type is equipped with coal gasification technology and is located near Sokolov and operated by a coal mining company. Also in Brno, the second largest city in the Czech Republic, a combined cycle plant was installed (95 MW_e/140 MW_{th}).

Small-scale CHP installations are gas engines combined with waste heat recovery coolers. There are over 500 small-scale CHP plants installed in the Czech Republic with a unit range between 10 and 1500 kW_e. Applications of small-scale CHP installations can be found in the smaller district heating sector, the residential and commercial sector and the industry (in which also biogas from sewage water treatment and landfill gas form landfill sites is included).

In district heat systems (about 210 CHP units), most of the units are located in boiler houses and work in tandem with gas-fired boilers (stand-by and peak boilers). The majority also operates in a peak load configuration, a smaller number operates in a base load configuration (preheating steam condensate in steam distribution systems). In the residential and commercial sector about 240 small-scale CHP units are installed. About 40% operate in base load. In the industry, only 50 small-scale CHP units are installed. This is caused by the large application of large-scale CHP in this sector.

More detailed information about the technical aspects of the CHP installations can be found in Annex A ‘Current state of CHP in Czech and Slovak Republics’.

2.4 Economic characteristics of existing CHP schemes

The installation of a CHP unit in the Czech Republic usually results from of a major reconstruction of the existing heat source due to termination of the technical lifetime or from the necessity to change an input fuel due to the newly applied environmental legislation (emission standards). A qualified decision on the reconstruction can only be made if all factors of both technical and economic (incl. financial) nature are well analysed and the main risks addressed. This chapter will describe those parameters that are crucial for economic assessment of the investment decision.

2.4.1 Main parameters of CHP economics

The major economic parameters influencing the decision on installing CHP are:

1. Investment (purchase) costs.
2. Operational costs, mainly fuel consumption and annual consumption of electricity, including pricing and tariff structure of this consumption, and maintenance costs.
3. Economic revenues (feed-in tariffs for electricity from CHP units and heat price, which highly depend upon the 2nd and the 4th point).
4. Operating regime of the heat source - load duration curve of the heat load in winter period and in other periods and availability.
5. Price of capital to be invested.

The Czech Energy Agency prepared a publication on the economic parameters of selected types of CHP schemes in case of a plant refurbishment. These parameters can be used as a guide to the formulation of business plan in case of CHP scheme implementation. The selected alternatives of industrial plant refurbishment were analysed using a professional software programme. Industrial sources of the thermal output of 10 and 35 MW were selected and technically viable alternatives of their refurbishment were assessed using discounted cash-flow method from the macro-economic point of view and the investor's (micro-economic) point of view. Various options of financing, credit conditions and taxation have been taken into account. Major technical data were collected of commercially available CHP technologies that allowed for specification of appropriate size of the unit in the selected output level and also corresponding requirements on the gas network capacity. For each group of heat output range, types of units have been ranked according to their economic efficiency.

2.4.2 Production costs

Investments

The investment costs are the major factor influencing the decision about a CHP source installation. These costs depend on:

1. purchase price of the CHP plant,
2. type of the plant,
3. type of fuel used.

The purchase price of the CHP unit is mainly determined by the share of foreign components in the final set. Units with gas engines and units with gas turbines are being delivered as a complete set, equipped with generator, heat exchangers, metering and control systems, etcetera. New plant construction requires many additional investment costs into the site, construction, infrastructure, etcetera. This is not the case for refurbishment of existing sources. The switch from coal to gas requires to pay for connection to the network and to negotiate the conditions of gas supply. Continued coal use requires new FGD technologies for emissions abatement. As follows from the above-mentioned CEA study and the assessment of individual technical options, the following investment costs should be considered in case of existing plants refurbishment, see Table 2.6.

Table 2.6 *Specific investment costs for refurshment existing plants*

Specific Investment [CZK/MW]	6 MW_{th}	10 MW_{th}	20 MW_{th}	35 MW_{th}
NGB+BPST	-	2.5 million	2.3 million	2.0 million
BCB+BPST	-	4.5 million	4.1 million	3.8 million
Gas turbine +HRU	-	5.7 million	5.3 million	5.1 million
Gas engine	4.0 million	3.3 million	-	-

NGB = Natural Gas fired Boiler
BPST = Back Pressure Steam Turbine
BCB = Brown Coal fired Boiler
HRU = Heat Recovery Unit

Operational and maintenance costs
In Table 2.7, the O&M cost for different CHP-schemes are given.

Table 2.7 *Operational & Maintenance Costs [CZK/GJ]*

Type of CHP		Gas Engine		GT	CC	
Capacity	[MW_{th}]	1.3	9.9	7.5	75	140
Fuel		NG	NG	NG	NG	NG
Operational hours	[hours/year]	2880	3100	7500	7000	5500
Personal costs	[CZK/GJ]	-	6.9	5.8	17.3	-
Maintenance costs	[CZK/GJ]	-	23.4	18.6	20.4	-
Total O&M costs	[CZK/GJ]	34	30.3	24.4	37.7	32

2.4.3 Fuel costs

The unit consumption of fuel per unit of output depends on the operational regime of the CHP unit and on the heat use. The level of heat utilisation in the gas engines based CHP units however have a decisive impact on the economic efficiency of the unit as expressed in the unit consumption of the input fuel in relation to the generated electricity. The unit consumption of fuel per kWh is three to five times higher in the case that heat is not used compared to the full heat utilisation in CHP units based on gas engines. The following table lists the average fuel prices of fuels used in CHP plants.

Table 2.8 *Price of fuels used in CHP plants*

Fuel	Price (average) [CZK/GJ]
Hard coal for industry	55
Hard coal for tertiary sector	60
Brown coal for industry	50
Brown coal for tertiary sector	55
Natural gas in industry	105
Natural gas in tertiary sector	105
Electricity purchase price	450

2.4.4 Economic revenues

The profitability of the CHP plants depends on the economic revenues, which are created by selling the produced electricity and heat, or by the avoided purchase of the energy carriers. Therefore the production costs of heat and electricity must be lower than the heat prices or the feed-in tariffs of electricity.

Feed-in tariffs
Current legislation regarding feed-in tariffs for electricity from CHP units stipulates (Article 18 of the Energy Act, No 222/84 Call) that the supplier of electricity is obliged to purchase electricity, in case it is technically possible, from CHP plants and from renewable energy and waste energy sources. The price of this supply is not regulated and the feed-in tariff depends on the agreement with the owner of the grid, i.e. with the regional distribution utility at present.

In the beginning of the second quarter of 1999, an agreement was signed between the state administration (Ministry of Finance and Ministry of Industry and Trade) and power distribution companies on the introduction of a flat feed-in tariff for electricity generated from renewable sources with the installed unit capacity of over 10 MW. These installations work as base load generators (i.e. 24 hours/day). This feed-in tariff has been set up as 1.13 CZK/kWh in case of power supply to the high-voltage grid and as 1.20 CZK/kWh in the low-voltage networks. The generation of electricity in CHP units with an other operating regime is priced according to a tariff system that favours peak or high load generation. Therefore, operating hours of CHP units are subjected to two principal parameters:

- parameters of individual boiler plants,
- local electrical feed-in tariffs.

These tariffs are different for each region and are dictated by the concern of the individual regional power distribution companies. Using these tariff conditions, we can identify two different principles (with some modifications for CHP unit size) for assessment on the optimal operation time of individual CHP units.

Regional electrical tariff policy and CHP design

The main aim of a CHP installation in general is the cheaper production of both heat and power. This depends on the local feed-in electrical tariffs and operational time for peak tariffs. Tariff policy differs by regional power distribution company. In the Czech Republic, there are 8 regional distribution companies (REAS). The tariff system has been constructed so as operation of plants is stimulated in the periods of high power demand. Most of distributors apply the principle that, in full utilisation of time and output of the unit, the average feed-in tariff of electricity equals to the level of the annual tariff. Although feed-in tariff levels are different in each region, we can generally say that peak electrical feed-in tariff is about 4 times higher than the off-peak tariff. The range of remuneration peak feed-in tariff is from 1.8 to 2.6 CZK/kWh, i.e. 160 to 215% of the basic annual feed-in tariff.

Heat prices

The price of heat is a crucial part of the economic assessment. In case of low feed-in electricity tariffs, the CHP producer moves the remaining costs to heat price and may loose its competitiveness. The majority of consumers in each district heating system are inhabitants, and since 1999 the heat price for inhabitants is not subsidised any more. Since then, big regional differences in heat price for inhabitants exist. The important parameters in determining the heat price are:

1. size and capacity of the district heating system (DHS),
2. fuel basis of each DHS (lignite, hard coal, natural gas),
3. lifetime of DHS and corresponding depreciation from installed equipment.

In the following overview, some typical DHS prices are listed mentioned ranked from the lowest heat price to the highest one. The lowest prices are in large old (write-off) DHS, based on lignite or hard coal. As an example heat prices (1998) from some DHS with CHP are listed in the following table without subsidies (tariff on the outlet of the plant).

Table 2.9 *Heat prices in some large district heating systems connected to large CHP plants*

Organisation	Town	Medium	Fuel	Price [CZK/GJ]
CEZ a.s.- Chvaletice CHP plant	Chvaletice	Hot water	Lignite	164.5
CEZ a.s.- Melník CHP plant	Praha	Hot water	Lignite	165.6
CEZ a.s.- Porici CHP plant	Trutnov	Hot water	Hard coal	195.7

Heat prices that are competitive prices to these large DHS with big CHP plants are realised by small heat-only boiler plants based on natural gas. There are many small DHS with a heat price between 200 and 280 CZK/GJ. There are also some small DHS with well designed CHP units and favourable feed-in tariffs, which have a similar heat price as the above mentioned boiler houses without CHP. There are nevertheless many DHS based on natural gas with much higher heat prices. One of the highest prices can be found in some DHS with big gas engines where the heat price is sometimes higher than 400 CZK/GJ. Other examples are given in the following table.

Table 2.10 *Heat prices in some district heating systems connected to boiler plant*

Organisation	Town	Medium	Fuel	Price [CZK/GJ]
Městské inž. sítě a.s.	Studénka	Hot water	Natural gas	313
JIP a.s.	Větřní	Steam	Natural gas	390

Also, heat prices from large old CHP plants based on heavy fuel oil are higher. The DHS in Liberec has a heat price of 347 CZK/GJ.

2.4.5 Operation regime

The operating regime influences the size and the operation of installed CHP units: peak load CHP or base load CHP. The aim of designers of CHP plants is to sell maximum of heat production and also to sell maximum of the total electricity production in peak hours and so make maximum use of the differences between the peak and low electricity purchase feed-in tariffs. Different configurations are available, which are described in Annex A ‘Current status of CHP in Czech and Slovak Republics’. Based on experiences with design of CHP units, we have learnt that gas engine CHP facilities operated in district heating systems (with more than 5,000 operating hours per annum) can be more profitable than big CHP plants.

The design of the unit is based on the minimum amount of heat necessary (in the summer time), sometimes using hot water storage tanks (heat storage for maximal production of electricity during peak demand). The main impact on the design is the demand for hot tap water during summer. The heat boilers usually cover remaining heat demand. For a typical municipal district-heating network, the optimum share of CHP is usually in the range of 20% to 30% of the peak heat load of the network. It is a rule of thumb that the capacity of CHP plants should never be oversized to avoid negative impacts of partial load operation. In contrast, undersizing is usually a smaller mistake from an economic point of view.

2.4.6 Conclusions

CHP projects require higher investments than heat-only the boiler plants. In the case of a coal fired unit this is about 30-40%, and in the case of natural gas fired unit’s 300%-400%. Therefore, an economic assessment is necessary to analyse the profitability of such a unit compared to the reference situation (the only boiler heat situation). The main components in the economic analysis are investment costs, O&M costs and the feed-in tariffs and heat prices. Also the operating regime has, due to price differences in peak and off-peak hours, a major impact on the profitability.

Small-scale CHP applications are designed on heat demand. From an economical point of view, it is not profitable to run these options in partial load. This applies to application of gas engines in the industrial sector as well as the residential sector. In several applications in the industrial and public and commercial sector, it may be more economically viable to design even small CHP plants on the basis of the electricity demand as a result of energy conservation measures.

2.5 Policy, legal and institutional framework

2.5.1 CHP policy

The most important energy policy document is the State Energy Policy. The proposal of the policy document of June 1999 states the support to promotion of CHP as one of the tools for improvement of energy efficiency and reduction of emissions of pollutants. Nevertheless, no specific target for the share of CHP in gross electricity production has been set yet.

2.5.2 Regulatory framework

The current legislative framework for activities concerning CHP consists of 22 Acts and Decrees. These acts specify basis conditions for business activities, define conditions for state regulation, taxes and protection of some category of end-users. Annex A contains a full list of these acts and decrees.

The Ministry of Industry and Trade grants licences for the business activities regarding generation and distribution of electricity and heat. Only natural persons that have the technical and financial qualifications can get one. The licence for distribution is issued for one described territory resulting in a natural monopoly by the licence holder. However this person is not protected against competition from other heat supply possibilities like electricity, direct consumption of other fuels). The general analysis shows that there is only one authority, which manages the process of licensing and regulation of business in the energy sector, e.g. for heat, electricity and gas. The Energy Regulation Authority is a section of the Ministry of Industry and Trade and is directly subordinated to the Minister.
Consumers are protected against the monopolistic behaviour of heat suppliers by supervision activities. These inspections are carried out by the State Energy Inspection, inspection of the State Trade Inspection, inspection of the State Protection of Environment and the Czech Office of the Safety of Work.

The valid Energy Act does not have clear and applicable provisions for solving the situation when a holder of the authorisation wants or is obliged to terminate his business activity. The situation could cause unexpected and non-solvable problems for the consumers. As far as the regulation of heat and electricity prices is concerned, the Ministry of Industry and Trade is the only authority, which is empowered to prepare a proposal for price changes. They deliver it to the Ministry of Finance for final approval and the consideration of the political/social aspects of any proposals based on economic analytic work.

2.5.3 Voluntary agreements

Recently, a voluntary agreement for increase of electricity purchase price from renewables, including CHP based only on the use of renewables, was signed. The partners are the Association of Entrepreneurs for Use of Energy Sources and all regional electricity distribution companies with participation of the Ministry of Industry and Trade and the Ministry of Environment. The agreement has been validated and it is implemented since April 1999.

2.5.4 Expected changes in the legal framework

In the near future it is expected that the *Energy Act* will be replaced by a new one to be fully compatible with the valid EU legislation, especially with regard to a gradual opening of the market with electricity and natural gas. Also, a new energy efficiency law is under preparation - *Energy Management Act*. The Act states the rights and obligations of the natural and legal persons during the production, distribution and consumption of energy, leading to an increase in the efficiency of energy use in the CR, protection of environment, support of a reliable energy supply, increase of competitiveness and support of sustainable development. Also a specific article is proposed on the obligatory CHP of electricity and heat production and on the obligatory monitoring of the minimum specified efficiency of energy use or the maximal specified energy losses. See Chapter 6.

2.6 Development trends of CHP

2.6.1 Recent development trends

Impact environmental regulation

In the Czech Republic and in other Central and Eastern European Countries (CEECs), domestic brown and hard coal have high share in the total fuel base for power and heat production and thus also on the overall air pollution level. Therefore, state authorities developed legal and economic tools in the air pollution control. Currently, amendments are under preparation of the following acts: Act No 309/1991 Call on the protection of the environment against air pollution in the wording of the Act No. 211/1994 Call, Act No 212/1994 Call on the state administration of the air protection and pollution charges, and the Act No 244/1992 Call on the Environmental Impact Assessment). The measures resulted in distinct drop in emissions of most pollutants in the first half of the 90s. The emissions of SO_2 dropped by 36%; NO_x by 60%; CO_2 by 15% and emissions of particulates dropped by 49% compared to the year 1990. Large power and heat producers have made huge investments in flue-gas desulphurisation and denitrifacion programmes to meet strict requirements of legal acts. Heat producers in district heating with CHP sources of a smaller installed capacity are recommended to refurbish its facilities by installing fluidised bed combustion technology, allowing for significant reduction of SO_2 and NO_x emissions or to built combined cycle plant with higher efficiency of electricity production.

Developments in district heating sector

The development of the Czech district-heating sector from 1989 to 1997 can be characterised as follows:

- Heat production for distribution decreased by about 16%.
- Electricity generation in CHP plants increased by 18%.
- The structure of fuels used for heat and power production in CHP plants is as follows:

– *electricity generation*	90% solid fuels (15% hard coal, 75% brown coal)
	5% fuel oils
	5% natural gas
– *heat production*	80% solid fuels (20-25% hard coal, 55-60% brown coal)
	14% fuel oils
	6% natural gas.

From these figures it becomes clear that solid fuels have a large share regarding production of heat and electricity. An average efficiency of fuel utilisation in CHP plants equals to about 63% in public CHP plants and to 66% in industrial CHP plants in the Czech Republic.

The present feed-in tariff for CHP generated electricity is in general an obstacle for the implementation of CHP in the district heating sector. It is insufficient for a profitable application of CHP produced electricity. This low feed-in tariff is based on the low prices charged for the public electricity supply.

After 1989 construction of few new CHP plants has started both classical ones and combined cycle ones. Some new big combined cycle CHP plants have also been recently installed in the Czech Republic or they are under construction now. More specific information on individual plants installed in the Czech Republic is adopted in Annex A Current status of CHP in CR and SR.

Governmental promotion of CHP
The large number of applicants for grants of the Czech Energy Agency for co-financing of small-scale CHP plants installation indicates a large interest in this field of CHP in the Czech Republic. Additionally there is an interest to invest in the rehabilitation of big CHP plants in municipal district heating as well as in industry. Besides foreign investors, some regional power and gas distribution companies are also interested to buy shares of district heating companies and CHP plants.

2.6.2 Long term development trends

Long-term development trends regarding combined cycle utilisation will depend on several factors:
- commissioning of the Temelin nuclear power plant in the year 2001-2003,
- rehabilitation and/or decommissioning of old coal fired power plants in the period 2010-2015,
- opening of the power market.

The following long-term objectives have been defined in the proposed Czech energy policy document:
1. Support of economically effective development of CHP units. Legal, tax and pricing instruments will be used to develop economic environment allowing for the most efficient utilisation of primary energy sources.
2. The development of regional energy systems will be supported, mainly in heat supply. Conditions will be developed on regional level for utilisation of all existing energy sources competitive in heat production, mainly of renewable sources. Regional self-sufficiency in heat supply will be promoted.

The price increase of some energy carriers will also be reflected in the price of district heat. Operators of district heating plants will have to apply energy efficiency measures to cope with demand decrease resulting from energy efficiency on the demand side. These requirements which influence the competitiveness of DH systems, will be more easily met by large city DHS with their own distribution network, boilers equipped with FGD technology and modern production units of high capacity (20-50 MW). The implementation of advanced CHP technologies in these systems has a much better chance.

3. CURRENT SITUATION IN THE SLOVAK REPUBLIC

3.1 Introduction

In the past, combined heat and power production in the Slovak Republic was used mainly in conventional CHP plants, which produced heat and power for industrial plants and for municipal district heating systems. Industry required heat mainly for technological processes in the form of steam and for space heating. District CHP plants were used as a centralised source of heat for space heating in buildings. In the 90s, new CHP plants were mostly based on gas turbines (combined cycle) and on gas engines. While conventional CHP plants were mostly constructed to burn solid fuels (brown coal), combined cycle CHP units use natural gas, or occasionally waste gases (e.g. biogas). Environmental concern is the major reason why retrofitting of old conventional CHP plants to gas-fired ones are being planned and implemented. This opens the opportunity to install CHP technologies, i.e. combined cycle CHP units.

3.2 Share of CHP

3.2.1 Share of CHP on installed capacity

The structure of power generation according to the installed capacity in the Slovak Republic is given in the following table:

Table 3.1 *Current structure of power generation in the Slovak Republic (December 1996)*

The total installed power capacity of the Slovak Republic	7171 MW	
of which:		
Installed capacity of hydro power and nuclear power plants	4159 MW	58%
Condensing steam power plants	1349 MW	18%
Other power sources	621 MW	9%
Industrial Cogeneration	778 MW	11%
CHP plants	265 MW	4%

Source: Energy Policies of the Slovak Republic, IEA, 1997 and SEA.

The following large CHP applications are found in the Slovak Republic:

- two lignite fired power stations of 2×110 MW_e each at Nováky (total 440 MW_e),
- four gas-fired heat plants in Bratislava (total 64 MW_e) and one in Trnava (12 MW_e),
- three gas- and lignite-fired pheta plants in Martin, Zvolen and Žilina (total 131 MW_e).

More than 50% of the installed power capacity exists of public power plants and public CHP plants. Additional over 30% is capacity in industry. The share of small-scale CHP capacity is very small. There is no specific information available regarding the share of the different CHP-schemes in the total electricity production.

3.2.2 Share of CHP in power and heat production

The overall consumption of primary energy sources in the Slovak Republic is being estimated at the level of 754 PJ. The final consumption of energy amounts to 552 PJ. Fuels (solid, gaseous and liquid) represent 603 PJ in the primary energy balance. In 1996, the production of electricity amounted to 25,330 GWh. This value has not changed during recent years and as also other statistical data come from this year, the year 1996 will be the base year for further analysis.

Table 3.2 *Power and heat (DH) generation in the Slovak Republic (1996)*

Type of power plant	Power[1] [GWh/year]	Heat [PJ/year]
Nuclear power plants	11,3	
Hydro power plants	4,52	
Condensing power plants	6,86	
CHP production [2]	2,69	68
Heat only boilers (Ind + DH)		156
Total	25,300	224

[1] Source: SEA.
[2] Conventional CHP plants, combined cycle, and small-scale CHP.

The Slovak electricity system consists of four public utilities, which are the dominant producers and suppliers, as well as a number of small private industrial co-generators and privately owned hydropower plants. The public system includes the national electricity generation and transmission company SE and three regional distribution companies:
1. ZSE, western regions
2. SSE, central regions
3. VSE, eastern regions.

With this information the share of power production by regions is estimated (see Table 3.3).

Table 3.3 *Installed CHP capacity by Slovak regions*

Region	SE [MW_e]	ZSE/SSE/VSE [MW_e]	IPP [MW_e]	Total CHP [MW_e]	Share [%]
Western	46	76	286	408	25
Central	440	131	137	708	43
Eastern	193	0	354	547	32
Total	679	207	777	1663	100

Source: Energy Policies of the Slovak Republic, IEA, 1997.

3.2.3 Share of renewables in CHP production

The first experiences with biogas as a fuel base for CHP units were evaluated. We expect an increase of CHP implementation in waste water treatments and landfills. However, it is necessary to note that the agricultural sector and waste use sector have serious financial problems and CHP implementation at this field will not be realised on a shorter term.

3.3 Existing CHP schemes

In the Slovak Republic, the same CHP options as in the Czech Republic can be distinguished:
1. Conventional plants (condensing and back pressure systems)
2. Combined cycle
3. Small-Scale (gas engine).

In general, the Slovak situation equals the Czech situation (see Section 2.3). Only the differences are mentioned below.

Conventional
The major part of electricity production from CHP in the Slovak Republic is produced at conventional CHP plants with steam turbines. Heat distribution from classical CHP plants is often done in combination with local district heating systems (condensing systems), from which flats, the tertiary sector and some small industrial enterprises are supplied. In big industrial factories CHP plants are usually installed with steam distribution (backpressure system) for industrial process purposes.

Combined cycle
Currently, combined cycle CHP plants are installed in three industrial enterprises only, but we can expect that in the future also public combined cycle CHP plants will be installed.

Small-scale
Small-scale CHP units are usually installed in small public and industrial CHP plants for space and hot tap water heating. They use natural gas and/or biogas (landfills etcetera), but most small-scale options are natural gas fired.

3.4 Economic characteristics of existing CHP schemes

The profitability of a CHP project is the crucial factor regarding investment decisions. The parameters to perform an economic assessment for the investment decision are described in this section.

3.4.1 Production costs

The economic parameters influencing the decision on installing CHP are the same in the Czech and Slovak situation. Only differences regarding fuel costs and economic revenues will be mentioned. For more detailed information see Section 2.4.

3.4.2 Fuel prices

Natural gas price depends on more local factors (wholesale, retail and households). At present the gas price for households is being adjusted by the government. The natural gas price for CHP units (mainly wholesale) is not subsidised and it is 3.58 SKK/m^3. It is assumed that in a near future fuel prices will not be subsided.

3.4.3 Economic revenues

In the economic evaluation it is necessary to consider the power feed-in tariff and the heat purchase price in the region where the CHP unit is installed.

Feed in tariff
The Slovak power distribution companies have rather complicated tariffs. Therefore, the economic evaluation we use some simplified assumptions for the average tariffs:
- feed-in tariff in the public grid between 1.0-1.2 SKK/kWh_e,
- own power usage estimated at 1.35-2.00 SKK/kWh_e.

Heat prices
The average heat price in the Slovak Republic is about 325 SKK/GJ.

3.5 Policy, legal and institutional framework

3.5.1 CHP policy

The lack of a clear energy efficiency and CHP policy is a main barrier to the promotion of combined heat and power in the Slovak Republic. The need for a policy framework for CHP is supported by two external commitments of the Slovak Government: First, by signing the Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects, the Slovak Republic has committed itself to draw up a programme to support energy conservation, including CHP. This includes relevant legislative and regulatory measures as well as subsequent enforcement. Second, one of the basic political objectives of the Slovak Republic is the accession to the European Union. Increasing the share of CHP is an important objective of the European Commission, which is addressed in the Community Strategy to promote Combined Heat and Power (1997).

In the Energy Policy of the Slovak Republic, the support of CHP implementation has been declared as one of the short- and medium-term goals. Nevertheless, no concrete action plan has been elaborated. Without having developed an enabling environment for CHP, the government intends to introduce an obligation of CHP installation in some specified cases in the Energy Efficiency Act, which is intended to come into force in 2001. Recently however, this obligation has been removed from of the latest draft of the Act.

3.5.2 Legislation

The current legislative framework for activities concerning CHP consists of the following acts:

Acts

1. Act No 70/1998 Call on the power sector (Paragraph 4, Paragraph 9, Paragraph 18) (Energy Act).
2. Act No 455/1991 Call on undertaking and trading.
3. Act No 286/1992 Call amended by Act No 397/1998 Call on Income taxation of Physical Persons, Paragraph 4e) on Tax Exemptions.
4. Energy Efficiency Act, currently under completion.

Relevant provisions

1. Compliance with the Act No 70/1998 Call on the power sector and with the revisions made to Act No 455/1991 Call on Undertaking and Trading have to be ensured - licensing requirements have to be met by the applicant (Paragraph 4 on Requirements for Granting the Licence, Paragraph 9 on Rights and Duties of the Licence Holder, Paragraph 18 on Purchase of Electric Power).
2. Price agreement between the purchaser and the producer has to be made that would respect price regulations in force.
3. Tax exemptions apply for plants for combined production of power and heat operated by both natural and legal persons - for income achieved for the first year of operation and the following five years.
4. According to the prepared Energy Efficiency Act, CHP production will become compulsory in case of new heating plant construction with heat capacity of at least 1 MWth, except the cases in which inefficiency has been shown by an energy audit (specified by the Act).

The Energy Act states the intention to retain substantial state powers and administrative discretion for regulation and intervention. In the ‘Energy Concept of the Slovak Republic to 2005’ a single buyer model has been chosen for the power sector and a separate, however no independent regulator should be established with limited powers under the Ministry of Economy. Granting licences and the designation of the single buyers for electricity and gas will be exempt from the normal appeal procedures applicable under the Code of Administrative Proceedings (Act No 71/67 as amended) and related regulations. In the Energy Concept also construction of new CHP sources has been mentioned a measure to improve the efficient use of imported fuels.

The Ministry of Finance is responsible for energy prices and tariffs, suggested by the Ministry of Economy. Consumer protection rules are set forth as part of the rights and duties of licence holders under the Energy Act as well as the duty of supply.

4. POTENTIAL OF CHP IN THE CZECH AND SLOVAK REPUBLICS

4.1 Definition of potentials

Within this study, two potentials of CHP are considered: technical and economic.

- The *technical potential* of CHP includes all technically feasible options. It is limited mainly by the technical conditions of conversion of primary energy to exploitable energy carrier (power and heat), as well by legal and environmental restrictions.
- The *economic potential* is the part of the technical potential, for which it is economically viable to apply CHP at given conditions, which are influenced by economic, fiscal and legislative conditions, government energy and economic policy, investment and operational costs, access to the capital, interest rates, etcetera.

In this study, an estimate is made of both the technical and economic potential. The assessment of the potentials is based on the development of the heat market, supply available of CHP technologies on the market, environmental restrictions and economic conditions. The period for assessment of potentials is 2005-2010. The assessment on the CHP potential requires very extensive work on collection of very detailed data by individual regions and/or by individual district heating system. As an assessment on the CHP potential was not the goal of the study, but the tool for investigations on obstacles to reach the potential only, the following two simplified methods were applied:

- A *bottom-up* approach in which the calculation of the potential is based on detailed data in one region and these are extrapolated to the whole country. This approach is useful in the case when detailed data on only specific region(s) is available and when these data can be easily extrapolated to other regions and the whole country. This approach was used to calculate the potential in the Czech Republic.
- A *top-down* approach in which the potential is calculated using the countrywide figures. This approach is useful when no detailed data are available on regional level and when the countrywide data is sufficient to reflect the actual situation. This approach was used to calculate the potential in the Slovak Republic.

4.2 The potential for CHP in the Czech Republic

4.2.1 Key markets for CHP

The potential of CHP in the Czech Republic depends on many different factors. The two main factors are: i) the technical conditions given by the structure of energy sources and ii) the level of district heating development. In the Czech Republic, a high level of large-scale district heating and CHP development has been reached. The reason for this is that district heating and CHP have a long-term tradition in the Czech Republic. That is why most of existing large sources of heat in district heating systems are designed as CHP plants. Even if the share of CHP is rather high both as installed capacity as well as power and heat production regards some potential for further extension of CHP still exists. The future development of CHP in the Czech Republic is mostly oriented on the penetration of new technologies and on the extension of existing district heating systems but not much on possibilities of building new district heating networks. When assessing the potential of CHP, the following two basic strategies are considered:

1. *Rehabilitation of existing large CHP plants and district heating systems in public heat supply and in industry (self producers).* In this sector one can expect only a very slow increase of the volume of heat supply, because the extension of current district heating networks is very investment intensive. The major technical obstacle to an increase of heat generation in most of big CHP plants is the limited future increase of demand for heat. That is why heat suppliers to large district heating systems are interested in combining the retrofitting of their heat sources with an extension of current DH networks and connection of additional customers.

The largest investment project of this type in the Czech Republic will be an extension of the district heating network to the southern part of Prague where new heat consumers will be connected with an annual heat consumption of over 2,000 TJ. The heat source for this district heating network is the retrofitted Melnik 1 power plant (annual volume of heat supply till now is about 7,000 TJ).

2. *Use of small CHP in decentralised municipal district heat sources and in industry.* In this category of CHP a significant increase of the new capacity has already been achieved. Annually there is an increase of some tenths of new small CHP units. Nevertheless, the share of these small-scale CHP plants on total installed capacity of all CHP plants and on heat and power supply is still rather low (about 10%). The potential for small CHP plants can be found both in the public heat supply in cities where small district heating networks exist and where heat is still supplied from heat only boiler plants, and in rehabilitation of energy sources in industry.

The process of CHP penetration has proceeded in both fields in the Czech Republic. Some of the large CHP plants have been retrofitted in last few years (e.g., Mělník 1 power plant, Zlín CHP plant, CHP plant of Trinec ironworks, Vresová combined-cycle CHP plant) and some other ones are being rehabilitated now (Kladno CHP plant, Kyjov CHP plant, Olomouc CHP plant, Ústí n/L. CHP plant). Additionally new small CHP units with piston gas engines with an output ranging from 10 kW to many MW as well as some CHP plants with gas turbines have been installed recently.

4.2.2 Current situation by region

As stated above, the bottom-up approach was used to calculate the technical CHP potential in which the calculation of the potential is based on detailed data in one region and these are extrapolated to the whole country. The first step to assessment on the technical potential for CHP was an analysis of the current situation in district heating and CHP in the Czech Republic on both country-wide and regional levels (eight regions of the Czech Republic). The analysed regions of the Czech Republic are (see also Figure 2.1):

- Capital city of Prague
- Central Bohemia
- South Bohemia
- West Bohemia
- North Bohemia
- East Bohemia
- North Moravia
- South Moravia.

Detailed data on these regions is not available in the publications of the Czech Statistical Office, but is available in different regional information sources, regional statistical publications and other possible information sources (existing studies, data from municipalities, operators of local heat sources and heat networks etcetera). The basic characteristics of these regions differ substantially. Big differences can be found in the number and density of population, concentration and structure of industry and consequently the installed capacity of power and heat production and consumption.

Table 4.1 *Basic characteristics of regions of the Czech Republic*

Region	Number of inhabitants [× 1000]	Area [km^2]	Density of population [capita/km^2]	Urban population [%]	Heat sources [MW_{th}]	CHP plants [MW_e]	District heating networks [km]	Industry number of employees [× 1000]
Prague	1,200	496	2,420	100	8,301	159	1,064	93
Central Bohemia	1,106	11,014	100	55	4,261	738	549	121
South Bohemia	701	11,346	62	64	2,488	142	603	98
West Bohemia	858	10,875	79	72	4,445	467	781	112
North Bohemia	1,179	7,799	151	81	5,991	1,941	1,257	169
East Bohemia	1,234	11,240	110	64	3,590	766	539	177
North Moravia	1,968	11,068	178	70	10,419	1,287	2,127	298
South Moravia	2,053	15,028	137	61	6,513	438	1,273	252
Czech Republic	*10,300*	*78,866*	*131*	*71*	*46,008*	*5,938*	*8,193*	*1,320*

A detailed review of all large CHP plants and review of available data on small-scale CHP plants was carried out. Data on installed capacity, power and heat production in 1997 according to above mentioned regions was collected and is presented on the following table.

