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Regulation of Heat and Electricity Produced in Combined-Heat-and-Power Plants

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THE WORLD BANK

REGULATION OF HEAT AND ELECTRICITY PRODUCED IN COMBINED-HEAT-AND-POWER PLANTS

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FOREWORD

Combined-heat-and-power (CHP) plants are an important source of heat for district heating (DH) systems and electricity for energy markets, especially in the larger cities of Eastern and Central Europe and the Former Soviet Union (FSU). In many countries of Eastern and Central Europe and the FSU, the allocation of expenses in the joint production of heat and electricity in CHP plants has generally resulted in the benefits of the joint production being allocated by the regulators to electricity rather than attempting to share the benefits with the two products, which is typically considered to be a cross-subsidy. This results in prices for heat from the CHP plants most likely to be too high currently, as the prices are usually at the same level as heat produced in heat-only boiler plants or even higher.

The deficiencies of this pricing method are beginning to be recognized in a number of Eastern European and FSU countries, especially since payments for DH are typically the highest or next highest expenditure in the budget of the average household, and consumers now have other alternatives to DH. By sharing some of the cogeneration benefits and thereby reducing the cost of DH and improving the affordability of heating and hot water services, the consumer base of the DH systems can better be sustained and access to these services by the poor households can be improved and better ensured.

At the same time, a number of countries in Western, Eastern and Central Europe are liberalizing their electricity markets and are concerned about ensuring the competitiveness of their CHP plants when the benefits of the joint production are shared to a greater extent with heat.

Thus, there is a need to examine what is the more correct way to allocate costs/benefits and market risks between the two products so that both electricity and heat are competitive in the market and affordable to consumers. This study was undertaken in order to review the state-of-the-art in the application of CHP cost allocation methodologies and regulation of heat and electricity under CHP production in order to increase awareness and understanding by the regulators and industry specialists in Eastern and Central Europe and FSU countries of the more appropriate cost allocation and regulatory practices that can be applied.

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ABSTRACT

This study reviews the current CHP situation with regard to the benefits of CHP, status of CHP usage, market liberalization, promotion policies for CHP and barriers against sustaining and increasing the use of CHP as well as the effects of CHP pricing on the competitive situation of electricity and DH in the EU Member States, EU Candidate Countries and FSU Countries. In addition, it examines the regulatory frameworks in these countries and establishes a basis for comparing cost allocation methodologies for CHP and for recommending methodologies to be utilized in different market situations. Experience from other parts of the world where CHP and DH systems are well developed could be beneficial to DH industry managers and regulators in Eastern and Central Europe and FSU countries in improving their policies and practices to better ensure the competitive position of both electricity and DH. Pricing heat and electricity from CHP plants more correctly will help these products to maintain their competitive positions and avoid stranded costs to the economy of existing infrastructure. The initiative is intended to increase the awareness and understanding of the more appropriate cost allocation and regulatory practices that can be applied and of the benefits that CHP plants can provide, especially in reducing emissions of CO_2 and other harmful greenhouse gas emissions.

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The study incorporates the findings of the World Bank's early activities in combined-heat-and-power and district heating in Poland, Estonia, Latvia, Ukraine, Russia and China.

ACRONYMS AND ABBREVIATIONS

CCGT	Combined-Cycle Gas Turbine
CHP	Combined-Heat-and-Power
CO_2	Carbon Dioxide
DH	District Heating
ESMAP	Energy Sector Management Assistance Programme
ETSO	European Association of Transmission Operators
EU	European Union
EUR or €	Euro
FC	Fixed Costs
FSU	Former Soviet Union
GHG	Greenhouse Gas
NETA	New Electricity Trading Arrangement
NO_x	Nitric Oxide
N_2O	Nitrous Oxide
OECD	Organization for Economic Cooperation & Development
RECs	Renewable Energy Certificates
RECS	Renewable Energy Certification System
ROCs	Renewables Obligation Certificates
SO_x	Sulfur Oxide
UNDP	United Nations Development Program
VAT	Value