Table 4.2 *View of basic data on CHP plants by region of the Czech Republic in 1997*

Region	Installed electrical capacity [MW_e]	Power generation [GWh/year]	Heat production [TJ/year]
Prague	159	313	5,870
Central Bohemia	738	1,762	19,570
South Bohemia	142	437	9,150
West Bohemia	467	2,030	9,390
North Bohemia	1,940	2,690	20,130
East Bohemia	766	1,320	3,520
North Moravia	1,290	3,080	41,750
South Moravia	438	801	11,980
Czech Republic	*5,940*	*12,430*	*121,400*

The low average number of operating hours is mainly caused by industrial capacity that has low utilisation due to the decrease in production in some industries. A brief overview of different regions from the point of view of population, concentration of industry and existing CHP plants and district heating networks is presented in Annex B ‘Potential of CHP in Czech and Slovak Republic’.

4.2.3 Technical potential in Central Bohemia and the Czech Republic

Based on an extensive analysis presented above, the following table summarises the total CHP technical potential in the Central Bohemia region by field of application.

Table 4.3 *Technical potential of CHP application by field in the Central Bohemia region*

Type of application	Field of application	Capacity [MW_{th}]
LS-DH	Extension of the capacity of large CHP plants in DH-systems[1]	60
MS/SS	CHP in municipal district heating networks of other cities	10
	CHP in industry	285
SS	CHP in residential sector for rural population	1
	CHP in tertiary sector	10
	CHP in transport and agricultural sectors	2
	CHP in retail and small business sectors	25
	Total technical potential	*393*

[1] concerning 5 cities.

The CHP potential in other regions of the Czech Republic was estimated using some basic characteristics of individual regions, namely number of inhabitants, share of urban population, industrialisation of the region, current statues of district heating networks, heat supply from CHP plants, etcetera. A large difference exists among individual regions in the share of heat that could be supplied from CHP plants on the total heat supply. In general, the highest share can be reached in heavy industrialised regions with a high density of population in urban agglomerations and with the possibility to use CHP in industry. The assessment on CHP technical potential was done according to the following four steps:

1. To get the first idea on possible future role of CHP by region, a ranking of individual regions by individual characteristics was made. The following table presents the ranking of individual regions by the level of individual characteristics. Additionally, the last column presents the sum of rankings and thus gives the total ranking of regions. Taking into account the results of ordering, the most favourable conditions for CHP development are found in the North Moravia region, while the South Bohemia region has the most negative conditions.

Table 4.4 *Ranking of the regions in the Czech Republic (1: highest)*

Region	Number of inhabitants	Area	Density of population	Share of urban population	Thermal output of heat sources	Power output of CHP plants	Length of district heating networks	Number of employees in industry	Total
North Moravia	2	4	2	4	1	2	1	1	17
South Moravia	1	1	4	7	3	6	2	2	26
North Bohemia	5	7	3	2	4	1	3	4	29
Prague	4	8	1	1	2	7	4	8	35
East Bohemia	3	3	5	5	7	3	8	3	37
West Bohemia	7	6	7	3	5	5	5	6	44
Central Bohemia	6	5	6	8	6	4	7	5	47
South Bohemia	8	2	8	6	8	8	6	7	53

2. In the next step, an in depth analysis of individual characteristics by each region was carried out. Using the average figures received from the Central Bohemian region, the rough CHP technical potential was calculated.

3. In the third step, regional capitals were analysed separately and results from the previous steps were corrected to reflect the specific situation in individual regions. Results of calculation of the CHP technical potential are by individual region are presented in Table 4.5. The results of the assessment of the technical CHP potential carried out within the current study is in good correspondence with the results of the PHARE study of 1995 taking into account that part of the potential presented in that study has already been implemented[4].
4. In the last step, the results were discussed with the Czech experts in CHP and district heating during the workshop. The conclusion of the discussion was that, taking into account the current economic situation of and mainly future development of heat demand, the potential is overestimated mainly in case of big CHP plants and industrial CHP plants. The reasonable increase of CHP plant output was estimated to be 2,000 MW_e till 2010. The figures in the above table were corrected accordingly, except for small CHP plants. The revised total figures are given in Table 4.6.

Table 4.5 *Total initial technical potential of CHP by region in Czech Republic till 2010 [MW_{th}]*

Region	LS-DH	MS/SS-DH	SS	MS/SS-Ind	*Total*
Central Bohemia	60	10	38	285	*393*
South Bohemia	50	7	29	185	*271*
West Bohemia	60	10	37	225	*332*
North Bohemia	90	5	58	350	*503*
East Bohemia	80	15	49	270	*414*
North Moravia	100	15	70	455	*640*
South Moravia	90	15	60	265	*430*
City of Prague	180	0	59	270	*509*
CR total	*710*	*77*	400	*2,300*	*3,500*

Table 4.6 *Corrected CHP potential in the Czech Republic till 2010*

Type of CHP plant	Potential of	
	Heat capacity increase [MW_{th}]	Power capacity increase [MW_e]
Large CHP	560	400
Medium/Small CHP	1,250	750
Medium/Small CHP in Industry	1,180	850
Total	*3,000*	*2,000*

The possible power and heat production of small-scale CHP was estimated as well and are presented on the following table.

Table 4.7 *Potential of power and heat production in small-scale CHP plants 2010*

Category	Potential
Power production generation	3 200 GWh/year
Heat generation production	16 100 TJ/year

4 In the PHARE study of 1995 a relatively large technical CHP potential was found - about 3,680 MW of thermal capacity and 2,750 MW of electrical capacity with the primary energy savings of about 70,600 TJ/a. Profitability was not considered for the determination of this technical potential. The profitability of the CHP potential depends on market conditions as well as on legal, administrative, regulatory and financial constraints set by the government. The extent to which the technical potential can be implemented depends on these conditions and it is therefore the subject to variation.

5 Even under the current conditions there is a considerable economic cogeneration potential mainly in industrial plants - about 510 MW of electric capacity - with the primary energy savings of about 12,800 TJ/a. If we assume a realistic increase of the economic cogeneration potential through an implementation of a proposed legal, administrative, regulatory framework by only 20% of current technical potential it gives an increase of economic cogeneration potential by about 550 MW of electric capacity with additional primary energy savings of about 14,100 TJ/a or 28.2 million ECU. This gives very good results from the analysis.

4.2.4 Economical potential for CHP

Method of calculation

As presented in characteristics of the different regions of the Czech Republic above, the development of CHP is ongoing even at current legal, administrative and financial conditions. The largest ongoing projects are:

- Kladno CHP plant - investments into a new technology are more than 240 mil. USD - heat source for district heating network of the city of Kladno.
- Brno Červený mlýn CHPplant - 95 MW_e + 140 MW_{th} - heat source for district heating network of the city of Brno.
- Kyjov CHP plant- CHP source of 23 MW for Vetropack Moravia Glassworks and for the city of Kyjov.
- Rehabilitation of the Olomouc CHP plant.
- Heat supply to the Prague district of Southern City (Jizní Město) from the Melník CHP plant - construction of heat feeders for heat supply from the CHP plant in volume of about 2 000 TJ/year and investments of 1.6 billion CZK.

All these investments are results of foreign strategic partners' entrance in certain Czech district heating companies. Additionally, annually there are installed some tenths of new small-scale CHP plants with the support provided by the State programme for promotion of energy savings and renewables. They are installed both in municipal district heating networks, in industry, in tertiary sector and by population. The total number of installed small-scale CHP units is 500. Nevertheless, the current progress in penetration of mainly small-scale CHP plants is rather slow due to different obstacles that are discussed in the next chapter of this report. The creation of more conform legislative, administrative, regulatory and financial conditions for investments and operation of CHP plants would promote penetration of CHP and a substantial part of the technical potential will change into the economic potential.

The major barriers are economic. Different activities for improving economic condition of CHP exist. One of these activities is the voluntary agreement between the Association of Entrepreneurs for Utilisation of Energy Sources and all regional power distribution companies with participation of the Ministry of Industry and Trade and the Ministry of Environment. The result of this agreement is an increase of power feed-in tariff from renewable energy sources and from small CHP plants based on utilisation of renewables. The Agreement has been in force since April 1, 1999. Regional distribution companies purchase electricity from small CHP units based on renewables (mainly biogas) at a price, which was increased by 12% to 1.13 CZK/kWh. This is only a small step to the improvement of economic conditions, nevertheless the next step would be to extend this preferential feed-in price to all small-scale CHP plants. As this would require is important as the agreement was reached with all power distribution companies it seems not to be realistic as voluntary agreement.

Scenarios for economic assumptions

The calculation of the economic potential of CHP was made for three scenarios till 2010. These scenarios are as follows: (A more detailed description of individual scenarios is given below):

- *Basic scenario* (business as usual): - prolongation of current economic conditions for CHP.
- *Scenario with increase of power feed-in tariffs* - an increase of current feed-in tariffs for small- and large-scale CHP plants will influence the level of economic viability of these plants. Assumed increase from current average price of about 1.13 CZK/kWh in the basic tariff to the level of 1.60 CZK/kWh.
- *Scenario with massive government support to CHP*- significant subsidies and further financial advantages for an implementation of small- and large-scale CHP plants will further improve their economic viability and increase the economic potential**.**

More information about these scenarios is available in Annex B 'scenarios for CHP in Czech Republic.

The results of calculation by scenario of the penetration of CHP, are presented in comparison with the base year (1995) on the following tables. To estimate the economic potential, a time horizon of ten years (till 2010) has been applied. The payback period was calculated for a range of different CHP schemes. Schemes with a payback period below eight years were considered economical.

Table 4.8 *Basic scenario (business as usual) [1995=100]*

CHP technology [%]	1995	2000	2005	2010
Natural gas small-scale CHP	100	200	390	800
Biogas small-scale CHP	100	160	280	470
Biomass small-scale CHP	0	100	240	350

Table 4.9 *Scenario with increase of feed-in power tariffs [1995=100]*

CHP technology [%]	1995	2000	2005	2010
Natural gas small-scale CHP	100	280	790	1800
Biogas small-scale CHP	100	335	560	920
Biomass small-scale CHP	0	100	240	350

Table 4.10 *Scenario with massive government policy on promotion of CHP [1995=100]*

CHP technology [%]	1995	2000	2005	2010
Natural gas small-scale CHP	100	200	390	1200
Biogas small-scale CHP	100	335	560	920
Biomass small-scale CHP	0	100	240	350

The results of calculations show that, even at current economic conditions, small-scale CHP based on use of natural gas would increase at an annual rate of 20% between 1995-2010. Small-scale CHP based on use of biogas would increase with the annual rate of about 10%. The calculation demonstrates that the increase of feed-in power tariff will have more important impact on CHP penetration rate than the massive state support of investments. The rate of CHP penetration based on biomass will be comparable with the rate of CHP penetration based on natural gas, but the penetration of this biomass technology will be delayed by five years.

Resulting economic potential of CHP

In comparison to the estimation of the technical potential, it is necessary to include the time horizon, for which the potential is defined. The year 2005 was taken as the time horizon. The economic potential of CHP is shown in the following table. Compare Table 4.6 for the technical potential.

Table 4.11 *Economic potential of CHP till 2005*

Type of CHP plant	Potential of	
	Heat capacity increase [MW_{th}]	Power capacity increase [MW_e]
Large public CHP	300	210
Small-scale CHP	250	150
Industrial CHP	400	290
Total	*950*	*650*

The results of the assessment of the economic CHP potential is in good correspondence with the results of the PHARE study of 1995 taking into account that part of the potential presented in that study has already been implemented[5]. The economic potential includes all economically viable application of CHP. In general, the economic potential is only about 30% of the technical potential till 2005.

4.2.5 Conclusions

CHP has a long history in the Czech Republic and the heat share (23%) and electricity share (19%) produced by CHP plants is high compared to many EU countries. Almost every district city has one or more CHP plants and at least part of the city is heated by district heating network. Many industrial plants operate their own CHP plant (often the industrial CHP plant supplies by heat also to part of the city).

Technical potential

Three fields for implementation of CHP and thus of the potential of CHP development have been identified in this study: The first field suitable for implementation of CHP is the rehabilitation of old CHP plants. This process has started by switching from coal to natural gas and by implementation of technologies with less emissions of pollutants. This type of rehabilitation will not increase heat production as CHP plants have a fixed heat market but electricity production will increase. The second fields are municipal boiler plants, which were built in districts that were not economically viable for CHP plants based on economic criteria of that time. This was mainly to due to lack of financial sources. These plants are located in many medium and smaller-sized cities including some districts of the capital of Prague. This segment creates the potential for applying small-scale CHP plants (if gas is available in these localities) and for an extension of existing district heating networks (i.e. Prague - Southern City). This concerns the extension of district heating to residential districts where there is still used local heating based on coal. The assessment of the extension of district heating is based on the assumption that district heating is cost effective when the density of heat demand is more than 20 MW/km^2, the same can be applied for implementation of CHP. The third field suitable for implementation of CHP is industry, the public sector and small and medium enterprises (SME). Industrial CHP plants will be rehabilitated and at SME small-scale CHP plants can be installed. The CHP potential includes also smaller local fields of heat consumption where it is possible, thanks to fast development of advanced technologies for small-scale CHP plants, to implement CHP. These fields are: industrial boiler plants, district and house boiler plants in municipal residential districts, boiler plants of administrative and commercial centres, schools, cultural and sport centres, hospitals and other health care centres, banks and insurance buildings, hotels, shopping centres etcetera. The technical potential of CHP application in the Czech Republic was estimated, using current level of knowledge on the most important segments of heat consumption and using results of analysis of the structure of heat sources in these segments. The assessment of the potential has been carried out for the individual regions of the Czech Republic.

An estimated technical potential of additional output of CHP is rather high: Heat capacity of 2,990 MW_{th} and power capacity of 2,000 MW_e, including 750 MW_e in small-scale CHP plants, which will be mostly applied in rehabilitation and upgrading of municipal boiler plants and smaller industrial plants and in services.

Economic potential

When evaluating the economic potential of CHP, the current economic situation of the Czech Republic was taken into account as well as the economic measures under preparation for promotion of CHP (proposal of the Government Energy Policy, Energy Act and Energy Management Act). The economic potential of the CHP development for the next five years period (till 2005) has been estimated at 650 MW_e of new power output in CHP plants. It represents of about 28% of the technical potential. The appraisal is based on the assumption that in these next five years, a small part of the technical potential will be realised. This is namely the part where the most favourable conditions will be (the payback period of investments will not be more than 8 years) and on the assumption that suitable projects will be granted by the subsidy from the State programme of energy savings and renewables.

4.3 The potential for CHP in the Slovak Republic

4.3.1 Technical potential for CHP

The assessment of the potential for CHP technologies is very complicated. No complete database exists, which would allow developing the potential. That is why less precise comparative and approximation methods were used in the assessment in this study. The required statistical data on boilers supplying heat to industry, residential sector and tertiary sector (without education and health care facilities) are available at Slovak Energy Agency (SEA).

At present about 7000 boilers are installed, of which about 5000 use natural gas as a fuel. Table 4.12 gives the breakdown according to capacity.

Table 4.12 *Installed boiler capacity in Slovakia*

Installed capacity [MW_{th}]	Number
up to 0.2	2,136
0.2-1.0	876
1.0-6.0	1,926
6.0-10.0	50
10.0-100	86
over 100	2

The following assumptions will be made: a standard boiler house comprises 3 boiler units, of which 1 boiler is installed as a back up boiler and 2 boilers supply with heat, one being utilised whole-year and the other only during winter peak hours. Furthermore, it is assumed that 1/3 of the boilers will be replaced by CHP units at reconstruction. The ratio between the electric and heat output (MW_e:MW_{th}) of 1:1,5 will be considered for small CHP units with piston engines, and 1:2 in case of higher outputs - in turbines. Under the stated assumptions, the results presented on the following table can be achieved:

Table 4.13 *Technical CHP potential for replacing heat boilers in the Slovak Republic*

Capacity range [MWt]	Average heat output [MW_{th}]	Average electric output [MW_e]	Number of CHP units	Total installed heat output [MW_{th}]	Total installed electric output [MW_e]
Up to 0.2	0.2	0.133	712	142	95
0.2-1.0	0.6	0.4	292	175	117
1.0-6.0	3.5	1.75	641	2,244	1,121
06.0-10.0	8.0	4.0	17	136	68
10.0-100.0	55.0	28.0	28	1,540	784
over 100	150.0	75.0	1	150	75

One can conclude that:

1. The potential in CHP units of small capacity range (up to 6 MW) represents in the final results potential installed capacity of (95 + 117 + 1121) = 1333 MW_e.
2. The potential in CHP units of higher installed capacity (CHP heating plants - industrial and district heating systems) represents potential power capacity of (64 + 784 + 75) = 927 MW_e.

As follows from the presented analysis, the total technical potential of CHP might amount to 2,260 MW_e. It is necessary to deduct the value of the power capacity of conventional CHP plants representing the value of 780 MW_e. The remaining technical potential is 1,480 MW_e.

4.3.2 Economic potential for CHP

The values of economic potential can only be understood as a theoretical value. We have to consider limiting factors, such as:

- limits to generation and supply of heat, which has a seasonal character,
- other fuels then natural gas, are also being used for heat generation, which at present are not applicable in CHP units,
- prices of natural gas, heat and electricity (sold and back-purchased),
- assumptions on annual operational time and following low cost-effectiveness reduce the potential for economic implementation of CHP.

From the national statistics on heat generation can be derived that of 68 + 156 = 224 PJ (62,221 GWh_{th}) of heat comes from industrial and district heating CHP plants and heat-only boilers. The total generation of electricity in CHP amounts to 2,689 GWh_e. In setting up the potential for electricity produced in CHP, it is possible to make an assumption that 50% of heat can be produced through CHP and 50% directly in heat-only boilers, i.e. without electricity (winter peaks, capacity disproportion, etcetera), i.e. 31, 110 GWh_{th}. As has already been stated above, a ratio of 1:29.8 is being achieved in electricity and heat generation. In conventional CHP plants this ratio amounts to 1:7, in case of wider application of modern CHP technologies the total ratio of generated electricity to generated heat can amount to 1:6. Due to a gradual replacement of boilers in real estates by CHP units electricity generation of 31,110: 6 = 5185 GWh_e might be achieved, which is an increase of 2496 GWh_e as compared to the existing status. If we project this value to the installed capacity of 780 × 2496/2689 = 724 MW_e we can state that the potential for CHP is 2500 GWh_e, resp. 720 MW_e.

The publication of 'Energy Policy of the Slovak Republic' of the International Energy Agency, states that the government in its Energy Concept assumes the reconstruction of boilers in the residential sector into CHP units with the potential of 100 MW_e and in the tertiary sector additional potential of 150 MW_e, i.e. in total 250 MW_e. According to the study worked out by the Austrian Energy Agency EVA in 1996, the potential for CHP has been estimated to be 3,000 GWh_e, i.e. 600 MW_e. The latter figure is consulted with the results of this study.

Another way of assessing the potential is based on the basic balances of natural gas consumption in the Slovak Republic. See Table 4.14.

Table 4.14 *Natural gas balance Slovak Republic [bill. m^3/a]*

Wholesale	4.6
Retail	0.4
Households	1.3
Others	0.3
Total	6.6

The consumption of natural gas within the sectors of the Ministry of Economy is 3.7 bill. m^3/a; consumption outside industry, residential and others (tertiary and communal sectors) is then 5.0 - 3.7 = 1.3 bill. m^3/a. It is possible to assume that this amount of natural gas is mostly used for space heating and heat and hot tap water heating. Another rough assumption has been made that 50% of this consumption can be used in CHP units and remaining 50% will be used in heat-only boilers. For CHP generation 1.8 × 0.5 = 0.64 bill. m^3/a of natural gas will be used.

The energy value of natural gas is 9.3 kWh/Nm^3. In CHP production this energy value will be utilised as follows:

Table 4.15 *Energy values*

	[kWh/Nm^3]	[%]
Electricity	3.72	(40)
Utilised heat	4.65	(50)
Losses	0.93	(10)
Total	*9.3*	*(100)*

The theoretical potential of electricity production is 0.64 × 3.72 = 2.4 bill. kWh/a (about 2,400 GWh_e/a). This value is consistent with the potential specified in the Paragraph 3.2.1. The directly proportional capacity potential is then 690 MW_e. If we use for setting up the likely capacity potential the most simple statistical method, i.e. the average from Paragraphs 1 to 4, then the resulting (724 + 250 + 600 + 690): 4 = 566 MW_e can be taken into account.

An additional potential for CHP is assumed in biogas utilisation in the environmental technologies and agriculture. An expert assessment of this potential was made, which may be in the level of 10 MW_e. After reconstruction of industrial and district heating CHP plants into steam/gas combined cycles CHP plants, it is estimated that fuel is better utilised for electricity generation by 10%. This can also represent an increase of the installed power capacity (and the potential for CHP) at the value of 80 MW_e.

Taking into account all the assumptions made, one can conclude that the economic potential of CHP amounts to 660 MW_e or 2,500 GWh_e/a. This power generation would increase the share of CHP on total power generated to about 23 % in the year 2010. This corresponds to a doubling of the current share.

5. MAIN BARRIERS FOR CHP

5.1 Introduction

Many barriers exist for CHP in the Czech and Slovak Republic. Some barriers are exactly same as those in the EU Member States, while others are more specific for Central Europe. The following barriers will be described in this chapter:

1. unclear government policy in the promotion of CHP,
2. unfavourable institutional framework,
3. inadequate legislation and regulatory framework,
4. unfavourable pricing and tariffs,
5. unfavourable conditions for financing CHP projects,
6. lack of awareness, knowledge and experience.

Although some differences between the countries exist, the main barriers hold for the Czech Republic as well as the Slovak Republic. Wherever the barriers are different, this is mentioned explicitly in the text.

5.2 Policy framework

A policy framework for CHP or for energy efficiency, which defines the structure for setting targets and priorities, has not yet been established in the Czech and Slovak Republic. However, as in other Central and Eastern European Countries, the Republics have agreed to meet the requirements of various EU legislation and international treaties that in fact require such an energy policy framework. It concerns e.g. the Energy Charter Treaty, the EU directives on internal markets of electricity and gas, and environmental treaties. Because of those international agreements, the governments of both Republics have been working for several years to establish an Energy Act. So far however, these Energy Acts have not yet been put in force. The current drafts of the Energy Acts make only a brief reference to CHP, which has no priority. No additional energy efficiency and CHP policy documents exists.

5.3 Institutional framework

The present institutional framework in the heat and electricity market does not promote CHP. The existing relations between the public power and heat producers and the distribution networks for electricity and for heat make it difficult for independent CHP producers to sell their products at adequate prices. For the CHP producers that want to sell heat and electricity, several parties are important:

- the public electricity network owners (the regional utilities),
- the central/public power producers,
- the heat distribution network owners,
- the district heating source owners in their region.

In the *Slovak Republic*, municipalities often own the district heating plants. In the *Czech Republic* recently the ownership of many district-heating plants has changed. Formerly the owners of the plants were municipalities (towns). After privatisation the shares of municipalities differ to a large extent; district-heating systems exist that are fully owned by municipalities, as well as ones in which municipalities are minority owners.

In both countries, the electricity network owners and the heat distribution network owners are in the position of natural monopolies. Between the public electricity network owners and the central power producers, as well as between the heat distribution network owners and the district-heating owners, historic, stabilised trade relations exist. Between them, a system of delivery prices has developed for various types of consumers. The prices differ according to the type of consumption, ownership of the heat plant, maintenance of the heat plant, etcetera. Many of the heat suppliers misuse the monopoly to project expensive investments and most production costs projected into the price of heat, paying little attention to the fact that this results in excessive payments of households for heat (see also Section 5.5).

5.4 Regulatory framework

At present no regulatory framework has been established. The proposal of a new Energy Act is still being discussed. Acts defining the role of CHP have not yet been approved. Several important barriers to the development of CHP arise from the lack of regulations that make CHP producers less dependent of the electricity network utilities. Despite legally there exists for independent producers free access to the grid, in practice inadequate payment for sales of surplus capacity to the grid and high tariffs for stand-by and top-up supplies offered by the distribution company can disqualify the CHP alternative. These are key factors impeding the penetration of CHP even in a partly liberalised European energy market.

Market opening

Differences will occur in the introduction of the internal market principles into the power sector legislation. While the *Czech Republic* intends open the market through introduction of the regulated third party access model (rTPA) or through 'pool' (nTPA), the *Slovak Republic* intends to introduce 'Single buyer' model. Nevertheless, in both models CHP economic competitiveness may become a crucial point of its extension, unless an effective strategy has been adopted and reinforcing measures that would promote CHP as an energy saving and environmentally friendly system of heat and power production. See also Chapter 6.

Energy efficiency regulation

The legislation related to CHP promotion is also based on similar principles in both countries, with small differences appearing recently. In the *Czech Republic*, the newly proposed Act on Energy Management Act stipulates in all plants with an installed electrical capacity higher than 5 MW the obligation to consider CHP alternative, unless the energy audit proves CHP uneconomic or technically unsuitable. In the *Slovak Republic,* this obligation has also been proposed in the new draft of Energy Efficiency Act, the electrical capacity threshold has been lowered to 1 MW, unless the energy audit proves CHP uneconomic or technically unsuitable. In the next recent draft, the obligation has been abolished. In both countries, these Acts have not yet been approved.

In the *Slovak Republic*, energy efficiency may improve in several aspects after the proposed Act on energy efficiency will be approved, but neither major support schemes to CHP nor a privileged position can be expected, though. The positive impact of CHP technologies on the environment will be reflected in environmental legislation in the form of bonuses. The most important barriers to the development of CHP result from the relationship between the CHP producers and other electricity production utilities. Obstacles to free access to the grid, inadequate payment for sales of surplus capacity to the grid and high tariffs for stand-by and top-up supplies are key factors impeding the penetration of CHP even in a partly liberalised European energy market.

5.5 Pricing and tariffs

The main barriers concerning prices and tariffs are the following:
- distorted prices for heat and electricity,
- cost allocation,
- low feed-in tariffs for electricity sales in case of sales into grid,
- a high heat price, in which most of the production costs are included,
- non-payment for heat.

These barriers will be explained briefly in this seating, and will be worked out more elaborately in Chapter 6.

Distorted prices
A major economic barrier in the generation and sale of electricity and heat arises from the distorted prices due to state subsidies mainly to households. Price distortions are a barrier in both the Czech and the Slovak Republic, although there are differences in the development of these price distortions between the two countries. The pricing and tariff policies in CR and SR originate from similar principles, but their development now is marked by differences. At first, prices of electricity and heat were (heavily) subsidised in both countries in the past. The removal of price distortions, which is necessary for the creation of a competitive environment in electricity and heat generation, has been limited by social policy (impact on low-income households).

In the *Czech Republic,* no subsidies on district heat prices are available since mid 1998 while in the Slovak Republic subsidies still continue even if they are being reduced step by step. In the *Slovak Republic,* the price of electricity increases much slower, which has worsened the conditions for CHP introduction compared to the Czech Republic. Industrial companies pay an in both Republics pay a higher than cost-based price on electricity and gas. Households benefit from cross subsidies, which will be removed in the near future, although faster in the Czech Republic than in the Slovak Republic.

Cost allocation
The low electricity prices do not create economic conditions for cost-effective investments in CHP. Successful small-scale CHP projects have always had some exceptionally favourable conditions in peak-tariffs, exceptionally long operating hours, state contribution to investment costs, etcetera. The cost effectiveness is given by the share of total costs for production and distribution of energy and revenues for sales, which depend on the current demand for electricity and heat (influenced e.g. by energy efficiency measures applied in end-use, district heat competitiveness, etcetera) and the sales prices. The production costs can be allocated to the cost of electricity generation and the cost of heat production. A number of methods is being used and the opinions on cost allocation in general or on individual methods differ.

The existing way of selecting on the method of cost allocation into electricity and heat is not favourable for the competitiveness of CHP heat, because all costs are allocated to heat production, with subtraction of the revenues from the sale of the co-produced electricity. This is especially unfavourable because of the low feed-in tariffs for electricity.

Feed-in tariffs
Revenues should be generated by electricity and heat sales. The feed-in tariff for electricity sold to the grid remains a critical point. The supplier of electricity has the obligation of electricity purchase in case it is technically possible, but the feed-in tariff depends on the agreement with the owner of the grid, i.e. with the regional distribution utility. The electricity network owners (electricity producing utilities), being natural regional monopolies, can set the prices for electricity individually. For delivery to consumers there is a maximum tariffs regulation (for electricity as well as for gas). For electricity purchased by the grid, there are no maximum or minimum tariffs. Electricity from the current power sources in the grid is rather low-cost and thus the feed-in tariffs offered are low and do not enable to get adequate payment for sales of surplus capacity from CHP unit to the grid. An exception exists in peak hours, in which the distribution company may prefer to buy electricity locally, and is prepared to pay a higher price for that.

High heat prices
The revenues from electricity sales have direct impact on heat prices, because of the way the costs are allocated to heat and electricity. The CHP producer compensates the inadequate revenues for electricity in the heat price. The district-heating source owners are natural monopolies, which can set the prices of electricity and heat individually, within the factural regulation principles for the price of heat. The heat price is in the *Czech Republic* 'cost plus', regulated with limits to the relative increase every year. The high level of the CHP heat price, though, threatens the competitiveness of sales, because CHP heat has to compete with heat from accessible natural gas and other fuels. Due to the low gas prices for households, part of the consumer's switch to gas. This means that the remaining district heating customers have to pay an increased cost, which makes it for them even more attractive to switch from CHP heat to heat-only options by natural gas or other fuels.

Non-payment
In heat sales another significant problem occurs: non-payment. The number of consumers who do not cover their bill for heat increases. Several reasons exist:
- technical constraints in setting up the exact costs,
- heat price increases,
- economic reasons (low income),
- political and institutional weakness of governments to solve the weak enforcement of law,
- low quality of heat delivery contracts.

5.6 Financing

In both countries, it is very difficult to find capital for investments in CHP project. In the *Slovak Republic*, both in-house and commercial capital is scarce. In the *Czech Republic*, however, commercial capital is available. The main problem here is not the lack of capital, but the strict requirements of the private financiers (i.e. conditions of available financial sources) for CHP schemes. At present there are only few companies in the *Slovak Republic* with sufficient in-house capital. Commercial finance is too expensive due to high interest rates and CHP projects become financially not viable as a result. That is why only projects have been implemented that have succeeded to get additional support (mainly from foreign institutions). The main financial barriers are described below. See Chapter 7 on more details in financing.

Economics of CHP projects

- The internal rate of return is low compared to other projects.
- The capital intensity is high compared to other heat solutions. Compared to the heat-only solution, CHP plants require higher investments: by 30-40% in case of coal fired plant; and by 300-400% in case of natural gas units. In case of lack of finance to retrofit a DHS and to install CHP, the cheapest option for investments in heat production is sought: heat-only. The Decisions on new CHP plants in the Czech Republic are mostly being taken in case of reconstruction of existing DH systems (coal-based) or refurbishment of industrial plants. In both cases, the alternative of a new CHP plant involves significantly higher investment costs, resulting from the high purchase price of the CHP units (of both EU and locally produced technologies). In addition, other costs are frequently involved - e.g. the necessity to reconstruct the distribution network, to pay for connection to the network and to negotiate the conditions of gas supply in case of switch from replacement of coal to gas. The continued coal use, on the other hand, requires to the installation of new FGD technologies for emissions abatement.

Capital availability and requirements

- General lack of in-house capital for investments. In-house capital is in general scarce or too expensive for investments into CHP, because investment cost of CHP is high and IRR of CHP schemes is lower than most core business projects.
- Capital is expensive. Commercial products offered by Czech banks range from 8 to 10% at present and loan duration offered may be of 8-10 years. Still, the price of the Czech capital is higher than that of neighbouring countries - Austria and Germany (4-7%) (providing finance to a number of ESCO companies of Austrian or German ownership).
- High risk perceived by the lender. Unless there exist long-term agreements on electricity and heat purchase, which give sufficient certainty of revenues to pay back the debt service, the risk perceived by the investor may be too high.
- The political risk of lack of cost-based pricing is high (see pricing and tariffs)
- The commercial risk of unreliable revenues from electricity and heat sales are high (see pricing and tariffs):
- Lenders, because of the unstable economic situation, request excessive guarantees. Due to the unstable economic climate and difficult prediction of client financial situation and project benefits, banks tend to rely on loan guarantees, which - both in case of municipality and of an industrial plant - may create a substantial obstacle.
- Czech investors have low credit-worthiness. For many investors, access to credits and/or other commercial finance (EPC) is impossible due to some of the following factors:
  - unclear or not transparent ownership,
  - sales difficulties due to recession (no profits),
  - unclear business plan (production programme),
  - poor financial standing of potential investors,
  - restricted municipal budgets.
- The rules for depreciation of technological equipment are not suitable for energy technologies and make problems mainly in new investments with high capital cost.
- A general problem for CHP financing is the lack of financial institutions other than banks. Investment funds and other financial groups have not yet developed.

Lack of skills and capacity

- A lack of managerial skills and capacities exists (see knowledge and experience).
- A shortage of expertise exists to develop a bankable project proposal; technological knowledge is good, but economic, financial and risk assessment has to improve (see knowledge and experience).
- Investors have limited experience in working with foreign and international financial institutions and products (knowledge and experience).

- Banks miss a long-term view on investment opportunities, well-developed energy concepts and proper project development (knowledge).

Other
- In the municipal sector, because of limited municipal budgets, CHP have to compete with other investments (waste and sewage water investments, infrastructure development) and with less capital-intensive heat production investments.
- For most international financial institutions, the complex procedures are not suitable for small-scale projects; CHP projects are considered small with low profit. Also big Czech banking houses are often not interested in smaller CHP schemes for the same reason.
- Leasing of energy technologies is scarce because these are difficult to place anywhere else and there are legal constraints so that the leasing company cannot retain them.
- When the financial situation of the client is such that it cannot be ensured that the debt will be paid back, this is a barrier for leasing as well as for commercial funding by a bank
- The weak financial situation of a client makes the risk for leasing on commercial funding by a bank too large.

5.7 Knowledge, awareness and capability

Several barriers for CHP can be attributed to lack of knowledge, awareness and capability:
- In municipal CHP plants often, a lack of knowledge exists in operating the plants. This is sometimes solved by contracting to external organisations, or by selling the plant to a private owner. A related problem is that municipalities lack the knowledge to contract external investors or to set up beneficial conditions in case of sale of the plant.
- Many potential users and possible investors are not aware of the advantages of CHP, in particular of small-scale CHP. At the same time, experience is lacking in dealing with proposals for CHP investments. This leads to the following barriers:
  - Shortage of trained and skilled staff to develop a bankable project proposal. Technical skills are often available, but there is a shortage of necessary skills to prepare a detailed technical, economic and financing proposal for the lender. The necessity of such detailed studies is being underestimated as well as the necessity to address all risks. Moreover, such studies are expensive and the investor is not used to pay high costs to external assistance in project development phase.
  - In addition, smaller banks may not have specialised skills in assessing the CHP project. This lack of experience leads to large overhead costs for the development of small CHP projects. At the same time, the need for external qualified assistance is underestimated, as well as the necessity for proper project development and its relevant costs.

6. REGULATORY FRAMEWORK

Energy and environmental regulation has a strong impact on CHP. In this section, the following relevant regulatory issues are discussed. Recommendations are given for improvements of existing legislation and the introduction of new regulation:
1. Access of CHP producers to the electricity heat grid.
2. Priority dispatching of CHP plants and purchase obligation.
3. Price and tariff regulation for electricity, heat and natural gas.
4. Levies and taxation.
5. Tradable green certificates.
6. Licensing of CHP producers.
7. Authorisation for the construction of new CHP plants.
8. Environmental regulation.

New and revised legislation is currently under preparation in the Czech Republic. The suggested regulation should be incorporated into the Energy Act (Section 6.10), the Energy Management Act (Czech Republic) and the Energy Efficiency Act (Slovak Republic) (Section 6.11), and the amendments to environmental legislation (e.g. the Clean Air Act (CR)).

6.1 Access to the grid, priority dispatching and purchase obligation

With the opening of the electricity market, the currently prevailing forms of CHP promotion used in a number of countries including some EU countries, namely the electricity and heat purchase obligation, regulated feed-in tariffs, priority dispatching etcetera, will contradict with the effort to establish objective, transparent and non-discriminatory conditions for electricity trading at market prices. In consequence, most countries have been abandoning the above principles or, as a compromise, reducing them to priority dispatching or purchase obligation at regulated prices of electricity from renewables only. Given the relatively small share of this electricity, its possible impact on the electricity market is negligible. Countries promoting CHP use for these purpose financial and fiscal instruments, which enable CHP investors and producers to reduce costs and penetrate the electricity and heat markets.

6.1.1 Access to the grid

Czech Republic

In the Czech Republic, access to the grid is regulated. The current Czech energy legislation (in particular, Energy Act No. 222/1994) stipulates that the holders of power distribution licences must purchase electricity from combined heat and power production whenever it is technologically feasible. The draft new Energy Act already introduces the requirements of EU (the Electricity Directive No. 96/92/EC) on the opening of the Czech electricity market. The new Energy Act will not include the current obligation of power distribution licence holders to purchase electricity from combined heat and power production whenever it is technologically feasible. Instead, in the draft new Energy Act it is stated that producers that operate CHP plant enjoy the priority of power transport via power transmission and distribution networks if they ask for this transport and if it is technologically feasible. The wording of the draft new Energy Act opens access to the grid, but do not impose an obligation to purchase power produced in CHP plant.

Slovak Republic
In the Slovak Republic the regulatory functions of the state have been defined in the Energy Act (Act No 70/1998 Call). Access to the grid is regulated (Energy Act No 70/1998, which includes licensing requirements for electricity purchase). This Act specifies conditions for licensing of businesses in the energy sectors. Paragraph 18 stipulates that distribution companies are obliged to purchase all electricity from power sources, in case these sources are environmentally substantiated and if economic and technical conditions allow for the purchase. The environmental conditions have not been specified yet, but are being prepared as a part of environmental legislation. The Act thus includes the obligation of power distribution licence holders to purchase electricity from combined heat and power production elsewhere it is technically feasible.

A general conclusion drawn from a COGEN Europe study[6] is that access to the grid for plant with output below 500 kW_e is restricted by connection charges. The same problem is likely to occur in the Czech Republic and should be addressed through regulation.

6.1.2 Priority dispatch and purchase obligations

The dispatch and purchase of electricity from CHP plants in the Czech and Slovak Republics should be regulated to reflect the EC Directive to ensure:

1. Priority dispatch of the most efficient plant (in terms of the amount of fuel required to generate 1 kWh_e), concerning all energy conversion plant supplying electricity to the network; this is in the national interest. However, in summer periods this may be disadvantageous for CHP plant as compared with other power generation schemes, but that depends on the type of plant with which the CHP is being compared.
2. Purchase on an avoided cost basis.

These directives and other EU legislation are to be embodied in the new Energy Act, which is currently in draft form in both countries. There are qualifying paragraphs allowing diversions from these directives in the case of technical or economic constraints. The regulation would control:

- dispatching in the national interest,
- dispatching priority to CHP plants amongst other purchase by the single buyer of electricity from CHP plants amongst others.

6.2 Electricity prices and tariffs

The prices of the products from the combined heat and power production, for which the operators of CHP units may realise their products in the market, are important economic parameters for CHP projects. In the following two Sections 6.2 and 6.3, electricity and heat prices and tariffs are discussed.

6.2.1 End-user electricity prices

Czech Republic
The level of electricity prices and mainly the structure of end-user electric power tariffs can substantially influence the power market and thus the level of feed-in tariffs for CHP plants and economic viability of such projects in the Czech Republic. The current tariff system for the sale of power to end-users in the Czech Republic, which has been adopted from the former Czechoslovakia, was developed in 1989 based on analyses of the average costs of power production and distribution in the power distribution system of the former Czechoslovakia.

[6] COGEN Europe. The administrative obstacles to the development of cogeneration - electrical network limits. Brussels (1999).

To date the old fashion tariff system remains in use and is applied with modifications using indexing methods taking into account the development of economic conditions and estimated degree of social bearing of the price increases. Distortions of power prices for households are being removed gradually since 1992 at the average annual rate of price increase of 15%. The largest single increase was done in mid 1998 by 24%. The adjustment of power prices for households is assumed to continue up to the year 2002 when prices for households and small businesses with equal consumption and voltage will be levelled. This will require an increase of electric power price for households by approximately 40%. The decision for power price adjustment for households has been a difficult political problem because not only electricity prices are being adjusted. Additionally prices of other energy carriers and services connected with housing increased as well, which generally increased the living costs of households as can be seen on the following table.

Table 6.1 *Development of costs of energy and services connected with housing, average data [CZK per household and month]*

	4th Q 1998	1999	2000
Rent	553	606	654
Electricity	548	548	631
Gas	303	303	348
Heat	580	603	623
Water and sewage water	173	198	218
Housing services	105	115	123
Total	4264	4372	4597
Annual growth		2.5%	5.1%

Source: Ministry of Finance of the CR.

Electricity prices for end users are regulated; the maximum prices are fixed. On 1 January 2000 a new tariff system came into effect; it is applied to all electricity users except households. The new tariff system includes a wider range of tariffs, both for electrical energy (kWh) and capacity (kW), so that any consumer can choose a tariff best corresponding to his needs. Seasonal tariffs, different for the winter period (from October to March) and for the summer period (from April to September), have been introduced. This modification of the tariff system is a first step in developing a completely new tariff system, which is to come into effect in 2001.

6.2.2 Short-term development of end-user electricity prices in the Czech Republic

The first step has already been made: electricity prices for households increased by 15% since 1 January 2000 while prices for other groups of consumers increased only slightly or even decreased (large consumers from very high voltage grid). Similar changes will continue in the next two years. The proposal of energy price adjustment for individual groups of consumers till the year 2002 prepared by the Ministry of Industry and Trade and Ministry of Finance is shown in the following table and figure. The aim of the price adjustment is that all consumers will cover short-term marginal costs.

Table 6.2 *Development of upper-bound electric power prices by individual group of consumers (excluding VAT and influence of inflation) - year-on-year increase [%]*

Year	1998	1999	2000	2001	2002
			Households		
Electricity	24	-	+15	+14	+13.1
			Small business consumers		
Electricity	.	-	+1.9	+1.8	+1.8
			Large consumers connected to the high voltage grid		
Electricity	.	-	-3.3	-3.8	-4.4
			Large consumers connected to the very high voltage grid		
Electricity	.	-	+4.4	+4.4	+4.4

Source: Ministry of Industry and Trade of the CR.

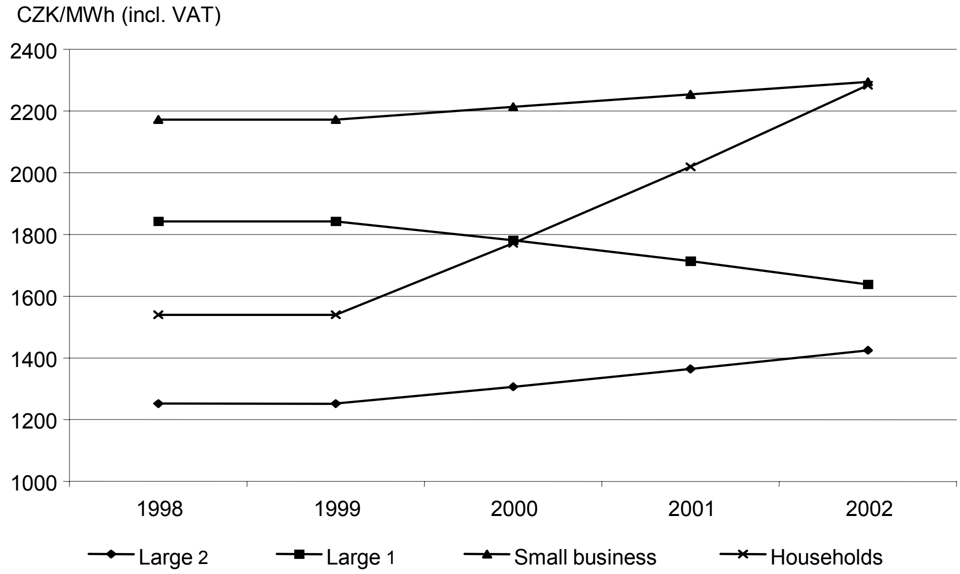

Figure 6.1 *Proposed power price adjustment programme*

Note:

Large 1: consumers connected to the high voltage grid, gas sector - medium-size consumers

Large 2: consumers connected to the very high voltage

The price structure for households remains unchanged, except for the maximum price, which has been raised in absolute terms. The completion of the adjustment of electricity prices charged to households is assumed to continue up to the year 2002 when prices for households and small business with similar consumption and voltage would be levelled. The impact of future adjustment of electricity and gas prices on household expenditures can be seen on the following table.

Table 6.3 *Development of costs of energy, average data [CZK per household and month]*

	Average household costs	Average increase of costs				Average household costs
	4th Q 1998	2000	2001	2002	Total 2000-2002	4th Q 2002
Electricity	548	83	88	93	264	812
Gas	303	45	38	30	113	416
Total	851	128	126	123	377	1228

Source: Ministry of Industry and Trade of the CR.

The policy of limited growth of regulated end-user electricity prices resulted in a general pressure minimise feed-in tariffs of power suppliers. This has a negative impact on new CHP plants that cannot offer a competitive electric power price unless increasing heat price.

6.2.3 Impact of liberalisation on electricity prices and tariffs (long-term)

The Czech Republic as an associated country to the EU committed itself to implement EU legislation. The most important recent directives of the EU related to energy sectors are directives on opening power and gas markets. Opening power and gas market will create a completely new environment for both producers and consumers. Within the new Energy Act in the Czech Republic, the major steps are proposed for opening power market which are based on the requirements of the Power Market Directive of EU. The table below shows the status of the proposal at the end of March 2000, but some acceleration of the process of power market opening is possible.

Table 6.4 *Major steps proposed for opening power market in the Czech Republic*

Date	Consumer capacity (single meter) [GWh]	Producer capacity [MW]	Milestones
January 2001			New Energy Act in full power
January 2002	>40	>10	
January 2003	> 9	100%	Removal of subsidies
January 2005	> 0.1	100%	
January 2007	100%	100%	

In general, the opening the power market can create new challenges and threats for future development of CHP (see special chapter). The major results of opening the power market from the price point of view can be summed as follows:

- Opening the competition can lead to a power price drop for some categories of end-users, mainly large consumers which take electricity from high and very high voltage grid and thus the interest for building own CHP plants can be reduced. Compare the development in the United Kingdom (see Annex E).
- The general reduction of consumer prices would result in a reduction of feed-in tariffs from IPP.
- Opening the competition will ease the access of IPP to the grid and allow for making negotiations on the level of price mainly if special services can be offered.

Slovak Republic

The current tariff system for the sale of power to end-users in the Slovak Republic is based on analyses of the average costs of power production and distribution in the power distribution system of the former Czechoslovakia. To date, the old fashion tariff system remains in use and is applied with modifications using indexing methods taking into account the development of economic conditions and estimated degree of social bearing of the price increases. The existing tariff system does not adequately respect the diversity of the needs of individual consumer groups, e.g., the seasonal character of their consumption, diversity of their needs for off-peak and peak energy supply, character of the consumption load curve, etcetera. It does not ensure that each consumer pays such a price to cover costs incurred by the consumer to power supplier. Therefore, power prices are being adjusted and a new tariff system is being prepared. The completion of the adjustment of power prices for households is assumed to continue up to the year 2002 when prices for households and small business with similar consumption and voltage would be levelled. The major aim of the proposed price adjustment process is that all consumers will cover short-term marginal costs.

6.2.4 Feed in tariffs

Czech Republic

The current Czech energy legislation clearly stipulates that the holders of power distribution licences are obliged to purchase electricity from combined heat and power production whenever it is technologically feasible. Although the price of electricity from CHP plant could be fixed by the Ministry of Finance (MF), in practice it is assumed that a licence holder (a regional power distribution company) should purchase electricity from independent producers at 'usual' prices. The 'usual' price in the Czech power sector is negotiated between the dominant power producer (ČEZ a.s.) and the regional power distribution companies (REAS). Following the adoption of the Energy Act (Act No. 222/1994), the principle has been adopted that the power feed-in tariff should not exceed the price that the dominant power producer (ČEZ a.s.) sets. This is a fixed price of CZK 1,030/MWh. In subsequent years, the feed-in tariff has developed differently in different regions under the influence of the market strategy of individual regional power distribution companies. Today, the individual power distributors fix the power feed-in tariff within the framework of their business activities, according to established practice. The current average feed-in tariff from CHP sources operated by IPPs is estimated at approximately CZK 1,200/MWh. Generally the current obligation of purchase of all power from CHP plants produced in combined power and heat production could create an incentive for building new CHP plants. Nevertheless a low feed-in tariff, which is usually offered by power distribution companies, is not sufficient for an economic viability of most of CHP projects in case that the surplus of electric power should be sold to the public grid.

The new Czech energy legislation (draft new Energy Act), which will introduce the requirements of the EU Power Directive on opening the power market in the Czech Republic, will eliminate the current obligation of power distribution licence holders to purchase electricity from combined heat and power production elsewhere if it is technically feasible. Instead of this obligation, the draft new Energy Act will stipulate that producers that are operating a CHP plant will have the priority right of power transport via power transmission and distribution systems if they apply for this transport and if it is technically feasible. The new Energy Act opens the access to the grid but does not force the obligation to purchase power produced in CHP plant. At the same time the Energy Act itself does not specify any conditions for setting feed-in tariffs for power from CHP plants. The price regulation will be the responsibility of the Regulator Office, which will set the methodology for price regulation in the Decree to the new Energy Act.

Basically, two ways of the future regulation of feed-in prices can be used: 1) fixed price, and 2) avoided cost. The first one is easy to set up and monitor, but may produce inconsistencies from one region to the next. Fixed price however is not considered in the draft new Energy Act. The second one, an avoided cost basis, would allow each regional distribution company (REAS) to set its own price for feed-in electricity, reflecting local conditions and respecting the adopted methodology. This would be more difficult to monitor, requiring transparency and auditing, which are costly be more costly than for the first method.

Slovak Republic
The current Slovak energy legislation stipulates that the holders of power distribution licences must purchase electricity from combined heat and power production elsewhere it is technically feasible. Although the price of electricity from CHP units could be fixed by the Ministry of Finance of the Slovak Republic (MF), in practice it is assumed that the holder of a licence (regional power distribution company) should purchase the electricity from the independent producers at the 'usual' prices. The 'usual' price in the power sector of the Slovak Republic is determined between the dominant power producer SE and the regional power distribution companies (REAS). In subsequent years, the feed-in tariff will develop differently in different regions under the influence and market strategy of individual regional power distribution companies and today the individual power distributors fix the power feed-in tariff within the framework of their business operations and established practices. It is possible to make an estimate of today's average feed in tariff from CHP sources operated by IPPs at approximately SK 1200 - 1300/MWh.

6.2.5 Impact of liberalisation on electricity prices and tariffs

Czech Republic
The Czech Republic being an associated country to the EU committed itself to implement EU legislation. The opening of the electricity and gas markets will create a completely new environment for both producers and consumers. Within the preparation of a new Energy Act in the Czech Republic, major steps are proposed for electricity market opening which are based on the requirements of the EU Electricity Directive (see Table 6.5).

Table 6.5 *Major steps in opening the electricity market in the Czech Republic*

Date	Consumer capacity (single meter) [GWh]	Producer capacity [MW]	Milestones
January 2001			New Energy Act in full power
January 2002	>40	>10	
January 2003	> 9	100%	Removal of subsidies
January 2005	> 0.1	100%	
January 2007	100%	100%	

The major results of the electricity market opening from the price point of view are the following:

- The opening of competition can lead to an electricity price drop for some categories of end users, mainly large consumers, and thus reduce the interest for building own CHP plants.
- General reduction in consumer prices might trigger pressure for reduction in feed-in tariffs for electricity from IPPs and, in consequence, might lead to reduction in CHP plant profitability.
- The opening of competition will ease the access of IPPs to the grid and allow them to negotiate prices, especially if special services (system and ancillary services) can be offered.

Liberalisation of electricity markets in the United Kingdom, which began 10 years ago, resulted in reduction in electricity prices charged to industrial users of 15% to 20% and in gas prices of 46%, and wound up many planned CHP schemes. A similar process can be foreseen in the Czech Republic if CHP does not receive any special support. Uncertainty over future energy prices has been a factor in the slow pace of implementation of CHP schemes in the UK. The new Energy Act in the Czech Republic seems likely to produce the same uncertainty about prices, which may mean that decisions on CHP plant construction and operation will be difficult to make. The draft new Energy Act does not specify any conditions for setting feed-in tariffs for electricity from CHP plants.

The price is left to be a competitive price on the electricity market. However, feed-in prices, high standby and top-up charges are not market prices; they represent barriers to CHP implementation and therefore should be regulated. Transparency of pricing would ease this situation. Specific regulations for each price/charge are discussed below.

Slovak Republic
The Slovak Republic being the associated country to the EU committed itself to implement EU legislation. The opening power and gas market will create a completely new environment for both producers and consumers. This will have to reflected in relevant legislation (Energy Act) in the Slovak Republic, the major steps have not yet been proposed that would accommodate requirements of the EU Directive on the market opening in the electricity sector. Steps taken in the Czech Republic can be screened and the impacts of the new Czech legislation should be evaluated in the process of harmonisation of the Slovak and EU legislation.

The liberalisation of electricity markets in the United Kingdom resulted in reductions in the price of electricity for industrial users of 15% to 20% and effectively ended many planned CHP schemes. In the Slovak republic with state control over the power market being retained, it is difficult to predict what will happen. CHP will not receive any special support. Uncertainty over future energy prices has been a factor in the slow rate of implementation of CHP schemes in the UK. The expected harmonisation of legislation related to power generation seems likely to produce the same uncertainty over prices which is likely to mean that decisions about CHP will be difficult to take.

6.2.6 Standby and top-up charges

Standby charges
The charge for standby capacity often is high in order to cover the worst situation. This is likely to reflect the dispatching of the least efficient plant during peak demand periods. Ideally, a retrospective assessment of real marginal cost would be the fairest approach to this issue since the worst case rarely occurs, but this may not be practical. It would involve complex individual calculations requiring sophisticated software and would be expensive to establish. An analysis of historical performance would allow performing the calculation of average standby cost, perhaps on a regional basis. The average standby cost for the next year would then be calculated from data for the previous year. This method could be included in the regulation to ensure fair access of CHP to the grid. It is recommended to carry out an analysis of the actual marginal cost for the past year and to use the resulting cost as a basis for setting a standby charge for the current year.

Top-up charges
The danger exists that a fixed charge will probably reflect the worst case situation. The retrospective calculation of the previous year’s average top-up charge (transmission and distribution charge) is the best method of setting the charge for the following year. It is recommended to use a fixed purchase price for electricity to ‘eligible customers’ on the basis of the previous year’s usual sale price charged to that category of customers minus the previous year’s transmission and distribution charges. This part of the Electricity Directive (Paragraph 18-2) could be applied only after electricity prices are brought in line with the real production and delivery costs (after 2002 in the Czech Republic). The provisions of the Directive and of other EU regulations are to be embodied in the new Energy Act whose draft is currently being discussed. These regulations should be in compliance with the requirements of the EU Electricity and Gas Directives, namely with Paragraph (24) of the Electricity Directive, concerning auto producers and independent producers, and with Paragraph (22) of the Gas Directive, mentioning the transparency of tariffs.

6.2.7 Additional (ancillary) services by IPPS

Under the current conditions in the Czech power system, the independent operators of CHP plant are not required to provide any additional services to distribution companies when selling electricity to them. The future open electricity market, however, may give an opportunity to small independent power producers to provide related additional services (ancillary services) thus giving them a chance to increase their revenues from power supply to the distribution network[7]. This concerns a whole range of services important for the reliable operation of power transmission and distribution systems:

1. Load-frequency control in the power system.
2. Long-term power reserve.
3. Voltage and reactive power control.
4. Restoration of power supplies after a breakdown of the system.

The provision of these additional services by independent power producers including the operators of CHP plant is not so widespread in the Czech Republic and the prices of these services have not yet been established. It is important that fair and transparent rules are implemented. A collective approach should be applied, which allows for the bundling of CHP projects in the assessment of the impact of CHP on the system.

6.3 Heat prices and tariffs

In most cases, heat demand controls power generation apart from some heat storage used to maximise power generation potential during peak periods. Most CHP schemes are built to meet industrial or community heat demands. The re-distribution of production costs between power and heat however is a significant problem in both the Czech and Slovak Republics. In the *Czech Republic*, subsidies to the heat price had been completely removed by 1998 and thus heat consumers pay full costs. Some CHP producers still apply cross subsidies between price of electricity and heat and/or among individual groups of heat consumers. In the *Slovak Republic*, the heat price is artificially high because of the direct link to the price of electricity, which is artificially low for domestic consumers and this has resulted in the need for a subsidy to the heat price. This subsidy is in the process of being removed. In that chapter, the ‘exergy’ method is noted as the best technical means to arrive at a reasonably fair allocating prices to electricity and heat. After 2002, energy prices in both republics are expected to have stabilised at realistic levels in all sectors. Additionally the electricity market will be opened for large consumers in the Czech Republic, which may substantially influence the power market.

6.3.1 Heat pricing in the Czech Republic

The methodology of heat pricing used in the past few years in the Czech Republic distinguishes between two categories of heat consumers: households and other consumers.

[7] Even now some power distribution companies offer a special tariff to CHP plants if they may supply power in peak hours. In general, there is a trend to use CHP plants that are connected to individual power distribution systems for load management.

Households

Concerning heat supply to households, the usual buyer of heat is an operator of the housing stock or an owner of tenant houses. In general households were eligible for getting a state subsidy on the final heat prices, which had been introduced from 1993 to 1998 [8]. The direct heat price subsidies were abolished in 1998 and replaced by an objective regulated heat price methodology. This price regulation sets maximal annual growth rate of heat prices.

Table 6.6 *Development of the regulated heat prices for households in the Czech Republic*

Period	Price regulations	Maximum heat price for households [CZK/GJ]		
		Tariff A	Tariff B	Tariff C
Year 1993	Measure of the MF 01/93	120	108	Unspecified
Year 1994	Measure of the MF 01/94	139	125	116
1-8/1995	Measure of the MF 01/95	153	138	128
9-12/1995	Measure of the MF 07/95	163	148	138
1-6/1996	Measure of the MF 01/96	163	148	137
7-12/1996	Measure of the MF 01/96	183	168	151
1-6/1997	Measure of the MF 01/97	180	162	151
7-12/1997	Measure of the MF 01/97	250	225	210
Year 1998	Decree of the Government No.	Marginal limit 350	Marginal limit 315	Marginal limit 294
Year 1999	308/97 (objective regulated	Marginal limit 350	Marginal limit 315	Marginal limit 294
Year 2000	price)	360	325	303

Note:
Tariff A - supply from a secondary line to the tenant house (measured at the foot of the building).
Tariff B - supply from a secondary line measured at the exchanger station or block boiler room.
Tariff C - supply from a primary line to the tenant house (measured at the foot of the building).

Nevertheless the generally binding procedure of distributing costs between individual products has never been included in the method for the calculation of entitlement to these subsidies.

Other consumers

No direct heat price subsidies were applied to other groups of heat consumers. An objective regulated heat price methodology is also applicable to this group of consumers. When step by step direct heat price subsidies to households were abolished some heat suppliers introduced cross-subsidies to maintain lower heat prices for households to keep this consumers.

6.3.2 Heat pricing in the Slovak Republic

Costs between power and heat. This has resulted in the need for a subsidy to the heat price in the past. The subsidies have recently been removed. Maximum price has been set up by the state, regulation of the heat price is being implemented through district authorities and the Ministry of Finance, who has to approve the price, increases on the basis of justifiable costs in any specific case. (Specified by a special regulation). The latest heat price adjustments in the Slovak Republic removed the major distortions in energy prices. Currently one price exists only. The development of regulated prices of heat after the year 2000 is still not yet clear. The Ministry of Finance proposes to keep the current regulated price system so that the annual growth rate of heat price would be 3 to 6% depending mostly on the development of fuel prices.

[8] Direct heat price subsidies from the state budget were introduced in the transition period from direct setting of country-wide maximal heat prices to the objective regulation of heat prices for households after 1990. The major reason for this arrangement was that during changes of ownership and/or privatisation of district heating systems and following rehabilitation of existing and/or investing in new heat sources including introduction of CHP, prices of heat from the public or municipal boiler houses started to rise rapidly. These subsidies were a high burden on the state budget (see following table).

Development of direct heat subsidies to households from the state budget in the Czech Republic

Total volume of subsidy	1993	1994	1995	1996	1997	1998
Actual position in billions CZK	5.63	6.59	7.3	7.02	4.26	0

6.3.3 Regulation of heat tariffs in the Czech Republic

Methods of heat price regulation and calculation

The current Czech energy legislation clearly stipulates that the holders of heat distribution licences are obliged to purchase heat from combined heat and power production whenever it is technologically feasible. The price set according to the provision of Paragraph 18 of the Energy Act (Act No. 222/1994), point 4, is subject to price regulations, which means that the price for electricity from CHP plants should be fixed by the Ministry of Finance (MF). The development of regulated prices for heat after the year 2000 is still not clear. The Ministry of Finance proposes to maintain the current objective-regulated pricing with the annual growth rate of heat price of 3 to 6%, depending mostly on the development of fuel prices. The obligation to purchase heat may need to be regulated after the 2002 price stabilisation in order to protect wholesalers and end users from inequitable contractual requirements. The Regulatory Office should set the contract conditions and the payments for transport of heat. It is recommended to separate heat price into fixed and variable elements in a two-component tariff. A single component tariff would be retained as an option for the end user. ESCOs may wish to set minimum and maximum levels of heat purchase in order to guarantee their revenue, but wholesalers and users need to be protected from the setting of inappropriate levels of usage. This protection could take the form of specified consumption ranges, recognising the normal quarterly variation in space heating requirements in conjunction with predictable annual variations, or with process demands where sales into industry are being considered.

The prices of heat from CHP plants result from calculations carried out by the producers and are highly dependent upon the cost distribution between heat and power production. No uniform and generally recognised method exists for a precise distribution of costs between the two products. Quite a number of opinions exist on the distribution of costs between electricity and heat in CHP production. We may base our judgement, for example, on the technical data relating to the distribution of energy flows in CHP production; subsequently on the distribution between power and heat at any other source. (Each CHP plant has its own heat diagram, which differs from others in terms of detail and at the same time, the operating regime of each plant is different). In this type of cost distribution by energy flow (energy method), the difference between power and heat energy is not respected in terms of the refined character of these two types of energy. The 'exergy' method makes it possible to respect this difference and takes into consideration the degree of refinement (and utility) of power as compared to heat energy. In practice, it is however hardly applied at all. In practice, simpler methods are applied to the distribution of costs. One of them is the, so-called, economic (or business) method. All the costs are assigned to the production of heat. The revenues from the sale of power are deducted. This method has a great disadvantage because the lower price of power causes higher price of heat, which in the consumers raises resistance and motivates them to search for other ways of satisfying their heat requirements, which may finally lead even to disconnection from the district heating systems (DHS). This tendency is currently appearing in the Czech Republic in relation to the increase in heat prices. This is true for the heat price based only on variable costs (price of supplied energy in CZK/GJ), which is applied in case of a single-component tariff. The two-component tariff is a more sophisticated tool in case of which the fixed component reflects fixed costs and only a variable component sets the price of supplied energy (second component of the price). The switch from a single-component to a two-component tariff is a current trend in the Czech district-heating sector.

Market-based pricing

Technically and economically, the biggest competitor to heat from the district heating systems is direct gas heating either in the form of central heating by gas boilers in houses or individual gas heaters in individual flats. When assessing the price of individual gas heating, the gas price must include 22% of VAT. For this reason, the usual market price in concrete place is calculated as the heat price from the local gas boiler room.

It is possible in this calculation to include only the, so-called, 'economically justifiable costs' pursuant of the applicable Act No.526/1990 (Price Act). The danger of loss of consumers overrides the influence of market conditions, as the district heating systems are the natural monopoly on their territory. The creation of a balance between the efforts of the heat producer to get the highest price (and profit) and danger of loss of consumers is usually realised via the application of the usual local market price of heat. The real price of heat from the district heating sources cannot exceed the usual local price. Space for the competition of the heat suppliers against the individual gas heating is delimited by the usual local price of heat and the actual costs incurred on the heat source in the district heating system including the costs of transporting heat to the consumers.

The economically justified cost items pursuant of the Price Act are as follows:
- fuel purchase expenses,
- fuel transport expenses,
- fuel preparation expenses (transfer of fuel to the boiler room, preheating of fuel oil, etc.),
- expenses on removal of solid waste after combustion,
- wage expenses of the operating personnel including obligatory social insurance and tax payments,
- energy expenses (electricity, water, pressurised air, own heat consumption),
- production overheads (other costs directly related to production),
- operating costs, maintenance, calibration of heat measuring equipment, etcetera,
- pollution charges (air-pollution and release of wastewater), excluding fines,
- maintenance and operating repairs of non-investment character,
- depreciation items equivalent to straight-line depreciation,
- administrative overheads,
- costs of lease of heat sources, transfer stations, etcetera,
- reasonable profit including appropriate income tax,
- tax pursuant of tax regulations (road tax, real estate tax, …).

Causes for high production costs for heat

The total costs of the production and distribution of electricity and heat may be kept at a reasonable level by good economic management and on the contrary, the poor dimensioning of heat sources and poor management of operations may lead to disproportionately high level of costs. Disproportionately high costs are usually due to the following causes:
- *non-targeted investments (high depreciation value)* - over-dimensioning of equipment, non-functional machinery and equipment, incessant duplicity of equipment, etcetera,
- *increased fuel costs* due to higher fuel consumption in consequence of the poor technical state of the equipment (boilers, combustion engines,…) and in consequence of incorrect operation. The energy efficiency of the heat sources may worsen by more than 10% due to the influence of these deficiencies and the fuel consumption increase in the same proportion. The technical factors that increase the consumption of fuel are:
  - unsuitable fuel for the installed combustion equipment (wrong way of fuel replacement),
  - low performance and duration of use of production equipment,
  - bad operation of the heat distribution system (principal technical disadvantages of steam distribution systems, wrong dimensioning of installations, high than necessary heat losses).
- *higher wage costs* due to the poor state of the equipment, which requires a higher number of operating personnel, and higher qualifications,
- *higher maintenance and repair costs* due to poor operation, higher fault-rate, inadequate prevention in maintenance, poor organisation of operating maintenance.
- *higher overheads* due to poor organisation of operations, uneconomic use of indirect material (incessant consumption of water, chemicals, auxiliary materials of all types, uneconomic use of transport means, uneconomic purchases)

- *incorrect depreciation* - only items that are actually part of the production process may be depreciated and entered as production cost (this is not the case of non-functional equipment and unusable parts of the plant, which due to the bad dimensioning of the plant are permanently non-operational).

Costs items that are economically unjustified, which the operator of the energy source cannot include in his costs are:
- asset retirement costs,
- penalties, late interest charges,
- cost of training employees for new plants and equipment,
- shortages incurred,
- damage to property, compensation of losses and indemnification,
- operating costs related to the repair of damage to property,
- shares of the profit, royalties to the members of the statutory bodies, etcetera,
- surcharges to wastewater and air-pollution charges, etcetera,
- interest on loans,
- contributions to the activities of superstructure company bodies, interest groups, etcetera,
- contributions to the activities of other legal entities, provided this duty is not stipulated by the law,
- costs of financing development activities and creation of reserves; etcetera.

Relative importance of cost factors

The reality concerning prices in the field of district heating is shown in the table below, which has been derived by averaging data from various localities and from heat sources and district heating systems of various sizes.

Table 6.7 *Average value of the major cost components for heat production at existing combined heat and power plants in the Czech Republic*

Cost item	Structure and average size of individual cost items and heat price					
	Fuel - brown coal		Fuel - heavy fuel oil		Fuel - natural gas	
	[CZK/GJ]	[%]	[CZK/GJ]	[%]	[CZK/GJ]	[%]
Fuel	85	51.2	170	62.7	125	60.4
Wages	10.5	6.3	12	4.4	10.8	5.2
Repairs and maintenance	16	9.6	15	5.6	15.1	7.3
Overheads	15	9	17	6.3	15.2	7.3
Depreciation	12.5	7.5	15.5	5.7	11	5.3
Other expenses	14	8.5	21.5	7.9	15	7.3
Reasonable profit	13	7.9	20	7.4	14.9	7.2
Calculated price	166	100	271	100	207	100
Actual price range	135-170		200-400		170-220	

The average value of the individual cost items relating to the production of heat at existing combined power and heat sources shows the major differences between the individual types of sources caused by type of fuel used. The fuel costs are always the largest cost component of the heat costs. When using brown coal, the ratio of the fuel cost to total cost is lower (approximately 50%) than for gas and liquid fuels (more than 60%). In comparison to this, the ratio of maintenance and repair costs is at sources using solid fuels higher than at sources using gas or liquid fuels.

6.3.4 Conclusions and future developments Czech Republic

In early 90s the relative prices for individual energy carriers for households were distorted due to the unclear government policy. The growth of heat prices was much faster than in case of gas of electricity for households. Additionally, power distribution companies introduced a special promotion tariff for direct electrical heating. This created unfair competition to district heating and tendency of switch from district heating to direct gas or electrical heating. The government recognised the problem and introduced direct subsidies to heat prices since 1993. Nevertheless the growth of heat prices was too fast in some regions. Direct subsidies were fully abolished in 1998, nevertheless cross-subsidies remains functioning in case of gas and electric power prices for households even if the government introduced faster growth rate on gas and electric power prices than on heat prices. When direct subsidies were step by step abolished before 1998 some heat suppliers introduced cross-subsidies among individual heat consumers to keep households taking heat from district heating and not switching to another heating systems, mainly to direct gas or electrical heating.

The development of regulated prices of heat after the year 2000 is still not clear. The Ministry of Finance proposes to keep the current objective regulated price system that the annual growth rate of heat price would be 3 to 6% depending mostly on the development of fuel prices. The new Energy Act will preserve the obligation of the holders of licences for heat distribution to purchase all heat from 1) CHP, 2) waste heat released from technological processes, 3) renewables, and 4) environmental friendly incineration of wastes. This obligation is not binding if 1) heat demand is met by other sources of heat of the same type, 2) this obligation would lead to an increase in the total price of heat, and 3) parameters of heat carriers are not compatible with parameters of the distribution system in the point of connection. The heat source owner is obliged to cover the justified costs of connection to the heating system.

For the new competitive energy market, a new approach to heat pricing and the implementation of new rules and methods of the heat sector regulation are proposed. The current approach to setting an objective-regulated heat price would be maintained, as a basis for setting the price ceiling which suppliers would not be allowed to exceed. Heat producers and suppliers would calculate their heat prices from the costs of individual links of the whole chain covering heat production, transmission, distribution and supply to end users. The heat price for end users should be based on cost calculation. Cross subsidising among different groups of end users will not be allowed. End users should be allowed to choose between a single-component and a two-component tariff. The Regulatory Office, which will be established under the new Energy Act, will supervise the pricing process.

6.3.5 Regulation of heat tariffs in the Slovak Republic

The developments in the Slovak republic are similar to those in the Czech Republic. The prices of heat from CHP sources are the result of the calculations carried out by the producers, which is highly dependent upon the distribution of the costs between heat and power production. No single and final method exists for the precise distribution of costs between the two products. The heat source owner is obliged to cover justified connection cost to the heat distribution system. For a new competitive energy market it is proposed to implement a new approach to heat price setting and new rules and methods of heat sector regulation. The current approach to setting of cost-wise regulated heat price would remain as a base for setting the upper price bound which suppliers would not be allowed to overpass. Heat producers and suppliers will base their heat prices on costs of individual parts of the whole chain covering heat production, transmission, distribution and supply to end-user. The price of heat for end-user should be based cost calculation. Cross subsidies among different groups of end-users will not be allowed.

6.4 Fuel prices and tariffs

6.4.1 Fuel prices

Czech Republic

An overview of prices by individual energy carrier, which could compete with district heating, is given on the following table. For comparison, also electricity and heat prices are included.

Table 6.8 *Review of prices by individual energy carrier in the Czech Republic (1 January 2000)*

Energy carrier	Price [CZK/GJ]	Note
Electricity - households	693	22% VAT rate
Electricity - industry	463	no VAT
Electricity - services	850	no VAT
Electricity - heating in households	401	22% VAT rate
Electricity - heating in other sectors	477	no VAT
Electricity - feed-in tariff	305.58	no VAT
LPG - households	322	22% VAT rate
LPG - others	263	no VAT
Hard coal - households	81	22% VAT rate
Hard coal - industry	56	No VAT
Hard coal - services	66	No VAT
Brown coal - households	85	22% VAT rate
Brown coal - industry	43	No VAT
Brown coal - services	70	No VAT
Coke - households	155	22% VAT rate
Coke - industry	116	No VAT
Coke - services	127	No VAT
Wood - households	58.8	22% VAT rate
Wood - industry	56	No VAT
Wood - services	56	No VAT
Straw - households	58.8	5% VAT rate
Straw - others	56	No VAT
District heating - households	325	5% VAT rate
District heating - industry	260	no VAT
District heating - services	280	5% VAT rate
LFO - households	258	22% VAT rate
LFO - industry	158	no VAT
LFO - services	165	no VAT
HFO - industry	81	no VAT
HFO - services	87	no VAT
Natural gas - households	147	22% VAT rate
Natural gas - others	135	no VAT

Solid fuel prices, both for fossil fuel and for renewables, are not regulated in the Czech Republic and their regulation is not likely to be introduced in the future either. Liquid fuel prices are not regulated and their regulation is not likely to be introduced in the future either.

6.4.2 Tariff setting natural gas

Czech Republic

Natural gas prices are regulated. Until the end of 1998, the tariff system had been based on a two-tier arrangement. The first tier was the relation between Transgas (TG) and regional distribution companies (RDC). Here, the maximum two-component price was applied - the commodity charge and the capacity charge. The other tier was the relation between RDCs and end users. End users were classified into three categories: households, small-scale customers and large-scale customers. Households were divided into two bands by their annual gas consumption. The first band, 0 to 900 m^3 per year, and the other band from 901 to 6,000 m^3 per year. Prices for these categories were set as maximum two-component prices made up of a fixed monthly charge and price per cubic meter of gas consumed. Small-scale customers were the second category, from 0 to 60,000 m^3. These prices were set as maximum two-component prices and included a fixed monthly charge for each off-take point and price per cubic meter of gas consumed. The third category included large-scale customers for whom prices were set as maximum-single component prices. On 1 September 1999 a new category, medium-scale off-take, was introduced, covering consumption from 60,001 to 400,000 m^3. Prices to alt customer categories except households were differentiated by category and by RDC. In the up to 60,000 m^3 category the fixed monthly charge was used just as in the previous periods, while maximum single-component prices applied to alt other categories.

On 1 January 2000, a new gas tariff system was introduced. The new tariff system is based on proposals by the regional distribution companies and an analysis of their actual costs incurred in gas supply to specific customer categories. The new system introduced a broader categorisation of end users - large-scale customers, medium-scale customers, small-scale customers, and households. The last two categories are further subdivided into three groups by their annual gas consumption. When subsidies to domestic prices will be removed, the two categories should merge and the only criterion for inclusion into a certain category is to be the customer's total annual consumption. Fore large-scale customers, the fixed monthly charge will depend on the daily maximum volume contracted. The new tariff system has introduced seasonally differentiated prices for the periods from April to September (summer price) and October to March (winter price). Seasonal prices will be used between Transgas and regional distribution companies, and for sales to customers with consumption of 60,000 m^3 and above, i.e. medium-scale and large-scale customers. The level of differentiation depends mainly on the costs of natural gas storage. It is envisaged that in 2000 a scheme of the three-month periodicity of natural gas price adjustment will be introduced to make possible a more flexible response to gas purchase price volatility on world markets. Since 1 January 2000, natural gas is traded in kWh.

Slovak Republic

In the Slovak Republic maximum prices of natural gas are being set by the Ministry of Finance for different groups of consumers. There are at present 5 tariff groups according to technical conditions of delivery and the amount of gas consumed. Four tariff groups have a two-component tariff, consisting of a fixed monthly payment and a variable component of price of gas. At present the price for small consumers is only 22% higher than the price for wholesale. Prices of natural gas for business sphere are regulated in monthly intervals by the Slovak Gas Company, who does so on behalf of the Ministry of Finance of the Slovak Republic. After 2003, a transparent gas pricing structure should be created that will make it easier for the eligible customer to select energy suppliers. From the perspective of the Slovak customer, natural gas price will be composed of the gas buying price at the Slovak border and the price of the services required: transport, distribution or storage.

6.4.3 Future gas prices in the Czech Republic (short-term)

In the short term the most important development is the adjustment of end-user prices of energy carriers to reflect true economic costs incurred by individual category of end-users on the energy system. In general, only electrical power and gas prices will be adjusted by the government (regulator) decision, other prices are not regulated (for heat see special chapter). This is a necessary step for the opening power and gas markets. The gas price development is given in the following table.

Table 6.9 *Development of power and natural gas prices for individual groups of consumers (excluding VAT and influence of inflation) - year-on-year increase [%]*

Year	1998	1999	2000	2001	2002
			Households		
Gas	27	-	+11.4 - +15.0	+10.7	+7.5
			Small business consumers		
Gas	.	-	+7.7 - +11.3	+7.1	+5.8
			Medium-size consumers		
Gas	.	-	+8.0 - +10.9	+5.4	+4.5
			Large consumers		
Gas	.	-	-0.2 - +2.7	+4.8	+4.4

Source: Ministry of Industry and Trade of the CR.

Note: due to the increase of the oil price, gas prices for all consumers were increased by 16% since April 2000, except for households where an maximum increase is given in the table, independently of the import price of gas.

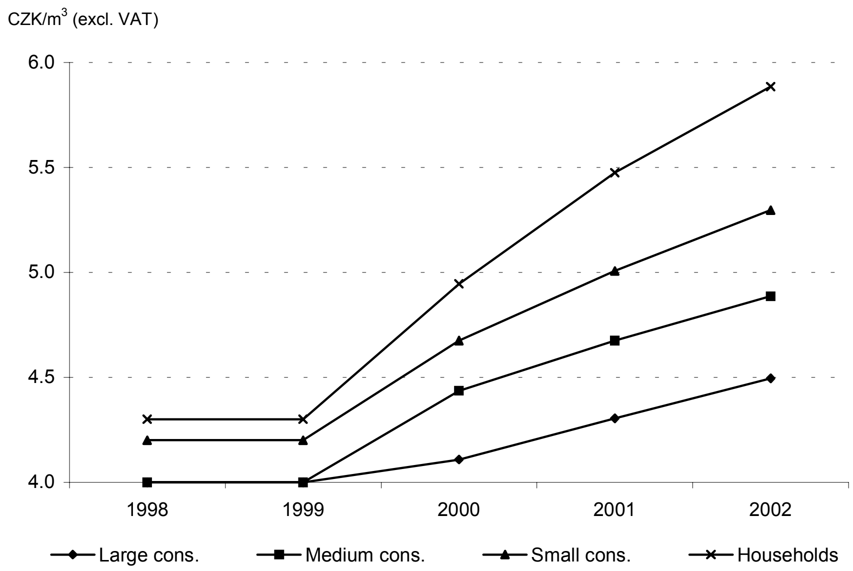

Figure 6.2 *Proposed short-term gas price adjustment programme*

6.4.4 Impact of liberalisation on gas

The Czech Republic's position paper submitted to the EU contains some key commitments. As from 2001, a new Energy Act will be in force, in 2003 Transgas' import monopoly will expire, and between 2005 and 2008 the Czech gas market will gradually be opened to meet the Gas Directives' requirements. The new Energy Act as proposed already respects most of the Gas Directive 's provisions. An exception is a transition period the country requests for the gas market opening, which should take in two stages as can be seen on the following table.

Table 6.10 *Major steps proposed for opening gas market in the Czech Republic*

Date	Consumer capacity (single meter) [mil. m^3]	Milestones
January 2001	-	New Energy Act in full power
January 2003		Removal of subsidies
January 2005	>25	20% of gas market
August 2008	> 5	33% of gas market

After 2002, a transparent gas pricing structure should be created, which will make it easier for the eligible customer to select energy suppliers. From the perspective of the Czech customer, the natural gas price will be composed of the gas buying price at the Czech border and the price of the services required: transport, distribution or storage. The opening of the gas market in the Czech Republic is likely to be followed by a drop in gas prices for large consumers, as was the case in the UK (see Annex E). In the first phase, the opening of the market will concern only large power plants including CHP plants. Only in the second phase, small and medium-scale plants will be involved. This situation will negatively influence the competitiveness of these plants. To solve the problem, the period between the two phases of the market opening should be minimised or fair competition should be ensured by other measures.

6.5 Conclusions pricing and tariffs

Uniform and transparent tariffs

The proposed programme of adjustment of energy prices charged to end users should be fully implemented to reflect real economic costs, introduces fair competition among individual energy carriers on the market and improve the competitiveness of district heating. The finalisation of the process of adjustment of energy prices for end users is a necessary precondition for accession of the Czech Republic to the EU and for the opening of energy markets. This cannot be postponed any longer. The introduction of new end-user energy prices should be accompanied by setting new end-user electricity, gas and heat tariffs that reflect the time, season, volume and required reliability of energy supply. In general, electricity, gas and heat tariffs should be set as two-component or single-component tariffs to enable consumers to choose their suppliers. Establishing clear and transparent rules for tariff setting should be the main task of Regulator rather than the approval of individual tariffs. At the same time, a uniform heat price/tariff should be established in each district heating system for small heat consumers (households, SMEs). These tariffs should be published and made available to any customer. Large consumers should pay negotiated tariffs. However, cross-subsidies should be eliminated. For this, the supervising role of the Regulator will be needed, at least in the transition period. The current regulations under which power and heat distribution companies are obliged to purchase all the power and heat produced in CHP plant reflect the strong regulation of the energy market. This practice cannot continue to the full extent in the future.

The current rules of feed-in tariff setting for electric power purchased from CHP plant at a regulated tariff are not in favour of CHP if new CHP plants have to compete with old coal-fired plants or nuclear power plants. More favourable conditions can be negotiated with power distribution companies if there is a need for power supply in peak hours.

New barriers and chances for CHP

Opening up the electricity and gas markets as required by the EU Directives will be a key step which can substantially influence, in a positive or a negative way, the future development of the market for CHP because:

- The opening for competition can lead to a power price drop for some categories of end users, mainly large consumers who take electricity from high voltage or very high voltage grid, and thus reduce their interest in the construction of own CHP plants.
- A general fall in consumer prices might result in the reduction in feed-in tariffs charged to IPPs and thus reduce the profitability of new CHP projects.
- The uncertainty about the future market development (volatility of fuel-input prices for CHP plants or purchase prices for electricity) will make long-term planning difficult and, in consequence, may discourage many potential investors from investing in CHP.
- Low electricity prices in the spot market may result in the outage/closing of some CHP plants.
- The gradual opening of the electricity and gas markets for different categories of consumers and suppliers will result in unfair competition between different categories (according to their capacity) of electricity generators, CHP included.
- Free competition will ease the access of IPPs to the grid and enable them to negotiate the price, especially if they can offer ancillary services.

The opening power and heat markets represent a challenge for CHP plant operators as they could offer a whole range of important services needed for ensuring security of power transmission and distribution system operation, for safe and reliable supply of electricity to consumers (reliable delivery and high quality of power). This could substantially improve the economic viability of many CHP projects. The provision of ancillary services by independent power producers including the operators of CHP plant is not so widespread in the Czech Republic and the prices of these services have not yet been established.

Heat market important

The EU Directives do not explicitly cover the opening the heat market. Nevertheless the heat market is very important in the Czech Republic. Opening the electricity and gas markets will strongly influence the heat market. Therefore the heat market should be given as much attention as the power and gas markets. An important player on the energy market will be ERO (the Energy Regulatory Office). While regulation at the national level is adopted in the draft new Energy Act, given the regional character of heat supply, the district heating regulation could also be organised at a regional level. This issue may be of crucial importance for the future development of CHP and, consequently, should be dealt with very carefully.

The protection of the global, national and regional environment will be given a higher priority in the future. In this process CHP production can play a positive role as a more environmentally friendly technology compared to the separated production of power and heat. This process will take long time though. In the meantime, fiscal measures should be implemented to promote energy efficient and environmentally friendly technologies like CHP production. Some of these measures are discussed in the following sections.

6.6 Taxes, levies and charges

6.6.1 Value Added Tax (VAT)

In 1998, most of VAT exemptions on energy carriers were eliminated in the Czech Republic and a general VAT rate of 22% has been applied since. Exemptions remain for renewables (primarily for biomass) and heat from district heating systems that are charged with a reduced VAT rate of 5%. The Czech VAT rate should be harmonised with the EU standard. For electricity, the basic VAT rate is applied. The Czech and Slovak Government intend to apply for derogation from the general VAT rules and maintain the current reduced VAT rate for renewable electricity and heat from district heating. If the derogation were not granted, the price of heat in district heating would rise by 16.5%. This may substantially influence the competitiveness of district heating compared with local heating using natural gas and thus reduce future potential for CHP development.

6.6.2 Levies

No special price/tariff incentive is available for CHP plants in the Czech and Slovak Republic although CHP technology is more environmentally friendly than separated production of power and heat. The general goal should be internalisation of external costs, which is a long-term process. In the meantime, the Government should promote the introduction of a scheme that would impose levies on less environmentally friendly technologies, while supporting energy efficient technologies.

The draft Energy Management Act in the *Czech Republic*, which was approved by the Government in December 1999, includes one of the policy measures that could help to promote CHP - the ‘green cent’ (or ‘green levy’) scheme. The scheme will introduce a levy of 1 haler/kWh (0.03 Euro/kWh) applicable to all electric power delivered to end-users. The levies will constitute revenues to the State Environmental Fund and would be used for the support of energy efficiency and renewables projects. However, the draft Energy Management Act does not specify the method of developing the yearly programmes of energy savings and promotion of renewables. In addition, the proposed scheme involves only one energy carrier – electricity – thus discriminating it against other energy carriers in the market. Imposing a levy is a non-system measure and therefore it should be in force only for a short period, followed by the introduction of another instrument (see hereinafter).

6.6.3 Duties

Duties on import of energy carriers are imposed in the Czech Republic on all imports. They differ by country of origin and by energy carrier. A short overview is given on the table below.

Table 6.11 *Duties on import of energy carriers in the Czech Republic, valid of 1 January 1996 [%]*

Energy carrier	Import from countries	
	Members of WTO	Unknown
Coal and coke	-	-
Fuel oil	5.8	17
Natural gas	1.4	15
Propane	1.4	15
Butane	1.4	15
Electric power	-	-

However, an increased rate of duties on import of electricity could improve economic viability of CHP projects. However this is not compatible with the WTO rules. The future development will depend on the development in the EU. Therefore harmonisation with EU and WTO is required.

6.6.4 Emission charges

In the Czech Republic different air pollution charges are set for large and medium emission sources, and for small sources (Clean Air Act No. 389/1991). The regulation from, 1991 specify the emission limits for large stationary sources with the installed thermal output exceeding 5 MW divided into three categories. The regulation was amended by the Directive from June 23, 1992 where the fees for pollution of environment are also specified. Depending on the output of the polluting energy supply facility the revenue from these charges goes to State Environmental Fund, to District Authority budget or to city budget.

Air pollution charges - Large and medium sources

The main economic incentives applied in the Czech Republic are pollution charges introduced under the Air Protection Act by law 389 of 10 September 1991. Charges are intended to reflect the external costs of pollution and are to be phased in gradually (see accompanying tables). The charges do not yet equal the external pollution costs nor do they consistently provide a sufficient incentive for polluters to take abatement action. However, the charges were increased more than 300% between 1991-97. These pollution charges mainly provide the main revenues for the State Environment Fund.

Table 6.12 *Charges for emissions Czech Republic (large and medium sources)*

Emissions	[CZK/ton]
CO	600
NO_x	800
SO_2	1,000
Hydrocarbons	2,000
Fly ash	3,000

Pollution charges are increased up to 50% by the Environment Inspectorate where emissions limits are exceeded.

Air pollution charges - Small sources

Act No. 389/1991 Call introduced also charges for the pollution of atmosphere by small-size sources registered in REZZO III up to CZK 10,000 for a single source per annum. Since there was a risk of arbitrary imposition of these charges, Act No. 218/1994 Call restricted this payment liability merely to minor polluters - entrepreneurs. Act No. 158/1994 Call, amending Act No. 389/1991 Call, differentiated, i.e., pollution charges according to the output of the source registered in REZZO III (thermal output less than 2 MW) and according to the kind of fuel used. Sources of pollution of atmosphere operated by physical persons (non-entrepreneurs) with thermal output up to 50 kW remained uncharged.

Table 6.13 *Charges for pollution of atmosphere prescribed to minor polluters - entrepreneurs (Czech Republic)*

	Charge [CZK/year]		
Fuel/ Output	0-50 kWt	50-100 kWt	100-200 kWt
Coke, wood, gas, fuel oil with 0.3 - 1% S	0	0	0
Light fuel oil	400-800	800-1,250	1,250-1,700
Other fuel oils	700-1,400	1,400-2,100	2,100-2,800
Hard coal	1,000-2,000	2,000-3,000	3,000-4,000
Brown coal and briquettes	500-1,000	1,000-1,500	1,500-2,000
Brown steam coal	2,000-4,000	4,000-6,000	6,000-8,000
Coal sludge and partings	10,000	10,000-20,000	20,000-40,000

Water pollution charges

The charges for the discharge of untreated effluents, or inadequately treated effluents are set by the Act No. 281/1992 Col. based on complicated formula. The basic principle is to set charges on the level, which is slightly higher than average costs of new water treatment plants.

Other charges

Other charges that are applied to energy sector are: waste disposal charges, levies for sequestration of agricultural land, charges for mining of raw materials. They are very specific and their role is marginal compare to emission charges.

Conclusions

The current Czech scheme of emission charges has the following shortcomings:

- The sources of air pollution operated by natural persons (non-entrepreneurs) with a thermal output up to 50 kW remain uncharged.
- The current rate of charges is insufficient and should be increased. Charges do not yet equal external pollution costs nor do they consistently provide a sufficient incentive for polluters to take abatement action.

Energy or environmental taxes and emission charges on all non-renewable energy carriers will increase the cost-effectiveness of energy efficiency investment, and thus increase their penetration. To overcome these shortcomings the revenues of emission charges could be used for financing subsidies.

Emission charges in the Czech Republic cannot be compared with emission charges in EU countries, both in terms of their rates and the range of emissions types involved. Therefore, the impact of possible future increase in emission charges should be first compared with the option of environmental tax implementation. In general, the following two options are possible:

- parallel existence of both emission charges and the environmental tax,
- replacement of the current emission charges scheme by an environmental tax scheme.

An analysis shows that the environmental tax scheme should be given priority[9].

[9] Update of the analysis of the impact of the environmental tax reform on households and entrepreneurs. IEEP, Prague, 1999.

Slovak Republic

In the Slovak Republic one can distinguish between air pollution charges for large and medium sources, and small sources. In general there are two problems with current emission charges:

- The sources of pollution of atmosphere operated by physical persons (non-entrepreneurs) with thermal output up to 50 kW remained uncharged.
- The current level of charges is not satisfactory and should be increased. The charges do not yet equal external pollution costs nor do they consistently provide sufficient incentive for polluters to take abatement action.
- The introduction of increased emission charges should be considered. Emission charges involve payments that are directly related to the pollution caused. Nevertheless the future increase of emission charges needs to be assessed and compared to the possible introduction of environmental tax. In general the following variants exists:
  - parallel use of both emission charges and environmental tax,
  - replacement of the current emission charges system by environmental tax system.

6.6.5 Energy and carbon tax

Czech Republic

Energy supply and consumption cause environmental problems. Environmental protection is therefore one of the main objectives of Czech energy policy. The focus in the analysis presented here is the reduction of CO_2 emissions. The Czech Republic has committed herself in the Kyoto Protocol to an 8% reduction target on greenhouse gas emissions in the period 2008-2012, compared to the level in 1990. However, further reduction of emissions may be necessary.

In the European Union and the Czech Republic, energy or carbon taxes are being discussed as a new instrument in environmental policy. The taxation of energy carriers on the basis of their carbon content (carbon tax) will improve the economic effectiveness of energy efficiency measures and of renewables generation, and will therefore promote their faster market penetration. However, it is important that the impact of this taxation is carefully assessed prior to its introduction. A number of proposals on the introduction of such a tax has been considered but any political decision has not yet been made. The time horizon of the tax introduction, even an approximate one, has not been set. The method of setting the tax rate is also lacking. However, both the time horizon and the tax rate are very important information for investors.

Application of combined heat and power production in district heating, industry, or in small-scale application will improve emission reduction. Combined heat and power production gain an advantage to separate electricity and heat production if the fuel prices increase or if energy taxes are applied. In a long-term scenario study[10] based on EFOM-ENV (least cost optimisation model) and CGE (Computed General Equilibrium model) calculation results, the following figure shows the impact of the carbon tax on the share of CHP in electricity production. Already in the base case, without carbon tax, CHP proves very successful, increasing to a share of 36% of electricity production in 2030. The main driver for the growth in CHP is its cost-effectiveness in particular in the period 2015/2020 when many existing coals fired power plants will have to be replaced. Gas-fired combined cycles will become cost-effective, especially in combination with introduction of a carbon tax. This leads to an accelerated increase in the share of CHP in the periods before 2030, compared to the large increase in the base case. There is no further increase of CHP production in 2030, because the share of CHP on total electricity production has been restricted to a maximum assumed market penetration, which already is reached in the base case (without carbon tax).

[10] Development of integrated scenarios Czech Republic, ECN+SRCI, Petten, 1999.

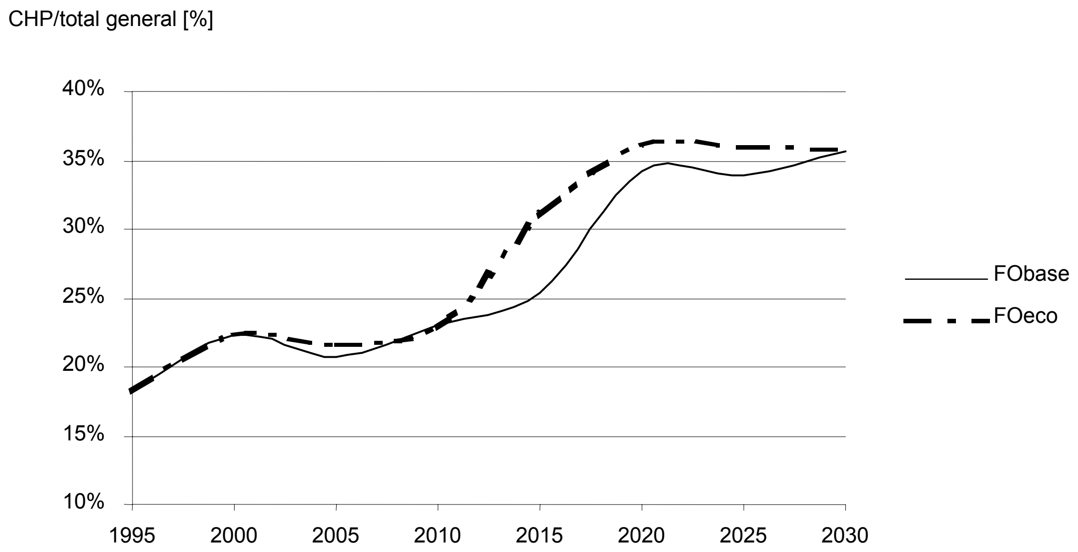

Figure 6.3 *Share of CHP in total electricity production, FO scenario, base case (FObase) and policy case with carbon tax (FOeco)*

Reference: Development of integrated scenarios Czech Republic, ECN+SRCI, Petten, 1999.

The calculations performed show that the introduction of a carbon tax would lead to a significant increase in the share of CHP in the period before 2030 (for details, see the base case study). The introduction of energy taxes is recommended. The tax revenue will be recycled back to the economy by lowering social insurance payments and other levies and taxes. The tax rates can be established at values recommended in a study carried out for the Ministry of the Environment[11].

Slovak Republic
Also in the Slovak Republic, energy or carbon taxes are being discussed as a new instrument of environmental policy. The introduction of energy taxes is recommended. The tax revenue will be reimbursed to the taxpayers by lowering social insurance payments and other taxes. The tax rates can be established at levels recommended in a study carried out for the Ministry of Environment.

6.7 Tradable Green Certificates

To meet environmental targets in a liberalising market, the design and implementation of policy measures and incentive schemes have to be in accordance with free market principles. The current incentive schemes, most of which have been established in the pre-liberalisation situation, might not be able to satisfy this requirement. This underlines the need for the implementation of new policy measures, more coherent with new market conditions. Electricity produced in CHP plants fired by renewable fuel (biomass) could be part of such a scheme. Given the fact that biomass has the largest potential compared to other renewable sources, this could in the long term have a significant impact on CHP also[12].

[11] SRCI CS: Evaluation of the Impacts of an Ecological Tax Reform, Prague, 1997.
[12] The Energy Efficiency Action Plan and the Renewable Energy Action Plan for the Czech Republic were prepared within the framework of the National Energy Efficiency Study for the Czech Republic (1999). These documents were published in English and Czech by the Netherlands Energy Research Foundation ECN (ECN-C-99-063, 064 and 065), and SRC International CS Prague, respectively.

The major characteristic of a green certificate scheme is that electricity generated from renewables is certified. These certificates have two purposes. First, they can serve either as an accounting mechanism in the case obligations set by the Government have to be met, or as a proof to consumers of green electricity that a certain share of electricity supplied to them has been produced from renewables. Second, green certificates make it possible to create a market for green certificates those functions independently from the electricity market. The following conclusions and recommendations can be made:

1. First experiences with the green certificate scheme in the Netherlands are positive.
2. To reduce uncertainty of potential investors and to minimise cost and volatility of prices, *clear long-term renewable electricity targets* should be set by the Government.
3. To reduce price volatility, *appropriate medium-term targets* (e.g. each year) should be set by the Government.
4. The *validity of green certificates should be unlimited.* The possibility of using future certificates to account for meeting the targets should be considered.
5. *Internationalisation* of the green certificate scheme should be pursued to enhance the stability of the scheme.
6. Based on an overall target, a 'fair' targets for each participating country could be set along with the curve of the renewable electricity percentage and the cost criterion.
7. In the longer term, such a scheme could be applied also to other energy carriers.

6.8 Licensing for combined heat and power production

Electricity supply licences are essential for the promotion of CHP. Chapter 3, article 6 of the EC Electricity Directive states that *'it must be possible for auto producers and independent producers to obtain authorisation, on the basis of objective, transparent and non-discriminatory criteria'*. In the UK, licences are required for plant exporting more than 500 kWe to the grid. The licence would be 'second tier' if the export power was less than 50 MW_e. Over 50 MW_e no licence is required to build the plant, only local planning permission. This provides control over large plant that could have a significant impact on local networks and environment, whilst allowing small plant to be more easily installed. In Denmark, Greece and Portugal, new capacity also needs to be approved, though differently in each country (see Section 6.1.1). Obtaining a licence in Germany is very complex and is therefore a barrier to CHP implementation.

Czech Republic

The current Czech Energy Act stipulates that anyone wishing to do business involving the sale of energy to third parties must have authorisation. The authorisation is granted by the Ministry of Industry and Trade for a period of 5 years. The draft new Energy Act introduces the term of *'licensing'*. As for a CHP plant, two licences have to be obtained for electricity generation and for heat production, separately. Licensing combined heat and power production could be a barrier only if the charge paid for a licence is high and/or if the bureaucratic procedures are lengthy. The draft new Energy Act stipulates free-of-charge licensing.

Slovak Republic

The current Energy Act in the Slovak Republic requires that anyone wishing to do business involving the sale of energy to others must have a licence. This is granted by the Ministry of Economy for a period of 20 years. The Energy Act should in the future include a requirement for a licence before undertaking and trading in the electricity business. It will regulate the granting of a licence, dictate the rights and duties of the licence holder and control the purchase of electricity. Licensing of CHP plants need only be a barrier if the licence cost is high and/or if the bureaucratic procedures are lengthy. If these two issues are regulated through stipulation of both costs for different types of licences (small, medium and large industrial scale) and timetable for licence application approval, licensing need not be a barrier for CHP projects.

6.9 State authorisation for the construction of CHP plants

The draft new Energy Act in the Czech Republic introduces state authorisation for the construction of generating capacity. As for a CHP plant, two authorisations have to be obtained: 1) for electricity generating capacity (of 30 MW_e or higher, in total), and, 2) for heat generating capacity (of 30 MW_t or higher, in total), separately.

As for the construction of CHP plants, clear rules for the granting of authorisations have to be laid down as a right to obtaining authorisation are not considered in the draft new Energy Act. In this respect, the following stipulations, among others, of the draft Act are of crucial importance: 1) Any CHP project must be in accordance with the regional energy planning, and 2) The plant has to use local or indigenous fuel or other energy sources.

6.10 Environmental regulation

Regulation already in place in both Republics has resulted in significant reductions in polluting emissions through the retrofit of fluidised beds and clean up technologies on solid fuel fired systems and from a conversion from solid fuels to gas. This process is expected to continue. Penalties for exceeding set emission limits are imposed but at a low level compared to fuel costs.

The effect of the Kyoto Climate Change Agreement is forcing all EU countries to develop systems to meet agreed targets. CHP has an important role in this process. In the Netherlands, existing legislation supports demand side savings through an energy tax the revenues that are used to stimulate CHP. Also tax deductions are given for CHP. In Denmark a carbon tax generates revenues which are recycled into environmental improvement schemes. In the UK, the Climate Change Levy is to be introduced in 2001, but companies that operate ‘good quality’ CHP schemes will be exempt from the levy (see Annex E.).

Because of the structural changes in the economy, particularly industries the Czech and Slovak Republics will have any problems in achieving a significant reduction in greenhouse gas emissions compared to the last year. Further regulations to meet Kyoto targets are therefore unnecessary. However, there is strong pressure from the EC to improve energy efficiency because energy use per unit of GDP is still relatively high. CHP is seen as a method of making a significant impact on energy efficiency and on environmental emissions.

There is a positive environmental impact from many CHP schemes, but not from all. New CHP schemes that only partly replace the output from existing CHP or heat only systems using solid fuel may not produce the expected reductions in emissions. As the plant loading decreases and fluctuations in output increase (due to the base load effect of the CHP), the environmental performance of the solid fuel plant could deteriorate. Regulation is advised that would require the review and evaluation of the wider environmental implications of each CHP scheme when a solid fuel fired plant is being retained.

Although EU legislation does not oblige Member States to implement CHP, the gradual liberalisation of the energy supply market and the emphasis on energy efficiency as reflected in the Energy Charter Treaty does impact on CHP schemes and, as a result, on their environmental performance. Regulation in these areas is difficult. The Republics have chosen to make CHP obligatory where technical and economic criteria are met, but uncertainties caused by changes in the market price for energy and reducing end user demands for energy could be used to avoid this obligation.

Czech Republic
Basically, the following environmental legal regulations are applicable to two different phases of CHP projects:

1. For plant construction - Act No. 244/1992 on environmental impact assessment, which clearly stipulates the methods of the assessment of the new technologies impact on the environment; this assessment is to be carried out as a prerogative for granting a planning permission/ plant operation permission.
2. For plant operation - primarily Decree No. 117/1997 issued by the Ministry of the Environment, which sets the emission limits and other conditions for the operation of stationary sources of pollution and for protection of the environment. This Decree provides a list of air pollutants, specifies the categories of stationary sources of pollution and technical conditions of their operation, requirements on monitoring air pollutant emissions and requirements on the quality of fuels.

Key Czech environmental regulations need to be harmonised with EU legislation. Primarily this concerns the implementation of EU Directive No. 96/61/EC on IPPC (Integrated Pollution Prevention and Control) and, secondly, the tightening of the limits of emissions of certain pollutants into the air from large combustion plants, especially of nitrogen oxides. A new EU Directive on that issue is currently under preparation as an amendment of Directive No. 88/609/EEC.

Slovak Republic
In general two levels of environmental regulation is applicable on CHP plants in the Slovak Republic:

1. Building regulation - Environment Impact Assessment based on the Act No 127/94 which clearly stipulates how the impact of the new technology on the environment should be assessed before the building/operation permission is issued.
2. Operational regulation - mainly the Decree No. 92/1996 of the Ministry of the Environment, which sets the emission limits and other conditions for operation of stationary sources of pollution and protection of the environment. This Decree provides the list of air pollution substances, specifies the categories of stationary sources of pollution and technical conditions of their operation, the requirement on monitoring of air pollutants emissions, and finally requirement of quality of fuels.

Basic regulation acts need to be harmonised with the EU legislation. The emission limits should be strengthened, mainly with regard to emissions of nitrogen oxides.

6.11 Energy Act

In both the Czech and Slovak Republic the Energy Act will provide a legal framework for the energy policy. The new Energy Act will be probably adopted before the end of 2000 and come into force in January 2001. The Act regulates the trading in energy carriers, including the steps towards a liberalised energy market. It defines the role of energy utilities in the field of the promotion of renewable energy and energy efficiency, including priority access to the grid for power and heat from CHP and renewable energy and/or the obligation of the purchase of heat. As for the access to the electricity grid, the Act should include provisions concerning the following issues:

1. Minimisation of licensing costs and the term of approval procedure.
2. Minimisation of access costs for <500 kW_e CHP plants.
3. Either setting of a fixed feed-in price or requesting each electricity distribution company to publish information explaining their methodology for assessing feed-in prices.
4. Ensuring transparency of the calculation of electricity standby charges (at regional level).
5. Ensuring transparency of the calculation of electricity top-up charges (at regional level).

6. Developing a transparent methodology for the priority dispatching of CHP plants based on overall thermal efficiency, particularly for the summer period; no economic disadvantage should result from such a dispatching mechanism.
7. Provision of a means of appeal by customers to the Regulator when charges are considered to be unfair.

In terms of heat, the Act should contain provisions for:
1. Transparency of the costing of heat for individual types of plant.
2. Guidelines for the setting of contractual minimum and maximum volumes of heat consumption.
3. A methodology for the calculation of the separation of heat and electricity costs (needs discussion with stakeholders).
4. Provision of a means of appeal by customers to the Regulator when charges are considered to be unfair.

6.12 Energy Management/Efficiency Acts

6.12.1 Energy Management Act (Czech Republic)

The draft Energy Management Act specifies the rights and obligations of natural and legal persons in production, transmission and consumption of energy, leading to more efficient use of energy in the Czech Republic and to environmental protection, stimulating a reliable energy supply, competitiveness and sustainable development. The Czech Government furthermore states that the free market does not provide guarantees for an efficient use of energy and environmental protection. Therefore, additional regulation is required. In December 1999, the draft Energy Management Act was accepted by the Czech Government and submitted to Parliament. This version of the Act contains the following main provisions relating to CHP:

- Obligation of energy audits in organisations with a certain energy use and source capacity. Exact rules for auditing will be laid down in decrees. Organisations in the public sector have an obligation to implement the audit results. However, the respective funding scheme has not been arranged. Individual sectors are expected to cover the costs of both the audit and its implementation.
- Obligation of energy audits on energy efficiency of all existing CHP plants with a certain volume of annual energy consumption specified in the Act.
- Obligation of an audit on the cost effectiveness of CHP when an application is submitted for a building permit for the construction of a new/ rehabilitation of an existing installation that produces heat or electricity only, without CHP. Under the Act, the CHP scheme is to be applied when the outcome of the audit is positive and the long-term purchase of power and heat are ensured. The obligation to check the viability of CHP scheme application holds for all plants of thermal capacity higher than 5 MW_t and also for electricity generating plants of total installed capacity higher than 10 MW_e (steam turbines), 2 MW_e (gas turbines), and 0.8 MW_e (gas engines).

Within the EU, no legislation is in force at the moment comparable with the proposed mandatory auditing and the CHP obligation stipulated by the Czech draft Energy Management Act, but EU legislation does allow to impose an obligation of CHP application. However, imposing an obligation as a key instrument for the promotion of CHP is not in line with the EC guidelines for CHP promotion as formulated in the Community Strategy to promote Combined Heat and Power (1997). EU experience has shown that CHP is not likely to be effectively promoted by the use of one single instrument. A comprehensive policy, involving a range of instruments, each addressing different barriers, is needed. Furthermore, a CHP obligation is difficult to impose in a liberalised market because it is not in accordance with market principles.

In the Czech Republic, a priority should be given to the development of a comprehensive policy of energy efficiency, in particular CHP, which would lay down targets and specify a combination of instruments to achieve them, regulatory measures among them. Such approach would be in compliance with the Energy Charter Treaty.

The main barriers to CHP development have been discussed in Chapter 5 of this rapport. It has been concluded that the most serious obstacles are the following: gas and electricity prices; economic viability of schemes, and access to capital on acceptable terms. These obstacles are not addressed in the draft Energy Management Act. They should be dealt with in the Energy policy document, and a number of them are.

A key area of concern in the Czech Republic is CHP efficiency. Energy audits should be enforced as a means of the verification of the technical feasibility and economic viability of CHP projects. Some formalised specification of the results of these audits will be very useful in standardising the Government's approach to this issue. A standardised methodology for the calculation of the IRR (internal rate of return) of CHP projects also needs to be developed. This methodology should take into account all the operating cost components allowing the Government to fix minimum IRR values for different types of plant.

6.12.2 Energy Efficiency Act (Slovak Republic)

The Energy Efficiency Act in the Slovak Republic will specify the rights and obligations of private and legal persons in sphere of conversion and consumption of energy, leading to an increase in effective use of energy in the Slovak Republic and to environmental protection. The Act should stimulate reliable energy supply, competitiveness and sustainable development. In the original draft of the Act and obligatory implementation of CHP technologies was required in designing heat and power sources over 1 MW. In the formal proceedings of commenting the draft Act the obligation was cut out of the Act. The final version of the Act will be submitted to the Government and the Parliament for approval by the Ministry of Economy by end of June 2000.

6.12.3 Review of the Acts

In both the Czech and the Slovak Republic, legislation has been drafted for the promotion of CHP within the framework of the Energy Management Act in the Czech Republic (EMA-CR), and the Energy Efficiency Act in the Slovak Republic (EEA-SR). The main component of the legislation concerning CHP is the mandatory application of CHP when cost-effectiveness is proven in combination with a stipulated energy audit (see Annex C). On the request of the Czech and Slovak Energy Agencies that are strongly involved in the preparation of the Acts, the draft legislation has been reviewed focusing on the following questions:

On the choice of instrument

1. Does the proposed obligation for CHP have an equivalent in the European Union, in particular the Netherlands, United Kingdom, Denmark, or Germany)? If yes, what are the experiences with this type of instrument?
2. What are the advantages and disadvantages of an obligation for CHP? Is this measure effective (does it promote CHP) and efficient (what are the costs and benefits of the implementation of the measure), and is it compatible with a liberalised energy market?
3. What is the expected impact of the obligation on the penetration of CHP?
4. What are possible problems in the implementation of the new legislation?
5. Is an obligation for CHP the best instrument for the promotion of CHP in the Czech and Slovak Republics?

On the design of the legislation

6. How is the legislation designed in detail? Is the text clear and consistent? What are possible improvements?

The review for the Czech Republic is based on the unofficial translation of draft dated December 1999. For the Slovak Republic, the draft dated May 1999 was used[13].

Differences between the Czech and Slovak acts

Some significant differences between the Czech and Slovak draft can be identified:

- The Czech legislation mandates CHP for thermal capacities over 5 MW_{th}, while the Slovak Act has 1 MW_{th} as standard. The range of 1 to 5 MW_{th} comprises a substantial share of decentralised CHP applications, particularly in the residential sector, the service sector, and in small industry. The impact of the Slovak version will therefore be larger.
- In the EMA-CR, a CHP obligation is also included for electricity producers from thermal processes. This is not the case in the EEA-SR.

Conclusions of the review

The main conclusions of the review of the draft CHP legislation in the Czech and Slovak Republic are:

- CHP is an important option for energy efficiency in the Czech and Slovak Republic. It is necessary to support CHP in order to increase market penetration.
- There is no legislation for the obligation of CHP in place in the EU at the moment that can be compared with the proposals. In the EU, e.g. the Netherlands and Denmark, the success of CHP can be attributed to other instruments.
- EU legislation does allow an obligation for CHP as included in EMA-CR and EEA-CR.
- The obligation as a key instrument for the promotion of CHP is not in line with the guidelines of the EC for CHP promotion.
- In many EU member states, a regulated feed-in price has been regarded a basic prerequisite for the promotion of CHP, in combination with other financial incentives (grants, subsidies). Recently, a shift towards tax incentives can be witnessed. The Czech and Slovak proposals are not in-line with this development.
- The EU experience has shown that CHP is not likely to be effectively promoted by the use of one single instrument only. Always, a comprehensive policy is necessary, in which a range of instruments, each addressing different barriers, are used. A comprehensive energy efficiency and CHP policy should be developed, of which regulatory measures can be a part.
- A key area of concern in the Slovak Republic is that CHP is justifiable and energy audits would be enforced as a means to check the technical feasibility and economic viability of schemes. Some formalised specification of the output from these audits will be very useful in standardising the government's approach to this issue. A standardised approach to the calculation of the IRR of CHP projects is also required. This would take account of all the operating cost elements allowing government to fix minimum IRR values for different applications.
- A CHP obligation is difficult to maintain in a liberalised market, because it is not based on market forces.
- The costs of implementing and monitoring mandatory audits and CHP implementation are high.
- The Czech legislation mandates CHP for thermal capacities over 5 MW_{th}, while the Slovak Act has 1 MW_{th} as standard. The range of 1 to 5 MW_{th} comprises a substantial share of decentralised CHP applications, particularly in the residential, service sector, and small industry. The impact of the Slovak version will therefore be larger.

[13] The reviews have been submitted to the CEA and SEA and have been used in the revisions of the draft. In the real draft of the EEA (Slovak Republic) the CHP obligation has been removed.

- It is recommended to ask the opinion of the European Commission and international CHP promoters, in particular COGEN Europe, while drafting the legislation.
- The first priority in the CR and SR should be the development of a comprehensive policy on energy efficiency, in particular CHP, in which targets are specified and a combination of instruments is adopted. The Energy Charter Treaty also requires this. An obligation could be part of this set. At the moment, such a policy does not exist yet. A regulatory obligation should be implemented only after such a policy is adopted.

7. FINANCING OF CHP PROJECTS

The financing of CHP project is a barrier in both the Czech and Slovak Republic. This chapter provides an overview of available sources of financing and their shortcomings. Recommendations are made to promote and facilitate financing of CHP projects, particularly with regard to the role of the Government.

7.1 Existing sources for financing

7.1.1 Available capital

The selection of the suitable way of financing of CHP depends to a large extent on the overall size of the investment, the conditions of the capital available, and the specific conditions of the investment (such as the return on investment), and others. In general, the following financing sources are available for investments:

- in-house capital (own capital sources),
- grant financing incl. international preferential loans,
- loans from international financial institutions,
- commercial loans.

Third-party ownership participation can also ease the access to loans. The following ways of support to investments belong to this group:

- privatisation,
- Energy Service Companies (ESCOs) involvement,
- leasing.

Especially for CHP investments, loans, and to a limited degree grants and third-party financing are the main financing sources used when the decision is made on investing into modernisation of the heat/and power sources and networks in both the Czech and the Slovak Republic. For any investment decision on building a new plant or on reconstructing the existing one, the managers need financial and related information on which to found their decisions. They often have to consider various proposals for capital investment and may have to choose between the available alternatives. This decision can have a significant effect on the profitability, financial stability and continued existence of the firm. The decision taken can also affect the standard of living of all those who are connected with the firm and of the customers. Not only are considerable amounts of money involved in CHP investment in capital equipment, but also the assets acquired last for a long time. All these facts emphasise the need for a very careful appraisal of investment opportunities. The future costs and revenues for each available alternative must be estimated as accurately as possible.

7.1.2 Project development

The project development phase consists of the identification of an investment opportunity, the assessment of the financial, socio-economic, environmental and institutional feasibility of the envisaged project, the financial engineering of the resources, and the design of contracts. The importance of the project development phase is often underestimated (both in time requirements and the related costs) by those who intend to invest in heat source reconstruction or building. It seems inevitable to strengthen the project development phase since it would assist in addressing barriers such as the lack of in-house capital, lack of technical expertise, lack of information on existing alternatives, lack of economic skills and knowledge on efficient strategies leading to risk minimisation.

Project development includes:

- *Business plan development for CHP*. For a firm, a detailed firm business plan should be developed. In case of a DH system a detailed energy concept and heat supply plan has to be worked out for the town as well. The following questions must be addressed:
  - What will the market for CHP products look like in the given place in the years of the investment recovery?
  - What is the competitive price of heat in relation to other heating opportunities and how this competitiveness will develop?
  - What are the ownership relations and what impacts can they have on project cash inflows? (Safeguarding heat sales needs to take into account possible privatisation of housing stock, influence and competence of the investor over the sales, etcetera.)
- *Feasibility study.* This study is based on the business plan. It has to develop a detailed technical-economic appraisal of possible alternative investment options, taking into account the local conditions such as the investment costs, operational costs, prices and tariffs of the electricity and heat supply and purchase, as well as the conditions for capital sources (cash-flow of the investment alternatives, NPV and IRR). All the risks of the investment have to be evaluated using sensitivity analysis of the major input financial data and impacts of their changes on the overall effectiveness and economic output of the plant. The study should address existing risks and develop a risk minimisation strategy.
- *Financing analysis.* This phase of the project development is mostly undertaken in co-operation with the financier and analyses in detail the selected financing options (guarantees available, financing conditions, contract itself and its legal enforcement, ways of spreading the risk, etcetera).

7.1.3 Investment risks

From a financial and investor's point of view, the obstacles that has already been described in the chapter on economic characteristics of CHP schemes and in the chapter of obstacles to CHP implementation are regarded as risks. Every CHP project faces different external and internal risks and needs to be appraised individually. Very broadly speaking, risk is the possibility of not achieving the objectives of the investment and can be subdivided into three major categories of external risk to the project and internal risks. The *external risks* related to CHP alternatives in both the Czech and Slovak Republics include:

- Political risk
  - slowly improving but still persisting lack of cost-based pricing,
  - unfair competition environment for heat supplies.
- Commercial risk. Most of the perceived risks of CHP investments fall into the category of commercial risks. This can be divided into technology-specific risks and market related risks. Market related risk includes among others:
- Project development risk - Chances of failure during the project development phase.
- Investor/business plan promoter risk - Risk of inexperienced project developers or weak project management (e.g. non-existence of a well-based municipal energy plan).
- Market risk - unreliable revenues from electricity and heat sales (low feed-in tariffs for electricity sales in case of sales into grid (exceptions exist), incompetitive heat price, in which most of the production costs are included, tariff structure very simple and old-fashioned, non-payers, etcetera).
- Fuel price risk.

The *internal risks* include:

- Technology related risks:
  - Track record of technology. Has the technology successfully been applied in actual projects?
  - Construction (pre-completion) risk. Has the building contractor profound experience with technology?
  - O&M related risks. Can the availability/efficiency levels be reached? Are the necessary technical resources available?
  - Security and quality of fuel supply.
- Lack of managerial skills and capacities (incl. lack of commitment or lack of commercial policy).

7.1.4 Financing structures for CHP projects

The wide range of technical designs and applications of CHP schemes is paralleled by a wide range of methods of financing. The financing structures of a CHP plant will show fundamental differences, depending on the individual features of the project:

- size of the CHP plant to be financed,
- field of application of the CHP plant (industry or district heating),
- owner or project operator of the CHP plant (independent energy producer, utility company or an external third party).

The bigger the CHP plant to be financed the more likely are methods of 'project financing' involving high costs of development due to their complexity. At the same time, also projects implemented by independent energy producers (e.g. industrial enterprises) will use project financing structures more frequently since industrial enterprises have a strong interest in preventing investments into 'auxiliary operations' (as is the energy supply of a company) from taking effect on the balance sheet. This can be achieved by founding a project company by which the energy supply is partly or totally excluded from business operations. In order to use project financing structures for smaller and medium-sized CHP projects also, it is necessary to form 'project umbrellas' since individual projects are usually too small to attract the interest of banks (in particular international ones). Under such a 'project umbrella' projects of the same kind are combined so that they are not presented as individual projects to possible lenders but as a conglomerate of several projects, which in sum represents a suitable project volume.

Financing through the local credit market requires relatively high equity needs and a relatively long credit period (nine years) in order to achieve the necessary debt-service ratios. However, under such conditions, an equity return of 26 per cent for a project life of 15 years based on conservative estimates proves very attractive. The application of this method of financing is limited by the relatively high equity needs but also by the fact that the entire investment has an effect on the balance sheet, reducing the scope for further investments. A significant increase of the return on equity can be achieved by applying more complex financing structures in terms of project financing. Investors may widen their scope by founding their own project partnerships. By combining guaranteed export loans, foreign loans with favourable interest rates and subsidised equity loans to refinance a potential Austrian investment, a favourable average level of interest rates can be attained.

7.2 Financing CHP in the Czech Republic

Most industrial energy utilities and all district-heating systems in the Czech Republic are privately owned and have to rely on the capital from the market for new investments. Private owners of the DH systems include foreign companies and banks, domestic investors (banks, funds, individuals), municipalities, in very small portion management/ employees. The amount of shares owned by inhabitants is nearly negligible. The mix of owners differs very widely from one DH system to another. In industry outsourcing has become very popular (mainly after production drop) and many industrial companies have sold their energy utility. Due to the state of most DH systems and industrial energy utilities, the need for investments is high. Most CHP investments have lower profitability due to lower revenues from electricity and heat sales. In addition the cost of capital reflects the level of risk and the risk related to CHP project cash inflows may be high due to lower reliability of heat sales and electricity and heat revenues. These two reasons make access to suitable capital difficult.

In the Czech Republic the main problem with financing CHP investments in both district heating systems and industrial utilities is not the lack of capital, but the discrepancy between expectations and requirements of the private financiers. This refers to conditions of available financial sources) on one hand, and economics (financial viability) of the CHP alternatives compared to heat-only solutions, on the other hand.

7.2.1 Financing from in-house capital

Financing CHP from in-house financial sources would be rare without the subsidy from the grant sources of the Czech Energy Agency. Even then it is mostly used for financing small CHP units in family houses or small blocks of flats. Moreover, the potential investors in the Czech Republic still lack in-house capital for investments for the following reasons:

- Decreasing or stagnating revenues in most industries and service sectors.
- Deficits in public budgets.
- Restrictions applied on public expenditures.
- Secondary debt (aggravated by difficult enforcement of claims).
- Repayments of other debt service (bridging loans, loans for company privatisation, reconstruction, etcetera).
- Priorities in industrial sector are given to other (more profitable) investments (core business investments, environment protection investments, etcetera). Even if the investment in CHP reconstruction is inevitable due to technical/environmental reasons, the IRR is being taken into account in the decision on reconstruction. The CHP alternative may lose due to the low IRR in comparison with heat-only alternative.
- In the municipal sector budgets have been in deficit or fairly limited and low revenues make investments into CHP projects very difficult. Other investments that are enforced by legislation have priority (e.g. wastes and sewage water investments), or by necessity (e.g. infrastructure development). In case the municipality is the owner of DHS and modernisation is inevitable, the ‘capital least intensive’ alternative is mostly sought that also has the least impact on the price of heat.

7.2.2 Grant co-financing, incl. local and international soft loan schemes

The state support programme for energy efficiency for 2000 includes support to CHP schemes. It provides grants, a combination of a grant and a soft loan, soft loans and guarantees to all types of investors. The state support can be complementary to all other financing options and is definitely the major incentive for CHP implementation in smaller and medium sized applications at the moment. Co-financing are provided by the Government from:

- directly the state budget (allocated by the Czech Energy Agency- CEA),
- from the State Environment Fund (SFZP) resources (revenues from fines for air pollution).

Soft loans can be provided by the:
- State Environment Fund,
- Phare Energy Saving Fund,
- Phare Business Environmental Programme.

State Environmental Fund and Czech Energy Agency
Under its Programme for air protection the State Environment Fund provides support to small and medium-sized CHP units by direct grant support or soft loans (3 to 7% and five year repayment period for CHP up to 30% capital investment) or combination of both, for projects meeting the eligibility criteria and strict banking criteria. In the case of CEA, grants are provided for CHP reconstruction of a heat source up to 50 MW of installed capacity. The grant can cover up to 25% of the capital cost. The state direct support can also be granted in case of leasing. Grant co-financing reduces the need for up-front capital (e.g. a loan with higher interest rate) and reduces the need for high revenues for heat sales mainly.

Since 1992 136 projects with 179 CHP units of the total electrical output of 36,364 kW were supported by the Czech Energy Agency. Out of the overall amount provided by the State programme (163.6 mil. CZK) there were 30.2 mil. CZK provided in the form of zero interest rate loan and 133.4 mil. CZK as a grant. The total cost of the projects amounted to 1,098 mil. CZK. The support of the state represented in practices about 15% of the project costs in average.

SFZP supported (in the past) only CHP units using renewables as a fuel - Three CHP projects were supported, including 7 CHP units with the total electric output of 5 MW_e, The most significant project was the installation of CHP units in the location of Děčín-Bynov, comprising the rehabilitation of existing coal-fired heat only plant and replacement of steam distribution network by hot water network. An additional 4 CHP units have been installed with engines of Deutz MWM 620-V 16K of the total electrical output of o 5Me. The overall costs of the DH system rehabilitation and refurbishment amounted to 220 mil. CZK. The subsidy of the Fund in the form of a grant amounted to 173 mil. CZK.

Phare Energy Saving Fund (Phare ESF)
The European Commission allocated ECU 4.7 million from the PHARE Energy Programme to the Ministry of Industry and Trade to establish a revolving fund that provides funding for energy efficiency projects under preferential conditions. The soft loans are available also for bankable DH rehabilitation projects, if these projects are generating sufficient energy savings (e.g. in case of reduction of heat distribution losses). Of the total of 23 projects supported by the to now, 3 CHP units were financed in projects of reconstruction of municipal and industrial heating systems. The fund is managed until 2007 by ČSOB, selected in a tender, which provide medium term and long-term investment loans with a preferential interest rate for financing small and medium sized energy saving projects (2-50 mil. CZK). The bank is being remunerated for administration of these loans. The preferential interest rate results from blending Phare funds resources and ČSOB resources in the loan in the ratio 1:1 (The interest rate is constructed as 1/2 Prime rate of the bank + 3.5% max). The prime rate as of January 2000 is 8%, loan interest rate about 5%-7%, duration up to 7 years. Within the overall cost savings achieved by the project, energy cost savings have to amount to at least 40%. The client is, nevertheless, also allowed to repay the debt from other sources if the project payback time exceeds the duration of the loan. The fund is open to any creditworthy client. A project verification study based on an energy audit has to be developed by the applicant proving financial viability of the project in addition to the standard bank requirements. A supporting scheme has been developed for the bank and for the clients to ensure the quality of the projects financed.

Phare Business Environmental Programme (Phare BEP)

The programme supports environmental projects in SMEs on a principle very similar to the Phare ESF. The projects have to achieve a substantial reduction of harmful emissions. The recent interest rate is about 5.5 to 6.5%. The repayment term is 5 years plus one year of grace period. The funds can be applied for by CHP investors in case of the replacement of coal by gas. The Programme is managed by IPB bank. In assessment of environmental impacts of the project has to be made, financed from EU funds. At least two CHP applications have been financed through the programme. The size of the soft loan is from 3.5 to max. 28 mil. CZK, covering max. 80% of the investment.

7.2.3 Loans from international financial institutions under preferential conditions

DHS projects can be financed either directly or through credit lines under preferential conditions (soft loans). Financial institutions that focus on financing of energy projects are:

- EBRD, in which a special department has been set up in 1994 - Energy Efficiency Unit. This department accepts projects of both public and private sectors. The conditions are to achieve energy savings in production, distribution or consumption. DH and CHP schemes are very interesting projects to EBRD. EBRD usually limits its co-financing to 35% of the capital costs of the project, usually not below 5 mil. EUR. Smaller projects can be financed from the bank's credit lines. EBRD provides also equity finance, mainly in investments into technology production and in ASCII establishment.
- BIRD, which is owned by the governments of 180 countries. BIRD is lending funds mostly raised through the sale of ABA-rated bonds in international capital markets (medium and long-term borrowing) or at market-based rates from central banks and other government institutions. It is known for its conservative lending policies and prudent financial management. Examples are projects Co-financed from GEE grant 7 mil. dollars and BIRD loan 5-6 mil. ECU. Its loans are only made available to governments, government agencies or institutions, which can obtain a guarantee from their government. BIRD provides:
  - partial risk or partial credit risk guarantees (with a counter-guarantee from their government) to private lenders,
  - assistance to those projects that promise high real rate of economic return to the country.

For most international financial institutions the procedures required are quite complex and are not suitable for small-scale projects. Most CHP projects in the Czech Republic are considered as small with low profit. In addition Czech investors do not have sufficient experience to work with foreign and international financial institutions and products (e.g. with the EBRD). The International Finance Corporation (IFC) finances projects both in private and public sector and assist in ensuring finance on the international markets. It also provides technical assistance and consultancy.

7.2.4 Local commercial loans

Project finance (non-recourse finance)

Legally separating a project from an industrial company, often in a Limited Partnership, may enable access to non-recourse finance based on the cash flow revenues from the joint venture. Through this construction, the investor can leverage extra debt finance without worsening the balance sheet of his core business or endangering his core business. The liability of an investor is limited to his or her own capital contribution. In case the corporate capital is limited, non-recourse financing may provide a means of increasing the debt element of a project's funding, where the project's revenues serve as a type of collateral. Besides, for large-scale projects, project finance may be the only source of finance available.

The disadvantage of project finance is that the bank will require a careful assessment of risks, costs and potential revenues, and a careful structuring of contracts to ensure it does not accept risks, which should be borne by the equity holders of the project.
The increased amount of investigation work required for the due diligence has a strong upward pressure on costs and time span of the project development phase. This makes the project finance instrument only applicable for large-scale investment projects. Large-scale cogeneration plants could benefit from project finance. For renewables projects finance is used for large biomass plants or waste incineration facilities.

Debt financing
Financing a part of the CHP investment through a bank loan is often used mainly by investors who already use loans for other investments. Industrial companies and towns, who mainly invest in this way, are better experienced in preparing a good proposal for the bank (either by themselves or with an external assistance). Often the investments are quite large and the CHP installation represents only a small part of the capital costs needed. For banks, large cities seem to be more reliable clients (tax revenues are sure). To finance a CHP project complete business plan is required and the sales of CHP products should be well assessed. Most towns - project hosts, though, has only short-term approach to the investment. The banks lack a long-term view on investment opportunities, well-developed energy concepts of towns and proper project development.

Barriers to commercial financing
The major barriers related to commercial funding of CHP projects in the Czech Republic are:
- *Price of capital.* The interest rates are derived from the inter-bank rate for the purchase of CZK from the Czech National Bank, Administrative margins and risk margins are added. These differ according to the client rating and the rating of the project and also according by bank. The current rate at the inter-bank market (as of January 2000) is about 6 % and interest rates are within a wide range of 8-12% for 5 to 9 years of repayment terms. Czech banks prefer capital intensive investments, in case financial viability is well guaranteed.
- *Unreliable heat sales and low revenues from electricity sales.* The commercial risk of unreliable heat sales and thus unreliable revenues for repayments may prevent the banks from financing CHP installation. This can mainly happen if the business plan has not been properly developed (e.g. municipal heat supply plan), management structures are weak and if heat sales are threatened.
- *Shortage of expertise to develop a bankable project proposal.* There does not seem to be a shortage of necessary skills to identify and develop CHP proposals, but the quality of projects submitted to banks for finance is often low in the Czech Republic. The economic, financial and risk assessment of projects in compliance with strict banking requirements has to improve.
- *Excessive guarantees requested by lenders.* Banks rely on loan guarantees, due to the unstable economic climate and the difficult prediction of the financial situation of the client and the project benefits and bad experiences in the past.

7.2.5 Third-party financing

Third party ownership participation can also ease the access to the capital. The following ways of support to investments belong to this group:
- privatisation,
- Energy Service Companies (ESCOs) involvement,
- leasing.

Privatisation
The involvement of private investors in DH systems can have also other objectives than to get access to capital - e.g. access to know-how, management reform, and municipality budget improvement through DH sales. However, unless privatisation is well designed and the criteria that investors must meet are clear and enforceable, a public monopoly is replaced by a private one with severe economic damages. This has already happened in the Czech Republic.

Involvement of Energy Service Companies (ESCOs)
The basic role of an ESCO is to provide comprehensive energy services to consumers including project development, investment appraisal, finance, engineering, project management, equipment maintenance, monitoring and evaluation. ESCOs can package their services using a variety of financing schemes. In this manner, ESCOs help to address the barrier of lack of specific expertise and in-house capital. Moreover, ESCOs are more willing to undertake feasibility studies to projects with higher returns and higher risks, because they can diversify the risk over more projects. It is clear that ESCOs do not only facilitate project development, but also provide risk-bearing capital and/or debt finance. The basic role of the ESCOs in heat and electricity supply systems (both municipal and industrial) should be to provide reliable and efficient heat supply to a consumer - to an enterprise or to a municipality. The advantage of third party financing is the distribution of financing over much longer period (e.g. 15 years) and the resulting lower annual financial burden. Capital has been provided by the third-party, security is not required in the form of real estates but rather in the form of possible long-term contracts of heat take-off. ESCOs may bring capital, invest and own the assets and have a long-term agreement on a fixed rent with the heat source operator, who is responsible in full for operation of the source, sales of heat to the town and sales of electricity in case of CHP. Under these schemes CHP installations are scarce, though, due to low cost effectiveness and impacts on price of heat that might become incompetitive and threaten the long-term heat demand. Another possibility is the establishment of a new company that operates a plant, in which ownership is shared. The ESCO takes over the investor’s risk, technical and operational/ performance risks. The town can have a supervisory role and take over the commercial risk for heat sales. In any scheme well-designed contract is the basis of a functional mutually beneficial relationship.

In the Czech Republic involvement of ESCOs in financing rehabilitation of heat production of municipal district heating systems is rapidly increasing. Mainly Austrian and German ESCOs bring capital to the district heating systems in the Czech Republic and get an ownership share. Different ESCOs are nevertheless operating on different principles and not all of them fulfil the role of operational and performance risk take-over. Companies most active in the field are e.g. ABB Brno, TENZA Brno, TEDOM Třebíč, EPS and HARPEN.

Leasing
Leasing is a concept that is equivalent to renting in combination with the option to obtain legal ownership at the end of the rental period. Depending on the type of lease-finance it can be classified under risk-bearing finance (equity finance) or under debt finance. For reasons of uniformity, lease finance will be treated here in this section of equity finance. Two main types of leasing can be distinguished: capital and operational lease. The difference between these two concepts depends on which party bears the economic risk. In case of capital lease, the user (i.e. the party who obtains the technology) makes regular lease payments during a period often equal to the economic lifetime of the equipment. At the end of the lease period the user becomes the owner of the plant. The contract is irreversible and the user of the plant bears the economic risk (i.e. the risk that the equipment may loose its value due to wear and tear, technological development, new market developments, etcetera).

In case of operational lease the lease term cannot be any longer than 60% of the economic lifetime of the equipment and the lessor (the leasing company/owner of the equipment) bears the economic risk. This type of lease can be kept off the corporate balance sheet and improves therefore the creditworthiness of the lessee. The advantage for the lessee is that lease payments can be expensed for tax purposes. Moreover, in comparison with loans minimal or no down payment is required.

The advantage of using the leasing concept for energy equipment is its ability to provide capital support in situations where traditional financial sources have been inaccessible or have failed. Moreover it can bring advantages in:
- Taxation (leasing is considered as a cost).
- Providing additional warranties (by the subject of the leasing or buy back purchase).
- Accelerated depreciation (the equipment is owned and depreciated by the leasing company usually within a shorter term than the leasing agreement duration).

In the Czech Republic an extensive leasing industry exists. Leasing companies lend out to six and seven years and cost of the credits exceeds that of loans obtainable from the banks. This is due to higher overhead and administrative costs. Leasing may be more accessible than bank loans, particularly if the borrower is already 'fully borrowed'. This is because the leasing company retains ownership in the equipment. Yet leasing of energy technologies is scarce due to the fact that many energy technologies are difficult to install anywhere else and some of them cannot be retained by the leasing company due to legal constraints. That is why leasing is provided often by a partner of the CHP technology producer for the technology. Some of the barriers to leasing can be similar to those faced by commercial banks. The financial situation of the client does not ensure that debt will be paid back.

7.2.6 Joint implementation

The marginal abatement costs of greenhouse gases in the Czech Republic are still relatively low compared to other Annex I countries. This leaves a certain potential for Joint Implementation Projects (JI). Next to the increase of energy efficiency, JI could bring several other benefits, such as technology transfer and the reduction of air pollution. Several more or less successful AIJ Pilot Projects were carried out in Central Europe in recent years, among which CHP projects. These and future projects have still to cope with several barriers especially concerning the lack of experience and novelty of the issue. As several UN FCCC Annex I countries have announced that they are willing to invest large sums of money into JI, this represents an important source of financing energy efficiency, in particular CHP, in the Czech Republic.

7.3 Financing CHP in the Slovak Republic

Considering a large potential for CHP, it is surprising that only few projects have entered a concrete planning stage or have been implemented. This development has repeatedly been explained by barriers commonly encountered by CHPs as 'independent' power plants all over Europe but above all by the low level of energy prices and the severe distortion of the market in Slovakia to the detriment of centralised heat supply. In the first half of 1996 the Austrian Energy Agency (E.V.A.) on behalf of the Federal Ministry of Environment and Family carried out a study of a number of concrete project locations suitable for the operation of CHP schemes. The study consisted of single economic feasibility studies of concrete project proposals, which in sum represented a cross-section of various technologies and applications of CHP schemes.

The results of these economic analyses show that the efficiency of CHP projects in Slovakia depends very much on the individual field of application. The following factors are of great significance:

1. A general increase of energy prices (adjustment to a cost-covering level) will be of little importance for CHP projects in industry with a high rate of capacity utilisation. However, this factor plays a major role in the district-heating sector.
2. If electricity prices are adjusted to a cost-covering level, the electricity factor immediately becomes more important, in which case the use of extraction condensation processes is preferable for reasons of cost-efficiency.
3. There is a capacity problem in the transport and distribution net of Slovakia's electricity supply system, which - as far as CHP schemes are concerned - may lead to high costs caused by standby electricity needs (corresponding to about three quarters of the demand charge).
4. The low energy price level is indeed a significant barrier but only for the projects designed for exclusive use in the district-heating system. The fact that in the profitable industrial sector no CHP projects (with a few exceptions) have been developed and implemented in Slovakia stresses the importance of the following barriers:
    - inadequate information on the economic potential of CHP schemes,
    - scepticism of the utilities about independent energy producers,
    - financing barriers; little experience with various methods of project financing,
    - the pressure of time due to emission regulations often leads to low-cost investments (e.g. simple exchange of boiler).
5. An important feature making CHP projects in Slovakia attractive is tax exemption granted for applying this technology during the first 5 years of operation (recently the Act No. 286/1999 and Act No. 397/1998 was amended by Act 366/1999 and put in force since Jan 1, 2000. This Act limits the tax deduction for CHP plants up to 1MW of installed capacity only).
6. Contrary to industrial CHP, it seems to be difficult in the present setting to finance CHP plants in the district-heating sector as stand-alone projects. The comparatively long payback periods entail credit periods that are not available at present at least on the Slovak credit market. Such projects may, however, be financed by a combination of guaranteed export loans, equity loans and favourable funds, provided the equity participation is adequate (Government guaranties are conceivable only in exceptions and for large CHP projects).

7.3.1 Financing from in-house capital

Problems with in-house capital seem to be even more acute in the Slovak Republic compared to the Czech Republic. Not only private capital but also capital sources in local commercial banks are scarce and can only provide capital in limited amount for high interest rates that do not allow to make CHP projects financially viable. The only solution is international loans and funds.

7.3.2 Grant co-financing, incl. local and international soft loan schemes

The Ministry of Economy of the Slovak Republic

The programme aiming at reducing energy consumption in apartment buildings and family houses has been designed to support projects of additional thermal insulation, the installation of metering and control systems and the upgrading of heating devices in flats and family houses. The support is implemented in two forms: B1 - the reimbursement of a part of interest rates of a commercial credit, maximally up to 70% or 3 mil. SKK or B2 - granting a recoverable financial support (an interest-free loan) with a pay-back period up to 3 years, maximally up to 3 mil. SKK. This support is being used for small-scale CHP units, number of supported installations is small.

The Ministry of Agriculture
Pursuant to Paragraph19 of the Journal issued by the Ministry of Agriculture in 1999, it will be possible to provide subsidies aimed at energy efficiency improvements in agriculture, food industry and agricultural service companies by using environmentally friendly fuels and energy, energy saving technologies and waste. The size of a subsidy may achieve 30% of capital costs in a standard year or 30% of the paid instalments of the credit in a standard year. The subsidies may be provided to compensate an interest rate of credits up to 10 percentage points of the interest rate from interest rates due in a respective budget year.

Österreichische Kommunalkredit AG - Ost Oeko Funds
The Ost Oeko Funds has been set up by the Austrian government with the aim of supporting the reduction of emission impact in near-border regions (up to 100 km) of Austria. This fund provides an opportunity to obtain 25% of capital investments and 50% of the cost for consultants and the development of an energy efficiency project. 'Greenfield' projects are not supported through this way. To get the funding it is required to send an application and the project documentation to Kommunalkredit prior to the implementation, as well as a tender, inviting Austrian companies.

7.3.3 Loans from international financial institutions under preferential conditions

For CHP projects, financing from foreign soft loans is also possible. The soft loan programmes are mostly launched by governmental institutions in order to support projects in specific fields. Soft loans represent long-term credits with a relatively low interest rate (up to 5%) which, moreover, include some grant. This grant allows softening a requirement for both internal and outside capital in the project financing. Unlike standard commercial credits, the soft loan programmes have precisely specified terms and conditions, as well as criteria such as the energy and environmental effects.

Environmental Soft Loan Programme for Eastern Europe
The programme is governed by Eksport Kredit Fonden (EKF) and a Danish Agency for the environmental protection (DEPA) and is tended, among others, for the implementation of energy efficiency projects in DH systems. The subsidies are provided by EKF and usually they account for 25% of all the funds, while cutting down credit and interest rates. At the same time, EKF provides a free guarantee for a financial institution providing a credit, so it is possible to obtain the credit with a 6% interest rate. Other grants may be provided for the approved projects to cover the costs for consultations. Any project must meet the following criteria: a direct positive environmental impact, the project cash flow is not sufficient to pay back credits and interests under the current market conditions, an investor must be solvent under the EKF rating, the project must be worth more than 20 mil. DKK, and an application for a soft loan must be thoroughly documented. To get a soft loan, it is required to issue a tender organised by DEPA. A tender refers to the overall delivery, including turnkey deliveries. The maturity of a credit may achieve 10 years, in some cases even more years, whereas a first instalment may be postponed. The soft loan programme covers CIRR by the EKF programme, thanks to which banks are able to provide the funds with a fixed credit rates of 5.73% for DKK, 5.96% for USD and 4.98% for DEM. Project developers, consultants and suppliers could apply for the support within this programme by sending project proposals to the Danish Agency for the Environmental Protection - DEPA. As long as it is not possible to obtain funds from the soft credit programmes, export credits might be used as an alternative way of funding. The majority of EU countries supports the exports of products of their companies by means of long-term commercial credits (up to 1 years) with a relatively low interest rate (5-6%).

Eksport Kredit Fonden (EKF)
This foundation has been established by the Danish government to provide guarantees for export credits to exporting companies, banks or credit insurance companies in cases, when the political and commercial risks are unbearable by the market. EKF represents a specialised department of the Danish Agency for the trade and industry. The guarantees of EKF cover political and commercial risks. EKF also provides guarantees for conventional medium- and long-term credits, as well as the financial leasing.

The Investment Fund IO
This investment fund was founded by the Danish government in 1989 as an independent institution supporting the commercial development and economic growth in reforming countries of Central and Eastern Europe in form of investment projects implemented in association with Danish companies. The Fund contributes to the implementation of investment plans as a shareholder in joint ventures, to which it can, moreover, provide a credit. IO has supported more than 200 projects since 1990.

Finanzierungsgarantie - Gesellschaft
This company is subject to the Ministry of Finance and encourages the participation of Austrian companies abroad by means of the financial and project guarantees, as well as 50% grants for project studies ordered by Austrian companies. FGG is experienced in project financing and presently is actively involved in attracting clients and at the same time, establishing project development companies in the neighbouring countries. In Slovakia negotiations on the selection of a local bank as a partner for the establishment of such a company, are underway with the Ministry of Finance.

Österreichische Kontrollbank
This bank is a member of the of the Paris club of OeKB, it is focused on supporting the foreign trade by providing a beneficial funding of exports and on supporting exports of Austrian companies by means of export guarantees, which are provided to Austrian vendors or directly to consumers in form of a financial guarantee. OeKB is also involved in project financing. An overview of OeKB products is on the Internet, whereas a local page allows, after feeding input parameters, to set the costs associated with financing.

BUERGES
This company co-operates with the Austrian Commercial Chamber and supports small and medium-sized Austrian companies establishing joint ventures abroad by providing grants through the FGG study fund, as well as financial guarantees (80% of credits, max. up to 10 mil. ATS and project guarantees (50% of the project costs up to 10 mil. ATS). So far, Buerges has no experience with contracting and is not active in acquiring new projects.

7.3.4 Local commercial loans

The comparatively long payback periods for CHP projects (mainly in municipal district heating systems) entail credit periods, which are not available at present on the Slovak credit market.

7.3.5 Third-party financing

Privatisation
Privatisation of heat and power systems formerly in the ownership of towns and municipalities has resulted in a number of ownership structures, in some of which good conditions for complete reconstruction and CHP introduction have been created, mainly in Eastern Slovakia.

ESCOs

ESCOs successfully started their operation in the Slovak Republic in the first half of the 90s, the distortions in heat prices have slowed down these activities. It is expected that with the removal of subsidies, the activities of ESCOs will increase. Financing through Energy Service Companies is mostly implemented on the basis of an agreement - energy performance contract. The complex way, in which the service has been provided have a lot of advantages compared to traditional commercial loan - risk sharing, guarantees provision, provision of implementation and operational service. These services cover all areas of energy production, distribution and consumption, including direct and indirect control over performance that enable consistent and permanent reduction of operational costs. The basic objective for financing EPC (Energy Performance Contracting) projects in the public sector is the stabilisation of the financial requirements for operation of energy facilities of the sectors. The investments are repaid through the energy costs savings achieved without additional investments required from the state budget. This will require further legal changes to be made. Nevertheless, EPC may enable to increase energy efficiency in public sectors without involvement of public capital sources. Long-term financing on the basis of Austrian and German capital might allow for CHP installations economic viability even in municipal sector, schools and hospitals, but price distortions and insufficient guarantees of the revenue stream have not enabled to finance any CHP project yet.

7.4 Conclusions and recommendations

7.4.1 Conclusions

1. The wide range of technical designs and applications of CHP schemes is paralleled by a wide range of methods of financing. The financing structures of a CHP plant will show fundamental differences, depending on the individual features of the project:
   - size of the CHP plant to be financed,
   - field of application of the CHP plant (industry or district heating),
   - owner or project operator of the CHP plant (independent energy producer, utility company or an external third party).
2. In the Czech Republic the problems associated with financing CHP investments in both district heating systems and industrial utilities are not related to the lack of capital. More important is the discrepancy between the expectations and requirements of the private financiers (i.e. conditions of financial source availability), on one hand, and the economics (financial viability) of the CHP alternatives compared to heat-only solutions, on the other hand. Nevertheless, many CHP applications have been financed. Especially for small and medium-sized CHP investments the net profit, depreciation, loans, to a limited degree grants and third-party financing are the major financing sources used when the decision is made on investing into modernisation of the heat and power sources and networks.
3. The project development phase (incl. detailed business plan) is often underestimated (both in time requirements and the related costs) by those who intend to invest in heat source reconstruction or building.
4. For the industrial and commercial sectors (i. e. in case of auto-producers) any CHP project is site-specific. Profitability is assured where the average price of electricity that would have to be purchased by the plant from a distributor is significantly higher than the price of own electricity produced from the CHP source. The installed electrical capacity must be well adjusted to the needs of the plant so that the benefit of lower costs of electricity produced in an own CHP source is not diminished.

5. Fiscal measures that directly influence economics (revenues) of CHP schemes should be prioritised by the state against investment support, because they are market productive and non-discriminatory. These may include either *fixed feed-in tariffs* for CHP producers, diversified according to the installed capacity or *tax deductions* for CHP equipment suppliers, and for companies producing electricity and heat in a CHP unit. In case of fixed feed-in tariffs, the state support should provide for reimbursement to distribution companies for the fixed feed-in tariffs to keep the competitive environment for them fair.
6. The direct investment support is selective and hence 'not market fair', mainly in the case of private investors. Yet it has proved to be an efficient tool for CHP promotion mainly for small CHP installations, financed from in-house capital. Maximum transparency needs to be maintained in the overall scheme to make the selection of projects and the decision making process easier.
7. Long-term loans (at least 7 years) with preferential interest rate that would allow repayment CHP investments without significant increase in heat price and consequent threat to the competitiveness of heat on the market seem to be the best way of financing municipal district heating systems.
8. Conditions of commercial loans have improved. On the basis of a well-prepared project proposal, banks are able to offer much better conditions than in recent years - a lower interest rate (even below 10%) and longer repayment conditions.
9. The Phare Energy Saving Fund has recently approved a loan for CHP installation of 5.5% interest rate with 6 year repayment period. Should the fund sources be increased, it might become a convenient source of soft-loan finance for more CHP installations.
10. Obligation of CHP installation, in case the audit proves that the minimum IRR level (expected to be introduced by the new Energy Management Act) is achieved, will have a substantial impact on investors' decision-making and hence on the allocation of funds for CHP plants. This regulatory measure should be linked with the support for investment.

7.4.2 Differences between Czech and Slovak Republic

In the Czech Republic, the main problem with financing CHP investments is not the lack of capital, but the discrepancy between expectations and requirements of the private financiers (i.e. conditions of available financial sources), on one hand, and economics (financial viability) of the CHP alternatives compared to heat-only solutions, on the other hand. A number of CHP projects have been implemented with state support.

In the Slovak Republic only very few projects have entered a concrete planning stage or have been implemented - mostly large steam-gas cycle plants (4) using project finance approach. In small scale CHP, no visible improvement has been achieved yet. This development has repeatedly been explained by barriers commonly encountered by CHPs as 'independent' power plants all over Europe. The most important factor is the low level of energy prices and the severe distortion of the market in Slovakia, which has a negative impact on the share of centralised heat supply. Moreover, the local capital available for CHP investments is scarce and difficult to access. To a large extent the barriers to financing CHP investments are the same in both countries. In the Slovak Republic, though, the implications of pricing policy are more severe and the state support is not comparable with that provided in the Czech Republic. Despite the fact that the need for new investments (both in industrial and municipal district-heating systems) is comparable as in the Czech Republic, the number of investments is very low.

7.4.3 The role of the Czech and Slovak government

The role of the Government should mainly consist in removing barriers that deform the market for CHP and in supporting measures that improve motivation for CHP installations. The measures recommended are even more important for the Slovak Republic.

1. Reduce the external risk to CHP investments through introduction of cost-based pricing, hence creating a competitive but fair environment for heat supply.
2. Alleviate the market risk, i.e. supporting the creation of transparent conditions for the setting of feed-in tariffs for electricity sales, improving heat tariff structure, improving enforcement of penalties for the non-payments for heat supply, and supporting the introduction of long-term delivery contracts for heat.
3. Reconsider the obligation of CHP implementation in the case of private subjects and the possible linkage with the support for investment through motivating instruments.
4. In the case of public subjects, the state should take-over or alleviates the extra-investment cost for the CHP alternative through clearly specified rules, depending on the economics of a specific investment, in addition to other factors.
5. Continue support (in 1999 improved significantly) to CHP installations, mainly through soft-loan schemes. The state should set up clear rules for the direct support, depending on the economics of the CHP installation as well.
6. Support should be also given to the continued operation of the Phare Energy Saving Fund. This fund is a revolving, fully market compatible scheme, but without further state/EU contribution the amount of available funds for investments is very small.
7. To improve access to commercial funding and SFZP funds, there is a requirement for the strong promotion of the need for both a detailed project development phase and for sound economic and financial assessment.
8. To host more JI projects, the Czech and Slovak Republics need to develop their own JI strategy. In the Czech Republic, the Ministry of the Environment, which is responsible for Activities Implemented Jointly/Joint Implementation, operates a JI registration centre. MoE, however, needs to adopt a JI strategy as a follow-up to the National Climate Policy, which has been negotiated by the Government on May 17, 1999. This strategy could be based upon strategic variants proposed by the National Strategic Study for JI (National Strategic Study for JI in the Czech Republic, World Bank, 1998) and upon the results of a follow-up study carried out in 2000.

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ANNEX A CURRENT STATUS OF CHP IN CZECH AND SLOVAK REPUBLICS

In this Annex detailed background information is given on the past development and current status of CHP in the Czech Republic in addition to Chapter 2 and 3 of this report. Also a detailed list of energy acts relating to CHP policy in the Czech Republic is given.

A.1 Development of CHP

31 Public CHP plants were in operation at the beginning of the 90s, with the total installed power output of 1944 MW. Of this 31% were units with backpressure turbines, 36% units with steam extraction/condensing turbines and 33% of condensating units. In the group of industrial CHP plants there were 107 plants at the beginning of the 90s. Of the total installed electrical capacity of 1878 MW 43% are of back-pressure units, 50% of steam extraction/condensing turbines and 7% purely condensating ones. The development of installed CHP capacity with back-pressure and steam extraction/condensing turbines and power generation in these aggregates has been included into the following table, separately for public and industrial plants:

Table A.1 *CHP plants power output and generation development*

CHP plants with		Capacity [MW_e] Back-pressure turbine	Steam extraction turbine	Total	Production [GWh] Back-pressure turbine	Steam extraction turbine	Total
Public	1989	606	702	1,308	1,978	2,602	4,580
CHP plants	1995	908	991	1,899	2,917	4,313	7,230
	1997	950	968	1,918	3,351	4,686	8,037
Industrial	1989	775	885	1,660	2,559	4,156	6,715
CHP plants	1995	672	644	1,316	2,160	3,310	5,470
	1997	613	640	1,253	2,047	3,294	5,341
Total	1989	1,381	1,587	2,968	4,537	6,758	11,295
CHP plants	1995	1,580	1,635	3,215	5,077	7,623	12,700
	1997	1,563	1,608	3,171	5,398	7,980	13,378

Source: Czech Statistical Office.

Data on the annual production of heat by public and industrial CHP plants is given in the following table.

Table A.2 *Heat production by CHP plants*

CHP plants [TJ]	Public	CHP plants Industrial	Total
1989	83,323	133,416	216,739
1995	100,360	82,836	183,196
1997	105,054	76,123	181,177

Source: Czech Statistical Office.

The number of public and industrial CHP plants is given in the following table.

Table A.3 *Number of public and industrial CHP plants*

Capacity	Number of plants
Public CHP plants	
up to 10 MW	6
11-50 MW	15
51-100 MW	8
over 101 MW	4
Industrial plants	
up to 5 MW	62
5-10 MW	13
11-50 MW	20
51-100 MW	8
over 101 MW	4

The corresponding consumption of fuels for the production of heat and electricity in 1995 is given in the following table.

Table A.4 *Fuel consumption for power generation in CHP plants in 1995*

Source of production	Total consumption of fuels [PJ]	
	Power generation	Heat production
Public CHP plants	70.1	141.4
Industrial CHP plants	55.7	105.7
Total	*125.8*	*247.0*

The regional split of CHP and the total amount of heat produced in CHP plants, split according to the sources and the share of CHP on total heat production is given in the following table.

Table A.5 *Heat production in CHP sources by region (1997)*

Region	Heat generation [TJ/year]
Capital Prague	5,871
Central Bohemia	19,566
South Bohemia	9,154
West Bohemia	9,393
North Bohemia	30,131
East Bohemia	3,516
South Moravia	41,754
North Moravia	11,984
Czech Republic total	*121,369*

Source: Czech Statistical Office.

A.2 Main CHP schemes

In the Czech Republic the following systems of CHP technologies are installed:

CHP plants with steam extraction/condensing steam turbine and backpressure turbine
Steam CHP plants are mainly equipped with backpressure turbines or extraction/condensing steam turbines. Most of the big installed steam turbines, which are under operation in the Czech Republic, are steam extraction/condensing steam turbines. These turbines are installed in heat sources of two the largest district heating systems: Mlník - Praha and Opatovice - Hradec Králové - Pardubice. Similar systems can be equipped with backpressure steam turbines. They are used in case, when steam is required by consumers for processes, mainly in industrial plants. However, these systems are not that often used in the Czech district heating systems.

Recently also small-scale CHP units, suitable for applications in district heating systems of the size of 10 MW_e, have been developed. Steam turbines (both backpressure and condensing) with regulated steam take-off represent a classical CHP plant scheme. These turbines allow for use of significantly cheaper solid fuels, mainly high-sulphur content brown coal. Modern FGD technologies enable the plants to meet the stipulated emission limits.

CHP plants with gas turbines and heat recovery boilers
In the 90s gas turbines together with waste heat recovery boilers were installed. Foreign producers of gas turbines have extended the offer by smaller units for CHP in smaller industrial plants and municipal district heating systems.

Combined cycle CHP plants
In recent years few larger CHP plants with gas turbines and waste heat boilers together with steam turbines were installed. One of the biggest installations of this type combined with coal gasification is located near the Sokolov city and it is operated by coal mining company. Another one is operated by the district heating company in Brno, the second largest city in the Czech Republic.

District heating
The current status of district heating in the Czech Republic results from a series of economic and demographic factors that influence the development of heat and electricity supply. Two major groups of heat producers existed in the beginning of 90s, comparable as to their total installed electrical capacity and to their annual electricity generation regards.
To certain extent they were also comparable as to their heat production.

- CHP plants operated by the public power sector, which produced heat and electricity and supplied them to the public power and heat networks.
- CHP plants operated by industrial sector, which produced electricity and heat primarily for their own needs and they sold surplus of electricity to the grid, and surplus of heat to external consumers or to the municipal district heating systems. During the privatisation of industry a number of these plants were separated from the parent industrial plants and entered the group of independent power producers.

The technological design of CHP plants was predominantly influenced by the primary energy sources to be used, i.e. domestic brown and/or hard coal. That is why coal-fired CHP plants with steam turbines have dominated.

Industry
Energy sources in industry were initially mostly developed as CHP plants with steam distribution network. Only in 60ies to 80ies, due to concentrated construction of housing, development of hot water based district-heating systems started, mostly supplied by heat from sources of the public power sector but also from industrial CHP plants.

Small scale options
The last type of CHP installations described here concerns small-scale CHP plants with gas engines and waste heat recovery in coolers (see Table A6) The current supply of CHP units with piston gas engines includes both Czech and foreign producers of the major components. The range of units comprises the smallest units of 9 and 22 kW and in regular series it exceeds the unit power output of 1,000-1,600 kW, the biggest unit of 3,800 kW output being offered as a district heating plant. We define small-scale CHP units as those ones with engines with power output ranging from 10 to 1500 kW_e. In the Czech Republic two main designs of small CHP units are operated: a) liquid fuelled engines, and b) gas fuelled engines. The overview of small-scale CHP installations by individual producer and technical data of each unit are available as a reference list of each producer. The majority of installations were subsidised by grant provided by the Czech Energy Agency (CEA).

To monitor the use of its subsidies, CEA prepares 'Catalogue lists' of these installations with assistance of energy consultancy and information centres (EKIS - CEA). This catalogue lists contain all the basic technical and economic data concerning the installation and operation of each CHP unit. All catalogue lists are registered in CEA. The overview of installed small-scale gas CHP units as of April 1999 is presented on the following table.

Table A.6 *Overview of installed small-scale gas-fired CHP units in the Czech Republic (1999)*

	Number of installed units by individual producer							
Unit output [kW_e]	TEDOM	MOTOR-GAS	MAEN	JEN-BACHER	DEUTZ	DORMAN	Total number	Total installed capacity[kW_e]
10	21						21	210
12.5	1			6			7	87.5
15				3			3	45
22	242						242	5324
30	7						7	210
45	21						21	945
75	9						9	675
83	7						7	581
100	2						2	200
132	19						19	2508
140	34	10					44	6160
175			1				1	175
180	9				2		11	1980
190	10						10	1900
235		7					7	1645
250		3			1		4	1000
260	17						17	4420
300			5			6	11	3300
310		4					4	1240
390	1					1	2	780
450		3	1	2			6	2700
500	3	1			4		8	4000
600			4			4	8	4800
620				2			2	1240
630		1					1	630
657				2			2	1314
826			2	2			4	3304
922			1	3			4	3688
1000	4			2	8		14	14000
1300					4		4	5200
Sum	*407*	*29*	*14*	*22*	*19*	*11*	*502*	*74 300*

Source: producers and suppliers of technologies.

As can be seen on the Table A.6 there are about 500 small-scale gas CHP units installed in the Czech Republic with a total electrical capacity of about 74 MW_e and heat capacity of about 115 MW_{th}. The operating hours of these CHP units depend on the parameters of individual CHP plants and the local power feed-in tariffs. These tariffs are different for each region and are dictated by individual regional power distribution company. Data on electricity and heat produced by these sources is not available, but an average operational time of all small-scale CHP units installed in residential and commercial sectors was estimated 4,100 hours a year. In this case the yearly total power generation is estimated 287 GWh/a and heat production of 164 TJ/a.

The small-scale CHP installations can be further split according to the sector of installation into:
1. district heating systems,
2. residential and commercial sector,
3. industrial sector in which we also include biogas from sewage water treatment and landfill gas from landfill sites.

Most of small-scale units operate in smaller district heating systems (about 210 CHP units). Most of these units are located in boiler houses and work in tandem with gas-fired boilers (stand-by and peak boilers). The majority also operates in a peak load configuration (see below). A smaller number of these units operate in a base load configuration, usually for preheating steam condensate in steam distribution systems. In the residential and commercial sector about 240 small-scale CHP units are installed, about 40% of which operate in the base load mode. In industry, due to the fact that in this sector mostly larger CHP units are installed, only about 50 small-scale CHP units have been identified. The majority of these units operate in a base load regime.

A.3 Operating regime of CHP

Peak-load CHP

The design of these systems is based on maximising heat and electricity production during peak electrical feed-in tariff and minimising production during low tariffs. We can divide these systems into two operating regimes:

1. The first one is more convenient and also more usual. This variant calculates purchasing of 90% from total electrical production in a peak feed-in tariff period. It is usually calculated with CHP installations with a heat capacity, which represents about 15-30% of maximal winter heat demand and the peak load for heat is supplied by gas fired boilers. In this case gas engine heat production represents of about 40% of total heat supply. To realise the maximum production of heat and electricity during peak load tariff period, sometimes a heat storage tank is used.
2. In the second case of peak load CHP (relates to a few very small units, which have a gas engine only, gas fired boilers are not installed), about 90% of electricity generation is realised during the peak tariff hours. These installations are found in family houses, where, besides the CHP unit, there is also an old solid fuel-fired boiler to cover remaining heat demand. As an example of this installation we can consider one bigger family house with one small-scale CHP unit installed. This unit was designed mainly for production during the peak tariff (180 winter days- 7 hours a day and 180 summer days - 4 hours a day). The produced heat can be stored in a heat storage tank. The heat capacity of this CHP unit is about 160% of maximal winter heat demand. The gas engine is thus utilised for 2,500 hours a year. A large portion of heat production in the summer time is wasted. The economic efficiency of this regime is far worse than the previous one.

Base load CHP

The difference between peak load and base load CHP units is the operational time. This difference is based on 4,000 operating hours a year. In the residential and commercial sector, rarely CHP units can be found that operate for longer time than 4,000 hours a year. These CHP units were often designed for 100% utilisation of electricity production on-site. These schemes are more usual in the industrial sector. A typical scheme in the residential and commercial sector is a CHP unit with a heat capacity of about 30% of heat demand in winter time (-15°C) and annual heat production of about 65% of all heat demand. In this case, the generated power is exclusively purchased by a low voltage public grid, but almost all in the time of low tariff (about 5,500 hours a year). The rest of heat demand is covered by gas-fired boilers only. Another base load installation of a small CHP unit (22 kW_e) represents an example of a CHP unit where all generated power is for on-site consumption and all produced heat is used for steam condensate preheating. This installation is convenient, because all production from CHP unit is utilised on-site. In this case only a very small portion of the generated power is sold and all produced heat is used in the plant.

A.4 CHP legislation in the Czech Republic

Energy and environmental regulation have a strong impact on CHP. In this section, the relevant regulatory Acts and Decrees are listed.

1. *Act No. 222/1994 Call, on conditions of business and performance of the state administration in the energy industries and on the State Energy Inspectorate*. The Act specifies the basic conditions for business activities in CHP, and simultaneously defines the rights and obligations of legal entities and natural persons connected with this business and authorities of the state administration including regulation,
   - Natural or legal entities are permitted to perform business activities under the conditions specified in the Act.
   - Business without the state licence is not possible.
   - Holders of the state licence have obligations and rights defined in the Act.
   - Holders of the state licence have obligation of public service from the law.
   - Holders of the state licence are the subject of the state regulation.
   - The State Energy Inspection is a control body even for business in CHP and has right to apply penalties.
   - The Law defines in its specific part the conditions for heat supply, heat connection, metering consumption, heat purchase, protection and safety zones, unlicensed off-take of heat.
   - Ministry of Industry and Trade is authorised to issue decrees to implement some Articles of this Act.

2. *Act No. 513/1991 Call - the Commercial Code* as latter amended. It defines contractual conditions on electricity and heat supply, between legal subjects, rights and obligations of both contractual bodies including possibility of means of correction before court.

3. *Act. No. 40/1964 Call - Civil Code as latter amended.* The Code defines commercial relations between the entrepreneur and the citizen. The electricity and heat supply should be based on the Civil Code.

4. *Act No.: 526/1990 Call, on prices as latter amended.* The Act defines rules on price negotiation, price regulation and price inspection.

5. *Decree of the Ministry of Finance 580/1990 Call to the Act on prices.* The Decree defines non-conforming economic profit, procedural problems of price regulation and price control.

6. *Decree of MIT 129/1995 Call* Defining in detail the licensing process, conditions and the extent of information which the licence candidate is obliged to present to MIT in addition to the process of publication of issued, cancelled and ceased licences. The Decree defines activities in energy sectors (as concern CHP) as 1) electricity generation, 2) heat production, 3) electricity supply, and 4) heat supply.
7. *Decree MIT 173/1996 Call* about the procedure of enforcement of the state regulation in the energy sectors. The Decree defines conditions for state regulation and amount of information, which the holder of state licence is obliged to present to the MIT
   - The holder of the licence for operation of CHP with electricity output over 50 MW is obliged to provide to the MIT data on costs, income, profits, new investments and others data according to the Attachment of the Decree.
   - Ministry of Industry and Trade is the sole authorised body for the submission of proposals for heat price changes to the Ministry of Finance.
   - Employees of the Ministry of Industry and Trade have the right to enter objects where it is performed the licensed activity and they have the right to control accountancy and other documentation.

8. *Decree MIT 155/ 1996 Call on solving the state of emergency in heat supply*. The decree defines the subject of emergency plan:
   - In case of emergency situation the customers are obliged to lower the consumption.
   - The level of consumption lowering should be negotiated with each consumer in the contract.
   - The consumption limitation should take into account priorities in heat supply as the health care, food production, schools etcetera.

9. *Decree MIT95/98 Call as amended by 34/99, on rules of activity of the Central electricity dispatch centre*. Defines that for the preparation of operation plans the following power sources have priority for usage:
   - CHP,
   - electricity generation based on renewable and waste energy.

10. *Decree MIT 85/98 Call on heating and supply of hot water* including the rules for distribution of costs between end-users. The Decree defines:
    - heating season,
    - start-up, end and interruption of heat supply,
    - heat supply quality,
    - minimum level of efficiency for heat production,
    - specific rates of heat consumption,
    - hot water supply quality,
      - control of the heat supply systems,
      - method and formula used for distribution of costs of heat or hot water.

11. *Act 338/1992 Call, on real estate tax as amended.* Following subjects are released from real estate tax for time period of five years following the year when the installation was put into the operation:
    - Appliances using solar energy, geothermal energy and biomass energy.
    - Changes of heat sources from solid fuel to natural gas (including CHP).
    - Improvement of thermal insulation of buildings lowering the heat consumption.

12. *Act 586/92 Call as amended, on income tax.* Some energy equipment, especially renewable energy sources have exemption from the income tax. For example, there is not applied an income tax on small hydro power plants, energy production based on heat pumps,, solar and geothermal energy and biomass in the year when the technology is put into operation and in the following 5 years The Act allows for all tax payers to deduct 10% of the purchase price of the technology (if they are the first owners) from the base for taxation and additionally small-scale CHP plants based on piston engines with capacity up to 2.5 MW are allowed to be shifted to the group of assets with more advantageous (faster) depreciation rate.
13. *Act 558/92 Call as amended, on value added tax***.** Some products and services have a reduced VAT in the level of 5% instead of the normal level of 22%, like:
    - heat energy,
    - heat pumps,
    - solar installations,
    - thermostatic valves,
    - hot water meters.

14. *Act 309/1991 Call on atmosphere protection against pollution (the Clean Air Act)* as latter amended. The Act divides the heat sources according to the output to three categories, it defines the emission limits, it defines the rights and obligations of operators, it determines the role of state authorities and it prescribes the charges and penalties for atmosphere pollution.

15. *Decree of ME 117/1997 Call determines emissions and further conditions for operation of stationary sources of pollution and protection of atmosphere***.** The Decree replaced older decree of the Ministry of the Environment No 205/1993 Call.

16. *Act on Water No. 138/73 Call as amended.* Describes condition and obligation connected with the use of water and treatment of waste water

17. *Waste management Act 125/97 Call*. Describes obligations of natural and legal persons connected with the treatment of all type of wastes. Defines the role of state authorities, fees, penalties, inspection, etcetera.

18. *Act 389/91 Call as amended, on state administration of the environment protection.* Defines the role and authority of the Ministry of Environment, Czech Environment Inspectorate, Offices of regional administration and municipalities in the protection of the environment.

19. *Act 244/95 Call on the environmental impact assessment.* Defines the obligatory assessment of the influence of heat production sources with the capacity higher than 20 MW. Describes the procedure and scope of assessment, lists the obligatory documentation, formulates the condition for public discussion, determines the role of individual state authorities, including the procedure for issuing a licence for doing the assessment.

20. *Civil Engineering Code 50/1976 Call as amended.* Defines the basic requirements on technical solution of a new building activity, including connection to heating and electricity distribution systems. Further includes:
    - Provisions about the system, rights and obligation of authorities and persons, procedures, rights and obligation of investors valid in the territorial planning.
    - Provisions about the condition for providing such activities like to run pipes, to excavate streets, etcetera.
    - Authorisation for building civil engineering work and commissioning and role and authority of Building Offices.
    - Inspection and penalties.
    - Documentation and its filing.

21. *Act 22/97 Call, on technical requirement on products***.** It defines how to determine the technical requirement on products - creation of technical rules and standards and their validity. Defines also rights and obligation of persons which present products on the market (how to demonstrate their safety). The Act is followed by a series of Government regulations about technical requirement for individual types of products.

22. *Act 174/68 Call as amended, on the State professional Inspection of the safety of work***.** Defines the role of Czech Office of the Safety of Work and is followed by series of Decrees of this Office which defines the conditions for the safety run of different equipment.

ANNEX B SCENARIO'S FOR CHP IN THE CZECH REPUBLIC

In this Annex, the scenarios for the economic assessment of CHP used in Chapter four are described in detail.

B.1 Basic scenario's for CHP in the Czech Republic

The basic scenario is neutral with regard to support of renewables, CHP production and energy savings. This scenario is based on current conditions both in the economic field and in the field of protection of the environment. The basic assumptions in the field of fuel and energy consumption are as follows:

- Removal of cross subsidies applied to households energy prices will be done till 2002.
- Energy prices will reflect the level of economic costs and reasonable level of profit till 2005.
- No consideration about further strengthening limits on emission valid since 1.1.1999.
- Any changes of excise tax and VAT on fuels and energy in comparison with 1998 level.
- No form of external environmental cost internalisation is considered (e.g. energy or CO_2 tax).
- No extended form of the financial state support is considered.

B.2 Scenario with increase of feed-in power tariffs

This scenario supposes setting minimal feed-in tariff for power from sources connected to the public network. In this scenario it is considered an increase of feed-in tariffs from renewable and other small-scale sources connected to the public network (i.e. wind power plants, small hydro-power plants and CHP units). We assume an increase of feed-in tariff to the low voltage and high voltage (which is the level of distribution companies) from current average price of about 1.13 CZK/kWh in the basic tariff to the level of 1.60 CZK/kWh. An increase of the feed-in tariff is not subsidised by the government and should be fully compensated by distribution companies (redistribution of the profit). Further assumptions in the field of fuel and energy consumption are:

- Removal of cross subsidies of households energy prices will be realised till 2002.
- Prices will reflect the level of economic costs and reasonable profit level till 2005.
- No consideration of a further strengthening of the limits on emission valid since 1.1.1999.
- Any changes of excise tax and VAT on fuels and energy in comparison with 1998 level.
- No form of external environmental cost internalisation is considered (e.g. energy or CO_2 tax).
- No extended form of the financial state support is considered.

B.3 Scenario with massive government policy on promotion of CHP

This scenario could demonstrate a possible penetration of individual categories of CHP when countrywide application of the state subsidy on investments to CHP equipment is used. As the main instruments in this scenario, a subsidy scheme for small CHP units was chosen**.** This level should demonstrate the average participation of the state on investments by realisation of a wide-range support program for these energy sources from the state budget. The formulation and results of this scenario calculation and also previous scenarios should not be interpreted as a proposal of real state support level. The results should be used mainly for the analysis of changes of economic viability of CHP sources, by providing investment subsidies, increase of feed-in tariff and for determination of their economic potential (the level of their possible extension) in these conditions and in competitive environment with other energy sources.

Granting of the state support in real conditions would not be a general or overall measure, but it should be based on detailed technical and economic appraisal of projects (based on uniform economic parameters) based on energy audit. Economic parameters could differ project by project even if a similar or the same technology is used. When the overall state support is granted the 'free-rider effect' could occur, i.e. the situation when support is provided to project which can be performed without any support. Further assumptions in the field of fuel and energy consumption in this scenario are as follows:

- Removal of cross subsidies for households will be realised till 2002.
- Prices reflect the level of economic costs and reasonable profit level till 2005.
- No consideration of a further strengthening of the limits on emissions valid since 1.1.1999.
- Any changes with excise tax and VAT on fuels and energy in comparison with 1998 level.
- No form of external environmental cost internalisation is considered (e.g. energy or CO_2 tax).
- Financial state support is considered at level of 20% direct subsidy to investment costs.

ANNEX C REVIEW OF DRAFT CHP LEGISLATION IN THE CZECH AND SLOVAK REPUBLIC

C.1 Introduction

In both the Czech and the Slovak Republic, legislation has been drafted for the promotion of CHP within the framework of the Energy Management Act in the Czech Republic (EMA-CR), and the Energy Efficiency Act in the Slovak Republic (EEA-SR). The main component of the legislation concerning CHP is the mandatory application of CHP when cost-effectiveness is proven in combination with a stipulated energy audit. On the request of the Czech and Slovak Energy Agencies that are strongly involved in the preparation of the Acts, the project team has reviewed the draft legislation focusing on the following questions:

On the choice of instrument

1. Does the proposed obligation for CHP have an equivalent in the European Union, in particular the Netherlands, United Kingdom, Denmark, or Germany)? If yes, what are the experiences with this type of instrument?
2. What are the advantages and disadvantages of an obligation for CHP? Is this measure effective (does it promote CHP) and efficient (what are the costs and benefits of the implementation of the measure), and is it compatible with a liberalised energy market?
3. What is the expected impact of the obligation on the penetration of CHP?
4. What are possible problems in the implementation of the new legislation?
5. Is an obligation for CHP the best instrument for the promotion of CHP in the Czech and Slovak Republics?

On the design of the legislation

6. How is the legislation designed in detail? Is the text clear and consistent? What are possible improvements?

The review for the Czech Republic is based on the unofficial translation of draft dated July 1999. For the Slovak Republic, the draft dated May 1999 was used. Please note that the new draft could have been revised since then[14].

C.2 Basic characteristics of the proposed legislation

The Czech and Slovak draft legislation is similar with respect to the instrument of setting an obligation to CHP for heat production. Article 7 of the draft Energy Management Act of the Czech Republic obliges an audit on the cost effectiveness of CHP when application is issued for a building permit for an installation that produces heat or electricity producing. It mandates the application of a CHP unit when the outcome of the audit is positive. The obligation to check the possibility of co-generation holds for thermal capacities of over 5 MW and also for electricity producers with a total generating capacity over 10 MW_e. Paragraph 15 of the draft Energy Efficiency Act of the Slovak Republic requires CHP for new heat plants and for extension or reconstruction of existing heat plants over 1 MW heat capacity. In case an energy audit has proven CHP to be inefficient, an exception is made to this requirement.

[14] The reviews have been submitted to the CEA and SEA and have been used in the revisions of the draft. In the real draft of the EEA (Slovak Republic) the CHP obligation has been removed.

Some significant differences between the Czech and Slovak draft can be identified:

- The Czech legislation mandates CHP for thermal capacities over 5 MW_{th}, while the Slovak Act has 1 MW_{th} as standard. The range of 1 to 5 MW_{th} comprises a substantial share of decentralised CHP applications, particularly in the residential sector, the service sector, and in small industry. The impact of the Slovak version will therefore be larger.
- In the EMA-CR, a CHP obligation is also included for electricity producers from thermal processes. This is not the case in the EEA-SR.

In the following section, the comments on the choice of the instrument of obliging CHP are given for both the Czech and the Slovak Republic. Because of the differences between the proposed legislation for the two countries, detailed comments on the texts are given separately.

C.3 Compatibility with EU regulation and policy

EU regulation

The Directive EU 96/92/EC on the internal market in electricity includes in Article 8, point 3 following text: 'A Member State may require the system operator, when dispatching generating installations, to give priority to generating installations using renewable energy sources or waste or producing combined heat and power'. Also, Article 11, point 3, reads: 'A Member State may require the distribution system operator, when dispatching generating installations, to give priority to generating installations using renewable energy sources or waste or producing combined heat and power. The Directive 96/92EC includes in Article 20, point 1 an obligation of Member States to take necessary measures to enable independent producers and auto producers to negotiate access to the system so as to supply their own premises and subsidiaries in the same Member State or in another Member State by means of interconnected system. This obligation promotes the efficient development of CHP. The Energy Charter Treaty and Protocol on Energy Efficiency and related Environmental Aspects becomes a part of EU Acquis in June 1999 when the last Member State - France - has ratified them. In the Protocol, Article 8 speaks about obligation of each Contracting Party to develop, implement and regularly up-date an energy efficiency programme. This programme may include activities such as h) support and promotion of co-generation.

Conclusions

- EU legislation does allow an obligation for CHP as included in EMA-CR and EEA-CR.
- The Energy Charter Treaty requires the development of a comprehensive policy on energy efficiency on energy efficiency, in which targets are specified and a combination of instruments is adopted. An obligation for CHP could be part of this set of instruments. At the moment, such a policy does not exist yet. A regulatory obligation should be implemented only after such a policy is adopted.

EU Policy on promotion of CHP

The Council Resolution on a Community Strategy to Promote CHP (18 December 1997) sets the EU strategy to double the share of CHP by 2010. The Strategy makes no mention of placing obligations upon heat and electricity producers to adopt co-generation. The Commission states that, although some scope exists at European level, the major responsibility for the promotion of CHP must lie with the Member States. The Commission also states that a Community strategy must be consistent with and take into account the policies of Member States that will potentially be affected. The emphasis of the strategy, therefore, is to address and dismantle barriers to the promotion of CHP and to create an environment in which it is economically sustainable. One of the Commission's main objectives is the harmonisation and liberalisation of the European energy markets. This liberalisation is likely to bring about reductions in energy prices, which will have both negative and positive impacts upon CHP depending on its application. Whilst a reduction in primary energy prices will enhance the economics of co-generation, corresponding reductions in electricity prices will pose a threat.

The Commission has proposed that, if necessary, 'appropriate measures' will be adopted in order to prevent such negative effects. The Commission recognises the following measures as effective instruments in overcoming these effects: internalisation of external environmental costs by levying an energy tax, negotiated agreements with industry, and financial instruments, such as third party financing. According the EC's guidelines on CHP, the Member States may establish a 'safety net' for CHP plants supplying heat to domestic customers. For industrial CHP the Commission sees less justification for support measures beyond the possibility for priority dispatching. Finally, the Commission sees financing of CHP as the key issue and will review state aid rules and guidelines, as well as the Electricity Directives.

Conclusions

1. The priority given to the promotion of CHP in the Czech and Slovak Republic is in compliance with the priorities of the EC policy on CHP.
2. It is the opinion of the European Commission that the promotion of CHP will be most effectively achieved through a combination of policy instruments aimed at creating an economically sustainable environment for its use. Although such instruments should be tailored for circumstances in each Member State, it is evident that the future liberalisation of EU energy markets will level the playing field in this respect. A regulatory obligation for CHP is not mentioned among the 'appropriate instruments', presumably because it is not a market conform instrument and is therefore not consistent with EU policy in this respect.
3. The Commission sees financing of CHP as the key issue. Czech and Slovak policy should address this issues in particular.

EU regulation

The Directive EU 96/92/EC on the internal market in electricity includes in Article 8, point 3 following text: 'A Member State may require the system operator, when dispatching generating installations, to give priority to generating installations using renewable energy sources or waste or producing combined heat and power'. Also, Article 11, point 3, reads: 'A Member State may require the distribution system operator, when dispatching generating installations, to give priority to generating installations using renewable energy sources or waste or producing combined heat and power. The Directive 96/92EC includes in Article 20, point 1 an obligation of Member States to take necessary measures to enable independent producers and auto producers to negotiate access to the system so as to supply their own premises and subsidiaries in the same Member State or in another Member State by means of interconnected system. This obligation promotes the efficient development of CHP. The Energy Charter Treaty and Protocol on Energy Efficiency and related Environmental Aspects becomes a part of EU Acquis in June 1999 when the last Member State - France - has ratified them. In the Protocol, Article 8 speaks about obligation of each Contracting Party to develop, implement and regularly up-date an energy efficiency programme. This programme may include activities such as support and promotion of co-generation.

Conclusions

1. EU legislation does allow an obligation for CHP as included in EMA-CR and EEA-CR.
2. The Energy Charter Treaty requires the development of a comprehensive policy on energy efficiency on energy efficiency, in which targets are specified and a combination of instruments is adopted. An obligation for CHP could be part of this set of instruments. At the moment, such a policy does not exist yet. A regulatory obligation should be implemented only after such a policy is adopted.

C.4 Comparison with CHP policy in EU countries

The main questions addressed in this section are: Has the proposed obligation for CHP an equivalent in the European Union (in particular in the Netherlands, United Kingdom, Denmark, or Germany)? If yes, what are the experiences with this type of instrument?

Comparison with the Netherlands
Two factors have stimulated the very successful CHP development in the Netherlands (see Annex E):
- financial factors (good feed-in prices and a special low gas-tariff for CHP),
- long-term agreements between government and industrial/ commercial sectors.

The most important factor was the higher electricity price that was obtained when the CHP installations started to be exploited by joint ventures between the heat demanding company and the electricity distributor. From this moment the exploiter did no longer get the avoided fuel cost for his electricity, but the avoided buying cost of the distributor, which was significantly higher, high enough to make CHP profitable. A second powerful measure for promotion of CHP in the Netherlands were the long-term agreements between the government and sectors in industry and commerce (MJAs). The threat of legislation being imposed when the targets are not met proves to be strong enough in the industrial and commercial sector to encourage energy saving. And because CHP has shown to be the most cost effective and easiest way to achieve energy saving, the MJAs led to a widespread application of CHP. But it also must be said that agreements do not work in all branches of trade in the Netherlands.

With regard to energy audits, in the Netherlands a local authority can oblige energy audits in the environmental permit (milieuvergunning) on the basis of the environment protection act, but there is no obligation for the local authority to do so. Furthermore, the act offers the options of obligatory implementation of energy efficiency measures, including CHP. However, this option is used to enforce the introduction of voluntary long-term agreements only, and not implemented in practice.

Comparison with the United Kingdom
The UK has no legislative obligation for heat producers or power generators to apply CHP under any conditions, favourable or otherwise, and its policy is therefore not comparable to the proposed policy of the Czech and Slovak Republics. On a percentage basis, the installed CHP capacity in the UK is currently amongst the lowest within the EU. Without legislative obligation for the application of CHP in the UK, its justification can be based upon financial motivation only. Following the deregulation of the electricity industry in 1990, the climate for CHP investment has been less than favourable. Competition within the electricity supply industry has resulted in considerable reductions in supply tariff and contract prices, and has also led to uncertainties as to the short and long-term future of the market. Electricity prices are now lower in the UK than for some decades. With the exception of the Non Fossil Fuel Obligation for renewable sources, there has been no legislation to grant feed-in tariffs for electricity generated via CHP and sold back to the Grid. Consequently the majority of small and medium-scale CHP systems have been designed to meet electricity baseload, rather than maximising efficiency by sizing on thermal baseload. Competitiveness and price lowering have also been a feature of the deregulated gas market. Despite being advantageous to new CHP installations, recent low prices and excess availability of natural gas have led the way to a significant increase in the use of Combined Cycle Gas Turbine generating plant, providing further sources of cheap electricity. The UK Government now believes that the latter has created serious distortions in the electricity supply market and has placed a moratorium upon all new gas fired generating plant, with the exception of CHP. The most recent potential boost to increasing CHP market share is the Government's announcement to introduce and Energy Tax on industry and commerce from April 2001. The intention is a 'fiscally neutral' levy, wherein almost all revenue will be recycled into business via a reduction in National Insurance Contributions, thereby maintaining industry competitiveness. An opportunity presented by the proposed Energy Tax is that of voluntary 'Negotiated Agreements'. Such agreements would facilitate a rebate of a proportion of the levy to industries that met agreed reductions in energy consumption. An obvious target would be the application of CHP, and such agreements have proven effective in encouraging the adoption of CHP in other countries, such as the Netherlands.

Comparison with Denmark
Denmark has no legislative obligation for heat producers or power generators to apply CHP, *per se*. The Danish approach to the promotion of CHP is to combine financial incentives with legislative measures which, although they do not obligate CHP, combine to create an environment in which it is economically favourable and in which the markets for heat and energy are guaranteed. The market for heat is guaranteed through empowerment of local authorities in the municipalities and counties to promote the most appropriate source of energy for heating and hot water. In co-operation with the local and regional energy supply companies it is the duty of local authorities to ensure that this strategy is realised and they have, therefore, the power to mandate the connection of a building to a public heat supply system. Local authorities can also ban certain heating systems in new buildings. The market for electricity generated by CHP is guarantied by the utilities' Public Service Obligation. This obligation mandates that power generated by CHP plant, or from renewable sources, must be taken into the grid in preference to other sources of power. Fair prices for heat and power derived from CHP are ensured through Denmark's Heat and Electricity Price Commissions. The Commissions review and approve heat and power prices annually, which are regulated to follow the cost of generation in addition to an acceptable surplus to finance capital expenditure. This instrument, therefore, eliminates any future uncertainty regarding external price fluctuations, etcetera and ensures return on capital invested. In addition, approval may be given to raise capital for future capital projects through price increase in advance of expenditure. Since the 1970s, energy taxation has been introduced into Denmark in phases and is now applicable to all sectors; domestic, public, commercial and industrial. Energy intensive industries are encouraged to enter into Voluntary Agreements wherein they receive substantial reimbursement of taxes through committing to energy savings measures with paybacks of 4 years, or less. The CO_2 tax element is levied automatically on all electricity at a rate corresponding to the CO_2 emitted through coal-fired generation. Payment is made to generators of electricity from CHP and renewable sources as a positive incentive to expand generation from these sources.

On an annualised basis, Denmark currently generates over 40% of its power requirement through co-generation. It may be concluded, therefore that measures to ensure secure and cost effective markets for CHP-derived heat and power, together with financial incentives and tax reimbursements, have created an effective and sustainable mechanism for the promotion of CHP in Denmark.

Comparison with Germany
In Germany there is no legal framework or a policy framework for the specific promotion of CHP. No specific measures have been taken to encourage it. The main stimulation for CHP is from an agreement on the feed-in tariff of electricity to the grid by auto producers that has been settled between the electricity industry, the industrial auto producers and energy consumers, and the German industry. Sales to the grid are based on avoided cost and differ according to whether they are guaranteed or not. The purchase of surplus electricity by the grid is not obliged, but in practice it happens according to the agreement. It can however be refused when the grid capacity is restricted. The agreement was amended in 1994, aiming at improving the tariff terms according to market principles. To promote CHP the tariffs vary with the time of year, which benefits operators of packaged CHP systems that feed into the public grid mainly in winter. Cogenerators should be treated equals to other producers, but it is possible to pay them a higher feed-in tariff. Anti-trust actions against this are possible. A policy that may act against CHP are federal plans to reduce heat wastage through fiscal actions. In cases where not all heat generated is used, this may be unfavourable for CHP.

Conclusions
In the Netherlands and Denmark, some type of obligation exists but the differences in purpose, design, and implementation are large. No equivalent obligation as in the proposed legislation in the SR and CR has been identified.

It is therefore not clear on what the statement in the EEA-CR is based on that says, ' the Act proposes a solution that is common in EU countries such as Germany and Denmark'. There are therefore no practical experiences in the EU regarding the effectiveness and efficiency of the proposed obligation of CHP. Therefore, from the experiences in the EU, no conclusions can be drawn on the effectiveness of the proposed obligation. As a result, the uncertainty with respect to the impact and costs of the CR and SR policy is high.

The EU experience has shown that CHP is not likely to be effectively promoted by the use of one single instrument only. In the four countries, a package of different instruments has been used to promote CHP. In many EU member states, a regulated feed-in price has been regarded a basic prerequisite for the promotion of CHP, in combination with other financial incentives (grants, subsidies, tax incentives). Always, a comprehensive policy is necessary, in which a range of instruments, each addressing different barriers, are used. No comprehensive policy on CHP exists in the Czech and Slovak Republic.

C.5 Choice of instrument

Although there are no experiences with CHP obligations as proposed as proposed in the Czech and Slovak Republic, some general remarks can be made on the advantages and disadvantages of such an instrument.

Advantages

1. Provision of information and raising of awareness. Lack of information and awareness is an important barrier for energy efficiency in the Czech and Slovak Republic. The obligatory auditing will provide valuable information on the cost-effectiveness of an investment in CHP and will certainly identify cost-effective projects.
2. Effectiveness. In general, regulatory measures, such as mandatory auditing and CHP can be very effective, presuming that the regulation is complied with.

Disadvantages

1. High implementation costs. The costs of administration that must be made to ensure compliance are presumably high: monitoring and inspection, and prosecution of those who do not comply with the rules. Making sure that the required audits indeed will be performed, and that the CHP obligation is complied with, will be a costly and time-consuming matter.
2. Barrier for other efficient technologies. Another disadvantage of obligations in general, is that they may counteract the use of other, innovative efficient technologies. Obliging CHP for example excludes the use of large heat pumps, while application of large heat pumps offers considerable opportunities for the efficient generation of heat.
3. Lack of financing and economic uncertainties. One general disadvantage is solved in the proposed legislation of both Republics: the risk of the costs getting excessively high for individual companies. To a certain extent this risk is taken away by setting the obligation only with a certain cost effectiveness of the investment in CHP. However, the level of cost effectiveness is not set in either draft. And still, the costs may be too high for individual companies to be competitive with other countries. Related issues are the feed-in tariffs and energy prices used in the assessment of cost-effectiveness. Given the uncertainty in future tariffs and prices, the obligation would burden the investor with a significant investment risk, which, in some cases, would not be taken voluntarily.

4. Uncertain impact. The impact of the proposed obligation on the penetration of CHP is not so easy to predict, because of the exception that is made for cases when CHP is not cost effective or (economically) efficient. It depends on:
   - The definition of cost effectiveness. According to the Czech legal system such definitions like a formulae for cost effectiveness are placed in Decrees to the Act and not in the Act itself. The question is not only how the formal definition in the Decrees to the Acts should be formulated, but also how it will be enforced and maintained in practice.
   - How many new (heat) plants are planned; how does the heat market develop, how does the investment climate develop?
   - It should be noted that the impact of other instruments is often also very difficult to assess.
5. Inconsistency with liberalised markets. A CHP obligation is difficult to maintain in a liberalised market as long as it does not hold for all the countries in this market, because it is not based on market forces. It does not make the investment in CHP more attractive, neither with regard to short-term profitability nor to long-term investment security.

C.6 Conclusions

The main conclusions of the review of the draft CHP legislation in the Czech and Slovak Republic are:

- CHP is an important option for energy efficiency in the Czech and Slovak Republic. It is necessary to support CHP in order to increase market penetration.
- EU legislation does allow an obligation for CHP as included in EMA-CR and EEA-CR, although an obligation as a key instrument for the promotion of CHP is not in line with the guidelines of the EC for CHP promotion. A CHP obligation is difficult to maintain in a liberalised market, because it is not based on market forces.
- There is no legislation for the obligation of CHP in place in the EU at the moment that can be compared with the proposals. In the EU countries, e.g. the Netherlands and Denmark, the success of CHP can be attributed to other instruments.
- In many EU member states, a regulated feed-in price has been regarded a basic prerequisite for the promotion of CHP, in combination with other financial incentives (grants, subsidies). Recently, a shift towards tax incentives can be witnessed. The Czech and Slovak proposals are not in-line with this development.
- The EU experience has shown that CHP is not likely to be effectively promoted by the use of one single instrument only. Always, a comprehensive policy is necessary, in which a range of instruments, each addressing different barriers, are used. A comprehensive energy efficiency and CHP policy should be developed, of which regulatory measures can be a part. It is therefore recommended to ask the opinion of the European Commission and international CHP promoters, in particular COGEN Europe, while drafting the legislation.
- The Czech legislation mandates CHP for thermal capacities over 5 MW_{th}, while the Slovak Act has 1 MW_{th} as standard. The range of 1 to 5 MW_{th} comprises a substantial share of decentralised CHP applications, particularly in the residential, service sector, and small industry. The impact of the Slovak version will therefore be larger.
- The costs of implementing and monitoring mandatory audits and CHP implementation are high.
- The first priority in the CR and SR should be the development of a comprehensive policy on energy efficiency, in particular CHP, in which targets are specified and a combination of instruments is adopted. The Energy Charter Treaty also requires this. An obligation could be part of this set. At the moment, such a policy does not exist yet. A regulatory obligation should be implemented only after such a policy is adopted.

ANNEX D POLICY INSTRUMENTS FOR CHP PROMOTION

A wide range of policy instruments has been applied in EU countries for the promotion of CHP. In this Annex, different types of instruments are briefly described, and instruments that have been implemented in different countries will be used as examples [15]. This inventory can be used as a reference for the development of CHP policy in the Czech and Slovak Republic. The main source for this Annex is the COGEN Europe 1999 Review [16]. For a detailed description of the situation in the Netherlands and the United Kingdom, see Annex E.

D.1 Regulatory framework

Access to grid

The Electricity Directive provides the regulatory framework for access to grid. On the level of the Member States, additional regulation should secure fair and transparent rules for CHP access to the grid. In most countries, the regulation is still in preparation. By allowing CHP producers to sell the electricity directly to a customer they are given a way to gain a higher price for the surplus power than is paid by the grid. This is called wheeling: selling surplus power to a specific user via the grid. Wheeling is for example allowed in the Netherlands, Denmark, UK, Finland. Wheeling is either not allowed or restricted in Austria, Belgium (restricted only to other premises of the own company), France (restricted only to a limited amount of premises of the own company), Germany (restricted only to consumers linked by ownership), Greece, Ireland, Portugal (restricted in proportion to the heat delivered) and Spain.

Purchase obligation

Several countries have a purchase obligation for surplus power from CHP or from autoproducers in general. In *France* the obligation holds for independent power producers with an installed capacity of 6.5 MW or lower. For waste incineration plants or District heating plants there is no threshold value. In *Sweden* the obligation holds only for capacities of 1.5 MW or less. In *Greece* the industrial sector, small-scale commercial CHP and the buildings sector have the right to feed-in surplus power to the grid. A restriction used to be (Cogen, 1999) that the capacity of the CHP installation wishing to deliver to the grid must not exceed the total thermal load of the user (with exceptions for renewable energy sources or non-toxic industrial by-products). It is obligatory to sell to the state-owned power producer. In *Luxembourg* the 1993 Energy Efficiency Law has introduced a buy-back obligation for the grid. (Cogen, 1995) *Italy* used to have a purchase obligation, but as of 1997 this does not apply for new plants. *Austria* does not have a purchase obligation for CHP as such, but for 3% of the electricity delivered to end-users must have been Several purchased from renewable sources. (Cogen, 1999). Feed-in is not obliged in *Belgium*, *Finland* and *Germany*, but in the last two countries in practice it does happen. In most countries (except Germany and Denmark) there are technical prescriptions for the supply of surplus electricity to the grid. In some countries (Germany, Greece, France, UK), utilities may refuse deliveries or surplus CHP power when the grid capacity is limited.

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[15] The overview reflects the situation in the first half of 1999. Given the fast reform of the electricity and gas markets, some information may be outdated. Furthermore, although the inventory the key instruments lists for promotion of CHP, it could not be completed fully within the project.

[16] COGEN Europe, 1999 Review, Brussels, 1999.

Priority dispatching
Some countries' new electricity laws, designed to fulfil the requirements of the EU Directive on liberalisation of the internal electricity market, explicitly include priority dispatching for surplus electricity from CHP. An example is the *Austrian* electricity law called EIWOG that is in force since February 1999. Under this law electricity produced in CHP plants used for the public heat supply has priority over electricity from other types of power plants. To qualify as CHP, efficiency and exhaust gas requirements must be fulfilled (Cogen, 1999).

Licensing of CHP producers
CHP can be promoted by making it easier to obtain a license for CHP installations. A European Council Recommendation (88/611/EEC) setting out policy principles to remove legal and administrative obstacles to CHP mentions fair authorisation procedures for new CHP plant as one of these principles. Also the EU directive 96/92EC O.J. L27/30.01.97 concerning the liberalisation of the internal electricity market allows Member States to give priority to CHP plant in consideration of new generating installations. In the *UK* there is a special provision for the assessment and approval of 'good quality' CHP projects, whereas otherwise new natural gas-fired generation will normally be inconsistent with the UK government's energy policy concerns. In *Portugal* a permit for the use of oil products in CHP is needed for schemes over 10 MW_e based on a technical and economic study of alternative fuels. For CHP the permission has been facilitated because of its economic and energy efficiency benefits. In *Germany* the procedures for obtaining licenses for electricity generation and distribution are very complex, and in the past have discouraged CHP between 10-30 MW. In *Finland* no special authorisation is required to construct a CHP installation (no permits have to be obtained for power generation at all).

Mandatory requirements (obligation)
Mandatory requirement is a regulation that demands that a particular technology must be used, for certain purposes under certain circumstances. A demand for the use of CHP presently does not hold for any of the EU countries. In the Energy Management Act of the Czech Republic and the Energy Efficiency Act of the Slovak Republic the main component concerning CHP is the mandatory application of CHP when cost-effectiveness is proven through a stipulated energy audit. A review of this draft legislation was carried in this study (Annex C of this report).

D.2 Pricing and tariffs

Electricity prices and feed-in tariffs
The tariffs for feed-in of surplus power influence the payback period or IRR of CHP. In most countries, tariffs and tariff structures are regulated. Different structures are possible: flat or composed tariffs, and also do tariffs in Europe vary with respect to height. Governments can stimulate CHP by setting the tariffs structures and heights, either directly or by improving the tariffs proposed by the utilities. Instead of tariffs being regulated, it is also possible that tariffs are set by the utilities that own the grid, or must be negotiated between auto-producers and utilities.

In *Denmark*, an amendment to the Act governing electricity prices was made in 1995 to secure stable prices for small-scale CHP plants on electricity sold back to the main utilities. The price paid is based around an agreed formula relating to the long-term marginal cost of generation by the national utilities. In *France*, temporarily, CHP was promoted by a new type of purchase contracts that could be made from 1997 onwards. These encouraged the dimensioning to the heat demand, the setting of the tariffs to the avoided costs, and made the development of the tariff visible. The purpose was to establish 1000 MW of new CHP capacity. Since this goal has been reached, new installations can no longer get this contract. (Cogen, 1999). In *Italy* feed-in prices are determined by a core rate, based on avoided costs, and an incentive rate, determined by the energy efficiency index. The energy efficiency index is highest for renewables.

The 1988 National Energy Plan and subsequent laws (1991) have improved tariff conditions for CHP, among other rating CHP with an energy efficiency index that ensures more attractive prices for sales of electricity to the grid. In *Portugal* tariffs for sale of electricity to the grid are state regulated and reasonably attractive. Since 1995 a Decree Law for CHP is valid. Among other, up to a monthly maximum supply the feed-in prices are guaranteed for the investment payback period, at maximum five years. The feed-in on top of this maximum guaranteed amount will be paid according to the avoided costs, according to a formula that is guaranteed for 15 years. In *Spain*, the regulated tariffs used to exceed the avoided costs, since an energy conservation law of 1980 introduces tariff incentives. However, by law of 1995, these tariffs have been lowered. The extra costs for the grid for purchasing surplus power is passed through to the consumers, neutral for the utilities. Since December 1998, a new special regime is valid for CHP. Among other, this means the right to grid connection, the right to feed-in at the average pool price plus a premium and to receive all electricity needed at a normal purchase rate. The premium per kWh differs between capacities below 10 MW and those from 10-25 MW. In *France* prices are established on avoided cost, and are derived of the selling price of the national power producer and grid owner EDF. The EDF selling price depends on the marginal development cost, resulting in too low prices for acceptable CHP payback periods. Back-up supplies are extremely expensive. In *Greece* the feed-in price of electricity is based on the total avoided cost, equalling 60% of the consumption tariffs for car producers and 70% for independent producers selling to PCC. A special form of negotiated tariffs is found in *Germany*. German feed-in tariffs are the result of negotiations between market parties organisations. In principle CHP should be treated as any other power producing systems. However CHP can be charged a different, higher feed-in price, but anti-trust actions to this are possible. The tariffs in the agreement are not favourable for small scale CHP. The Supreme Court has decided that these tariffs are not binding and that the real avoided costs should be paid, but these have not been defined. Another decision of the Supreme Court was made on the costs of back-up supply. These should not exceed the costs of actual delivery (Cogen, 1999).

Gas prices

Some examples of countries where CHP has been stimulated by tariffs setting are the *Netherlands*, *Denmark* and *Austria*. In the Netherlands a special low gas-price for CHP in combination with a higher feed-in price for the surplus power stimulated CHP, but is now abolished.

Heat prices

In *Denmark* electricity and heat supply prices are regulated to follow generation costs, together with a reasonable surplus for capital investment. An overall surplus in one year must be redressed by a reduction in price in the following year, and vice versa. For large generators (including CHP) the electricity prices to end-users must be approved annually by the Electricity Price Commission. Only costs relating to the actual generation of power and heat can be covered. For small scale CHP and district heating, the price of heat to end-users must be approved by the Heat Price Commission (Cogen, 1995).

Levies and taxation

Governments can stimulate energy efficiency by enhancing the price of energy with a levy that has a specific destination, or with a taxation, like an energy tax that may add up to the state revenues or that may be sluiced back to the taxpayers by lowering other taxes.

An example of a levy with a specific destination was the so-called MAP-levy in the *Netherlands*. This levy was imposed on the end-use prices of energy to finance the Environmental Action Plan (MAP) of the energy utilities. This was based on an agreement between the government and the utilities in 1991 and was given a legal basis in 1996. The effect of the levy should be that end users use the energy more efficient because of the higher price and that funds are created for subsidising efficiency measures, such as heat distribution systems (Oosterheert, 1998). These funds finance the Environmental Action Plans of the Dutch energy utilities since 1991. In these plans a lot of energy conservation measures have been subsidised.

Among them were insulation of buildings and retrofitting boilers with high-efficiency boilers, but most of the funds have been spend on small-scale CHP, which contributed for the major part of the energy savings achieved. (Slingerland, 1997). Since the 1st of January 1996 the Regulatory Energy Tax (Dutch abbreviation: REB) is valid. The aim of the REB is to provide a market incentive to make energy saving more profitable. The REB is meant for small consumers of energy, in existing and new houses. Electricity consumption over 50.000 kilowatt-hours and natural gas consumption over 170.000 cubic metres is exempted from the tax, as well as the first 800 kWh of electricity and the first 800 m3 of natural gas. In 1999 the tariffs are: for electricity 0.0225 Euro/kWh, and for natural gas 0.0725 Euro/m3, which means an increase in price of about 20% and 40% respectively. The energy distribution companies collect the REB. For producers of renewable energy the tax is added to the price per kWh they receive. The other revenues are passed to the tax authority, except for the tax clients of district heating pay. This tax is left with the exploiter of the DH system. The Dutch government uses this also as a measure to stimulate district heating. As the REB is an instrument for energy saving, the revenues the government gets are sluiced back to the consumers in the form of lowering of other taxes, such as income tax for households and various taxes for companies.

Also in *Finland* energy conservation is promoted by energy taxation. The level of this taxation varies year by year. *Sweden* has energy and environmental taxes that have minor exemptions to CHP. *Denmark* imposes green taxes on trade and industry that are returned to these sectors as investment grants. In the *UK*, the Non Fossil Fuel Obligation also supports waste fired CHP. (Cogen, 1999)?

D.3 Financing of CHP projects

Fiscal measures

Tax deductions can promote the purchase of the CHP installations. Because lower taxes have to be paid, taxes, like subsidies, increase the IRR and decrease the payback period. Examples of countries with tax deductions for CHP are the Netherlands that has high tax advantages for investments in CHP, and France that also has tax deductions on investment costs of CHP. In the Netherlands CHP can get low interest financing as a so-called 'green investment'; private persons that invest money in these green investments do not have to pay income tax on this money, which makes the investment profitable even if the interest is lower than usual (Cogen, 1999; EVN 1997).

In the *UK***,** a climate change levy has been proposed on coal, gas and electricity, with a rebate for those who make negotiated energy efficiency agreements, of which investments in CHP can be a part (Cogen, 1999). In *Italy*, CHP installations pay reduced gas taxes (Cogen, 1999). In *Germany*, tax exemptions are made for CHP for taxes on mineral oil and gas, while auto producers are exempted from taxes on electricity production. In *France*, CHP profits from tax exemptions on energy efficiency measures and from the possibility of accelerated depreciation, resulting in lower local taxes (Cogen, 1999). A new proposal for a Directive entitled *Restructuring the Community Framework for the Taxation of Energy Products* was adopted by the Commission in 1997. This Directive will offer Member States the opportunity to grant commercial advantages to cogenerated heat and renewable sources of energy.

Soft loans

Governments can also stimulate investments in CHP by providing so-called soft loans. The money given as a soft loan does have to be paid back to the government or the government fund, but the interest that has to be paid is lower than the market interest and can be as low as zero. This increases the profitability of lending money for investments in CHP. In *Portugal*, for example, reimbursable loans are given that are interest free up to 20% of the investment costs.

Grants and subsidies
Subsidies stimulate the purchase of the installations, contributing to the costs of the installations. In most countries CHP is supported directly or indirectly by subsidies (grants), as in the following examples. In the *Netherlands*, CHP has been stimulated indirectly by debt-neutralising subsidies for District Heating. In *Austria*, CHP receives central state support; 10% of investment costs for natural gas fired CHP, 30% for renewable fuel CHP (Cogen, 1999). In *Belgium***,** there are funding grants for CHP (Cogen, 1995) and subsidies for the Flanders and Wallonian organisations promoting CHP (Cogen, 1999). And also in *Luxembourg***,** there are incentive payments for CHP. *Italy* subsidises capital costs (40%) and feasibility studies and construction designs of CHP (50%). *Portugal* subsidises CHP investment costs with 15-25%. In *Greece* CHP is subsidised by an EU programme, and there are government investment grants (Cogen, 1999). In *Ireland* EU subsidises CHP via the Thermie programme, with subsidies for demonstration of small CHP. In *Sweden* grants are available for investments in biomass CHP (25%). In *Sweden*, biomass CHP receives investment grants. In the *UK*, capital grants are given for small CHP under 1 MW_e.

D.4 Other measures

Energy efficiency covenants with industry
A covenant is an agreement between (associations of) industries and government. The agreement can be for example about reduction of energy consumption per unit of product by a certain percentage, and can also specify the techniques to use this goal, of which CHP could be one.

In the *Netherlands* the 'long-term agreements' (MJAs) of the government with industry and commerce are covenants that have stimulated the use of CHP. These are bilateral agreements between sectors in industry and commerce in which the sector commits itself to taking a lot of environmental protection measures. In return the government promises not to impose extra measures on the sectors during the period the agreement is valid. In the sector agricultural greenhouses the MJA has led to a boom in CHP units (Boonekamp, 1995). To the industrial end users CHP proved to be an optimal way to fulfil the CO_2 targets they agreed on in the 1990s in their energy conservation covenants with the Ministry of Economic Affairs. The result was that new CHP installations were increasingly based on heat demand, rather than on electricity, which led to much larger plants to be installed than previously (Slingerland, 1997). If the agreement is not met, regulations may apply that do not apply as long as the agreement holds. Also in *Germany*, the Federal Government according to the new Act revising the Energy Industry Legislation is obliged to stimulate voluntary commitment and may set objectives for the amount of CHP capacity.

Joint ventures with the energy industry
Joint ventures between an industry and an energy utility are good for CHP, because they reduce the investment cost for the industry, and allow the joint venture to make their own agreements on the surplus of electricity. Also in *Austria* utilities are often direct investors in CHP installations. This makes that grid access generally is not a problem.

The *Belgian* state power producer Electrabel since the early 90s promotes joint ventures with industry. In the *Netherlands* the incentive for these joint ventures was a decree of 1986 that reorganised the electricity sector. This became an important turning point in the history of CHP. Until then the electricity generation and distribution were organised in regional companies which were owned by the local governments. For electricity delivered to their grid they paid a price based on the cost of the avoided fuel. By decree generation and distribution were separated. The distribution companies were allowed to install generation capacity up to 25 MW. From now on a company who wanted to have its own CHP installation organised a joint venture with the local distribution company.

Now the price this joint venture gets is no longer the avoided fuel cost, but the avoided purchase cost by the distribution company, which is considerably higher. The result was that purchase cost of distribution companies got lower, as well as the price of heat for the heat demanding company.

Local energy planning
Governments can stimulate CHP by setting CHP targets and issuing guidelines for local/regional authorities to stimulate CHP. For example *Denmark* has placed an obligation on municipalities to establish CHP of biomass projects in all DH areas with more than 1 MW of heat capacity. The Danish government guidelines for CHP planning have been used to insist that CHP supply at least 90% of the local heat market (COGEN Europe, 1999). The EU Strategy Paper proposes a target for the share of CHP in gross electricity production of 18% compared to the current share of 9%[17].

In the *Netherlands* an experimental instrument Energy Performance on Location (EPL) stimulates CHP because it is in favour of district heating in new housing locations. On the 1st of February 1998 the experiment was started (Oosterheert, 1998). In this EPL-method, the total energy performance of a newly developed housing location is considered, including the utility buildings that belong to this location, and the energy-infrastructure (Rooijers, 1998). The method contains a standardised calculation of the energy performance of the object and a minimum requirement to the performance. Further the actors involved are free to choose from the possibilities which there are to achieve the goal. Due to choices made at the design of the calculation method because district heating is the easiest way to achieve a high score in the EPL. Therefore the EPL in fact is in favour of district heating in housing locations.

Information and awareness
Providing information and promoting awareness on the possibilities to save energy by applying CHP can be done by several means, like demonstrations programmes, energy efficiency audits, feasibility studies, publishing brochures and leaflets, and providing advice. Often subsidies are given to finance these. Also several countries have an agency to promote CHP, give information and advice, and arrange third party financing.

The European Commission already in 1974 formulated an industrial expert group tasked with investigating improvements to thermal power station efficiency. The findings of the group led to the adoption of a Council Recommendation (77/714/EEC) for Member States to establish advisory bodies encouraging CHP schemes and increased energy conversion and investigating and eliminating non-technical barriers to CHP. Examples of countries with such advisory bodies are the *Netherlands* that used to have a Project Office for CHP. Also *Belgium* has its national promotional organisation for CHP. In *France* there is the Club Cogéneration. In *Luxembourg* the organisation Luxenergy promotes CHP/DH and industrial CHP. In *Spain* IDEA runs information programmes on CHP and gives advise.

Standard contract for small-scale CHP
The large overhead costs for the development of small CHP projects is a major barrier. These can be reduced if a standard contract could be applied. Experiences in *France* and *Spain* have demonstrated the benefits. The standard contracts would include export and top-up electricity prices, standard conditions for grid connection and standard legal clauses.

[15] A Community Strategy to promote combined heat and power (CHP) and to dismantle barriers to its development. Communication from the European Commission (EC COM97) 514.

ANNEX E THE FUTURE OF CHP IN THE NETHERLANDS AND THE UK

In this Annex, a historical overview is given of the development of CHP and CHP policy in the Netherlands and the United Kingdom. Also, the prospects of CHP in liberalised markets are discussed.

E.1 The Netherlands

In the last two decades, combined heat and power (CHP) developed considerably in the Netherlands. The expansion of CHP is the result of a combination of (policy) measures taken in the past. Recently, the effect of liberalisation of energy markets on prices and tariffs has been signalled to form a threat to CHP. This section will explain the background of the Dutch CHP boom and will describe the potential threats to the future of CHP.

E.1.1 Past development of CHP

From 1980 to 1985, the Dutch electricity system was mainly based on natural gas. As the prices of natural gas were related to oil prices, electricity was similar to natural gas relatively expensive, due to the high oil prices. In principle, the high gas and electricity prices in these years caused a favourable rate of return for CHP. However, the growth in CHP-capacity remained slow, which was mainly the result of the central generation capacity being too large, the remuneration fee for electricity being low and the size of CHP installations being based on the electricity demand instead of heat demand.

Around 1985-1987, the unbundling of production and distribution in the electricity sector encouraged the distribution companies to take part in decentralised CHP. The remuneration fee for electricity supplied to the national grid by CHP was increased. As part of a promotion programme, special tariffs for natural gas were introduced for CHP producers. In addition, producers received higher investment subsidies for installing CHP. A new support office was established for the co-ordination and implementation of CHP. The relatively clean combustion of new combined-cycle plants created another argument in favour of CHP. The favourable conditions in the late eighties caused a steady growth of industrial CHP with 150 MW a year.

In 1990, the government decided to purge the financial debts of district heating projects. This opened the opportunity for the Dutch power producers, organised in Sep, to launch their 'Heat Plan' involving the investment of five combined cycle units (in total 1250 MW_e) for district heating. Meanwhile, the number of small-scale CHP projects increased, in particular in the greenhouse sector.

From 1990-1993, CHP increased strongly due to a strengthened concern for the environment. A special tariff system for the remuneration of electricity from CHP resulted in very good price conditions for CHP. The government provided additional financial support to CHP-projects because CHP could contribute to reducing emissions (SO_2 and NO_x). The power producers enlarged the objective of the heat plan to 2500 MW_e. Industries and distribution companies also regarded CHP as the most important technology and instrument to reach the environmental goals they agreed upon with the government. The agreements involved the objectives of the Environmental Action Plan of the distribution companies and the Long Term Agreements of large industries with the Ministry of Economic Affairs.

In addition, CHP was the best option for distribution companies to develop production capacity. Joint ventures between electricity distribution companies and large heat consumers proved to be the most attractive and widely used legal framework for CHP investments. At the end of 1993, the CHP capacity had increased to 3000 MW. All actors had adjusted their CHP-targets to a higher value and regarded CHP as the main option to commit to the environmental agreements made with the government.

In 1994, the development of CHP was slowed down due to an increasing overcapacity in the Dutch electricity sector. The remuneration fees for electricity were decreased substantially and the subsidies by the government were abolished since CHP proved to be economically attractive. At the end of the nineties, climate policy gained more interest, which resulted in policy plans and measures to reduce the energy use and mitigate greenhouse gas emissions. CHP did also benefit somewhat from these policy actions.

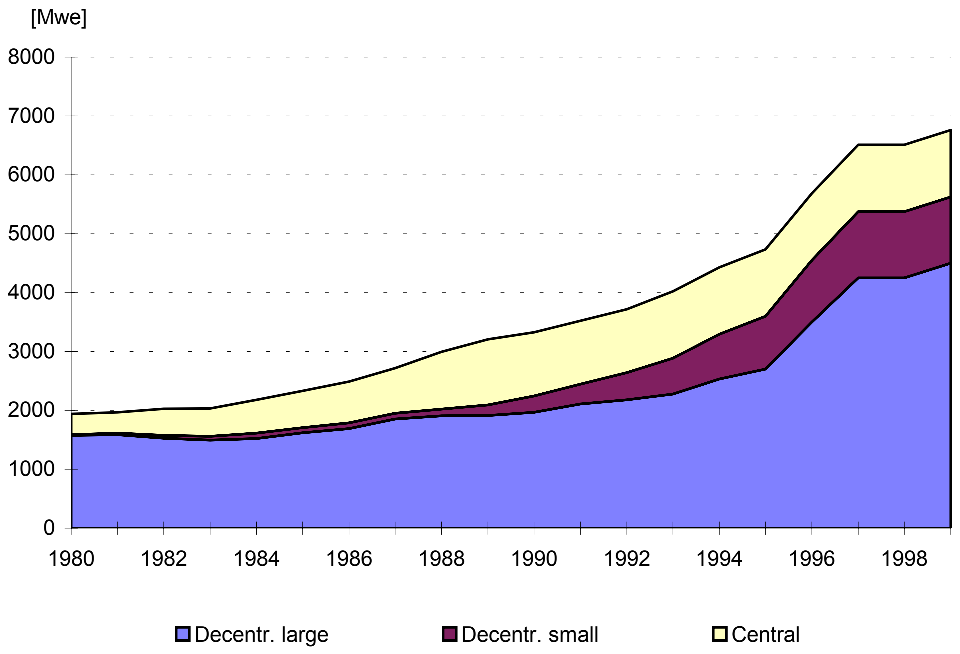

Figure E.1 *Development of CHP capacity in the Netherlands, period 1980-1999*

Around 1999-2000, the Dutch government adopted a new Electricity Act and Gas Act. Both acts are based on the EU-Directives and involve the liberalisation of both the electricity and the gas market. Due to the liberalisation of the energy markets, CHP will no longer benefit from a special gas tariff and special remuneration tariffs for electricity. In contrast, CHP will have to cope with uncertainties associated to liberalised markets. These aspects may impose threats to the future development of CHP, which will be elaborated more in the next section.

A number of external developments and policy measures have influenced positively the development of CHP in the Netherlands (see also Figure E.1). Table E.1 clearly indicates that those factors varied over time. It shows there is no single key factor that caused the success of Dutch CHP.

Table E.1 *Impact of exogenous factors, policy measures and actors on the installation of CHP*

	80-85	85-87	87-90	90-93	93-96	96-99	
Exogenous factors							*Actors*
CHP efficiency	+	+	+	++	++	++	--
Greenhouse effect	·	·	+	++	++	++	All
Surplus capacity	-	0	+	0	-	-	Sep/distr.
Price ratio gas/elect.	0/-	-/+	+	++	++	+	--
Joint venture constr.	·	0	+	++	+	+	Industr./distr.
Policy measures							
Subsidies	+	++	+	++	0	+	Government
Special gas tariff CHP	0	+	++	++	++	++	Gasunie
Remuneration fee	-	+	+	++	+	+	Distr.com.
Support office CHP	·	+	+	+	+	+	Government
Covenant Sep	·	·	·	+	+	0	Sep/Government
Heat plan Sep	·	·	0	+	+	0	Sep
Long Term Agreements	·	·	·	++	++	++	Industr./Government
Environment Action Plan	·	·	·	++	++	+	Distr./Government

- = brake, 0 = neutral, + = stimulating, · = not relevant

E.1.2. Future threats of CHP

As mentioned above, the effect of liberalisation of energy markets on prices and tariffs could pose a threat to CHP. Results of studies on the future of CHP in The Netherlands (Van Dril et al., 1999; Van Dril et al., 2000) show that profitability of investments in CHP may substantially decrease in a liberalised energy market. The main reason is the strong competition on the electricity market and the uncertainty whether prices will cover more than just marginal fuel costs in the near future. Moreover, the new gas tariffs are not favouring CHP. Below, the future threats to CHP are elaborated more.

E.1.3. Liberalised electricity market

The Dutch electricity market will be liberalised in three phases. Since January 1999, the electricity market is open for large industrial customers (>2 MW). In 2002, the medium customers (< 2 MW, 3×80 ampere) will also be free to choose their electricity supplier. Finally the small consumers will have a free choice of energy supplier as from 2004. As a result of the phasing of the liberalisation, two types of customers can be distinguished: captive and non-captive customers. Deliveries to the latter are only allowed by existing energy distribution companies. In order to protect this group against high electricity costs, the electricity tariffs will be set by the Ministry of Economic Affairs. In addition, small electricity generators will be subject to tariffs regulated by the Ministry of Economic Affairs until 2002.

With the liberalisation of the electricity market, the electricity price will be separated into two components: commodity price and transport tariff. The former will be left to the market while the latter will be regulated strictly (i.e. by means of a regulated third party access). The transport tariffs are based on a so-called (cascade) point tariff system. This system implies that the tariff only depends on the grid level of the connection of the end-user. It is, therefore, independent of the transport distance. The Dutch transport tariff system is subject to criticism since its structure appears to be unfavourable for decentral production, for instance CHP. In addition, the old system of remunerating CHP for lowering the grid costs is abolished in the new electricity Act.

Commodity prices are determined on the market and they are, therefore, subject to uncertainties in the market. Currently, the Dutch electricity market is facing an overcapacity, which will result in lower electricity prices because, according to economic theories, prices will equal marginal production costs in fully competitive markets. As long as the overcapacity persists, the electricity market is bound to be unstable. However, when the electricity market is more stabilised, producers can more easily apply long-term contracts based on average production costs to overcome the financial risk regarding the uncovered fixed costs of an installation. In this case, producers as well as customers could secure a reasonable fixed price without great financial risks. Also long-term investments, which is necessary to maintain a reliable electricity production, will then be possible.

Obviously, the cost effectiveness of CHP depends heavily on the electricity prices and therefore on uncertainties in the electricity market, since CHP will no longer benefit from standard remuneration tariffs for electricity.

E.1.4. Liberalised gas market

The gas market will also be liberalised in phases. According to the Dutch Gas Act, the large gas customers (> 10 million m^3) will be free to choose their supplier at the beginning of 2000. In 2002 the middle segment (> 170.000 m^3/annum) will be free followed in 2004 by all customers. Similar to the electricity market, liberalisation of the gas market will have a large impact on the structure of the energy market. According to the Dutch Gas Act the gas supplying companies (Gasunie and the distribution companies) have to separate their transport activities from their other energy service activities. In this way, gas prices will be divided in a transport tariff and a commodity price.

Access to the network will be defined by a negotiated third party access protocol (n-TPA). This means that the tariff will be negotiated between the customer and the gas producer (Gasunie or distribution company). The tariff mainly consists of a payment for connection, system costs and transport costs. Because of the n-TPA regulation and the currently strong position of the Gasunie, the gas prices will (at least in the short run) be dominated by the system introduced by the Gasunie. In this system, the commodity price is set by the oil price and the transport tariffs mainly depend on the maximum (hour) capacity required yearly. The latter is rather unfavourable for consumers with a fluctuating demand pattern. This will also apply to gas-fired installations which are used for peak load production and these installations will, therefore, face higher gas prices in comparison with the same installation producing base load production.

In the old zonal tariff system, gas prices were differentiated on a volume-based system, in which CHP was subject to a favourable tariff. Since this system is abolished in the liberalised market, CHP will be confronted with much higher prices especially those which are involved with a fluctuating energy demand pattern.

E.1.5 Conclusions

In a regulated energy market, gas and electricity prices are more or less fixed. This results in solid investment opportunities for electricity producing installations. In a liberated energy market, gas and electricity prices are based on market developments instead of production costs. This will create uncertainty about the price developments of these energy carriers causing uncertainty about the profitability of gas fired electricity-producing installations. The impact of a changing energy market on the economic potential of CHP will depend on the development of the energy markets. Due to an overcapacity in electricity production, a strong competitive electricity market is expected in the Netherlands at the start of liberalisation of the electricity market. The electricity price will be determined by the average marginal production costs of electricity in which the fixed production costs can hardly be covered. Such a market will therefore create an unfriendly investment climate. Only small investments for lifetime extension of existing installations could be an opportunity.

Obviously, the above also applies to investments in CHP. However, it may affect CHP even more since CHP does not benefit from the economies of scale which is associated to the centrally produced electricity. In addition, CHP will also be subject to unfavourable gas prices instead of favourable gas prices of the old zonal system. This situation may result in a stabilisation or maybe decrease of the CHP share in the Dutch electricity production, without further policy measures.

E.1.6 Reflections

In the Netherlands, the boom of CHP is the result from a mix of measures, which varied over time:

- regulated feed-in tariffs,
- special gas price for CHP,
- fiscal measures,
- subsidies,
- voluntary agreements energy efficiency,
- joint ventures energy industry,
- environmental action plan of distribution sector.

The Dutch situation has shown that a programme for the promotion of CHP should not only focus on one policy measure but should include a range of policy measures. In the Dutch case, the conditions for CHP were, however, almost too favourable for some time resulting in an overcapacity for the electricity production. Obviously, such situations should be avoided.

With the liberalisation of the energy market, most of the measures mentioned above will be abolished, especially the regulated feed-in tariffs and the special gas prices. The latter two can almost be regarded as unavoidable consequences of liberalisation. However, transport tariff system appears to be unfavourable for CHP for both gas and electricity, in particular for small-scale CHP. That is, CHP appears to be charged with relatively high tariffs since CHP is often faced with fluctuating patterns for gas demand and electricity required from the grid. Herewith, these transport tariff systems can discriminate CHP. These regulated conditions should be avoided to prevent imposing market barriers to the development of CHP.

In the Netherlands, a number of policy measures, with respect to climate change, still favour the conditions for CHP. For instance, benchmarking[18] is the major policy measure to mitigate greenhouse gas emissions in the energy-intensive industry. For other industry, energy efficiency is part of issuing environmental licenses. CHP appears to play an important role in benchmarking and improving energy efficiency since it is generally regarded as a cost-effective way to increase energy efficiency. In addition, taxes on energy use increased substantially, in particular for small customers.

Since CHP is exempted from this tax, the conditions for CHP improve with these higher taxes, especially in case of small-scale CHP. Finally, the Dutch government contemplates introducing a special certificate for CHP, which should be similar to the system of green certificates, which means that end-consumers possessing such a certificate can apply for a reduction on the energy tax.

Since a number of issues are still uncertain for the future of CHP in the liberalised energy markets, the Dutch government will monitor the developments of CHP.

E.2 Utility privatisation in the UK and its impact on CHP

E.2.1. Introduction

The purpose of this section is to summarise the experience both of the privatisation process in the UK and of its impact on CHP. Parallels with the situation in the Czech and Slovak Republics could then be reflected in measures taken in those countries gaining from both positive and negative aspects of that process. The main legislative events enabling privatisation in the UK were:

- Gas
  - 1986 - competition for gas consumers with loads over 250 GJ per year,
  - 1995 - industry split into shippers, transporters and suppliers.
- Electricity
  - 1990 - users with demand over 1 MW,
  - 1994 - users with demands over 100kW,
  - 1998/9 - all users.

In terms of the impact on prices in the UK, the following broad figures are relevant for the period between 1990 and 1997:

- Gas price: decreased by 46% in real terms (disproportionately after 1995).
- Electricity price: decreased by 21% in real terms.

The current situation in terms of the proportion of electricity in the UK generated through CHP systems was 6 % from the total generation of 330 TWh in 1999. 96% of electricity generated through CHP schemes is in plants over 1 MW, whilst 85% of the plants are less than 1MW in capacity. To complete the background, the proportion of electricity generated from gas fired power stations in the UK changed from 2% in 1992 to 21% in 1996, the so called ‘dash for gas’. The government has limited this expansion by requiring that these plants must have significantly higher overall thermal efficiency than is possible from power generation alone. Although unpublished the efficiency required is thought to be around 70%.

[18] Benchmarking refers to the commitment of the energy-intensive industry increasing the energy efficiency of industrial process up to the world top level. In return, the Dutch government will not impose additional climate change policy measures to the energy-intensive industry.

The re-structuring of the electricity industry was intended to stimulate competition in the generation and supply systems. It was accepted that the transmission and distribution systems needed to be operated by one organisation, the National Grid Company (NGC). Consumers can purchase from the generators, of which there are currently two major companies, from the pool or from the suppliers (there are 12 Regional Electricity Companies - REC's) as appropriate to their usage. CHP plant operators are able to sell surplus power back to either the supplier or to the pool. The industry is still in the process of modification by the regulator. The next change is soon to be implemented, called the New Electricity Trading Arrangements (NETA), this will interpose a fourth layer into the structure that will amongst other things enable consumers to obtain lower prices from suppliers.

Key issues for the privatisation process from the CHP viewpoint are:
- availability of connection to the grid,
- access to the electricity grid,
- use of distribution system,
- planning,
- licensing,
- emissions,
- incentives for CHP.

Each of these will be discussed in the next section with reference to the UK situation.

E.2.2 Key issues

Electricity Connections

The grid company has serious concerns about the stability and hence security of the electricity supplies as more CHP systems are brought on line. One example of this concern is the 'rate of change of frequency' (ROCOF). The concern is that frequency disturbances in the existing network that are currently within the limits of control, may cause CHP systems to 'trip' and that this in turn would create stability problems in the network. The potential installers of CHP systems complain of a variety of problems in obtaining the necessary connections to the grid. These are:

a) Communication with the REC's is difficult, the REC's say that this is because they have insufficient resource to meet the demand for information. Sometimes they are required to quote for projects that are unlikely to result in an installation, whilst in other cases they have to quote for the same project to a number of interested parties.
b) Potential installers of CHP complain that the REC's quote excessively high fault levels on some systems that leads to a significant increase in capital costs.
c) Often the costs for the lifetime operation and maintenance of new electrical installations are incorporated into a single capital cost, which again makes the project more expensive.
d) There are frequently different quotations for the same connection from different suppliers/contractors.

The REC's are perceived as being a barrier to the implementation of CHP by potential installers. There is a lack of a standardised approach to the process of connection costs. The REC's lack of resources appears to be the major cause of these problems. This is avoidable at a cost, but since the Regulator is attempting to reduce electricity charges, the tendency is for the REC's to reduce staffing levels. A legal requirement to meet the reasonable requirements of the CHP industry, if built into new regulations may ease this problem.

Gas Connection
The gas transport company TRANSCO has a duty to supply gas to consumers. They are able to require a contribution to the cost of providing the necessary pipework and systems to the perimeter of the customer's premises. In recent years there has been a problem with the supply of gas to the southern parts of the UK. The main cause of this problem is the privatisation process. Before the separation of the industry into shipper, transportation and supply sections, British Gas had total control over the whole system. Now, the shippers are able to purchase the lowest price gas from the North Sea fields and this is mainly available from the northernmost fields. Therefore the loading on the northern part of the gas distribution system is greater than that originally intended. More gas is being transported from the North and the capacity of the North to South pipelines in insufficient, limiting further expansion of gas usage in the South of the country. Clearly this limits CHP development amongst others. This situation is being addressed but at significant cost to TRANSCO.

Communication is a problem for potential CHP installers for the same reason as for electricity connections, there is insufficient resource in an industry still going through a process of change and under significant pressure to reduce costs. A similar solution to that proposed for the electricity grid access is suggested.

Electricity Grid Access
The key issue in this context is that the price of electricity exported from CHP plants to the grid is unregulated. The prices quoted by the REC's are not transparent and the pool prices are usually quite low. The real marginal value of this electricity is not correctly reflected in the offered prices. Price transparency is therefore essential.

Another significant issue is the cost of standby power supply from the grid. It is rare for a CHP scheme to incorporate 100% standby capability because the capital cost would make the project uneconomic. Therefore CHP operators usually depend on grid supplies for the standby power. The cost of standby is considered not to reflect the true cost of its provision. Again transparency in the valuation of this standby capacity is essential to a fair system that does not discriminate against CHP.

Use of Distribution System
It is possible for CHP operators in the UK to construct their own distribution systems provide that they comply with the requisite regulations. One such case in the UK is that of Arjo Wiggins, a paper making company on whose site was built a 14 MW CHP scheme, surplus electricity being sold via a private line to the local harbour company. This is a positive point, demonstrating the flexibility of the regulations.

An exporter of electricity can also sell directly to another consumer using existing NGC systems by paying a 'use of system' charge as well as being able to sell to the pool or to the REC. The transmission use of system (TUos) charge is usually around 5% of the total price of electricity to the final consumer and the distribution use of system (DUos) charge is usually between 15% and 30% of the final user price. The Regulator has been examining the basis for the DUos charging structure and has set a new 'fair' basis. This allocates reasonable costs to all aspects of the operation of the REC's, taking account of their need both to make capital investments for the future and to make a reasonable profit. Nevertheless, there are already signs that the REC's owners may not like this situation and one multi-utility company has announced that they are willing to sell their electricity distribution company. It is thought that the general climate for lower profits in the industry is unwelcome.

Licensing
Major electricity generating plant is required to have a license that is provided by the Department of Trade and Industry through the Director General of Electricity Supply. Smaller schemes are exempt:

- Less than 100 MW capacity and exporting less than 50 MW.
- More than 100 MW capacity and exporting less than 10 MW.

These smaller schemes require second tier licenses if they are larger than 500kW.

Emissions
Current regulations dictated through the Integrated Pollution Control (IPC) legislation require that emissions to air from power generation and other relevant processes are maintained below specified limits dependent on the thermal input to the plant - above 50 MW. Smaller plant above 20 MW is controlled by the relevant local authorities under the dictates of the Clean Air Act.

A new regulation is soon to be in force called Integrated Pollution Prevention and Control (IPPC). This applies to all EC countries. In the UK it will replace the IPC legislation. It will control all emissions from specified processes including combustion and will incorporate emissions to air, land and watercourses.

Incentives for CHP
When the privatisation process began, CHP was a difficult measure to 'sell' to potential users. The usual comments were:

> 'We are not confident that the prices for energy will be predictable and hence that our scheme will be economically viable.'
> 'CHP is not our core business, we don't understand it and we would prefer to invest our limited resources elsewhere.'
> 'These Contract Energy Management companies want to own that part of our site where the CHP plant is sited. This limits our flexibility for future site development.'
> 'The long term contracts (7 years plus) could be a problem if our business and hence the use of the site incorporating the CHP system changes.'

Against this background and the reality of an almost overnight reduction of between 15% and 25% in electricity prices in 1990 during the first round of privatisation, the prospects for CHP were poor. However, since the split of the gas supply industry in 1995 and the more significant fall in the real price of gas (in relation to the small reduction at the time of the first stage of gas privatisation in 1986), industrial and commercial CHP schemes have been much more popular. There is now a better understanding of CHP and of its value to business as a result of promotion by the government Department of Trade and Industry.

A number of schemes are available to support CHP in various forms:

a) The 'Non Fossil Fuel Order' (NFFO) imposed a tax on all electricity sales, the revenue being used to support renewable energy schemes that could incorporate electricity and heat generation (such as waste burning). This support took the form of a subsidy to the sale price of electricity sold to the grid that price of electricity being guaranteed for the life of the project, usually considered as 15 years. In each year since its inception, there has been a gradual reduction in this subsidy for new projects. The intention was that these types of projects would then be proven and that investment would continue without that support.
b) The easing of the regulations concerning payment for grid access are being reviewed since some CHP installers have commented that they are paying TUos charges when there plans do not use the transmission system. They only use the distribution system (at lower voltage) because of the proximity of the ultimate user of the exported power.

c) With limited funds the Energy Saving Trust (EST) provides capital subsidies to schemes less that 1 MW in capacity. The EST is funded by the utility companies in a system set up by government.
d) In the capacity range 1MW to 20 MW, TRANSCO, the gas transportation company, supports the cost of feasibility studies in industry and commerce. About 25 such studies are privately funded in this way each year.

Further incentives for energy saving, including CHP will be provided through the IPPC legislation due to enter into law in March 2000 in the UK. This requires that industrial companies falling under this legislation must employ energy efficient systems in the course of their operations.

Another piece of legislation that will come into force in April 2001 is the Climate Change Levy (CCL). This will increase gas, coal and electricity prices by an average of about 15% (excludes the domestic sector). The levy will raise £ 1 billion per year which will be recycled back into the economy in the form of; Reduced national insurance contributions paid by employers; In support of energy saving schemes including CHP through first year capital tax allowances; And through promotional and consultancy support for energy saving programmes. Oil, which is already subject to a customs and excise duty, will have its price raised in relation to the CCL.

Also, a ‘Good Quality CHP’ scheme will be introduced at the same time as the CCL. This will allow operators of CHP plant exemption from the levy on that part of their CHP fuel that they burn most effectively. In other words, only CHP which is considered to be of ‘good quality’ will be considered for exemption. The quality of the CHP will be judged on the basis of an index that reflects not only the overall thermal efficiency of the process but also the higher ‘value’ of the generated electricity.

E.2.3. Conclusions

The experience in the UK that is transferable to the Czech and Slovak Republics is:
a) Transparency of pricing at all stages in the supply chain is essential to a fair pricing policy, both for electricity sales and in the case of CHP for the price of surplus electricity exported to the grid or to another user.
b) Provision of an adequate structure in the utility companies to cope with the requests for support for grid access from potential installers and operators of CHP schemes. Regulatory framework incorporating such provision is necessary.
c) In longer term, the IPPC regulations will impact on the Republics and the eventual law governing those regulations could be more specific in its support for CHP than in the UK case.
d) Open access to transfer electricity through the existing grid or through privately constructed lines.
e) The timing of the privatisation process, with electricity first, will probably reduce electricity prices and result is fewer economically justifiable CHP projects. A means of lessening this effect should be considered if government are committed to the further introduction of CHP. Some sort of relief of taxation on capital plant or subsidy to the price of fuel supply or energy generated from CHP plant may help this situation.
f) A review of the impact of privatisation on the electricity and gas supply systems is recommended to forestall the security of supply issues that have been raised in the UK
g) A programme of promotion and education will alleviate the problems caused by a lack of understanding of CHP in the business community, particularly the non-technical people who control finances.

The UK energy utility systems are under constant review and changes to address grid access and security of supply issues are still being made 14 years after the start of the process. In the Czech and Slovak Republics, this process could be shortened if it is possible to adopt the correct approach at the start of the process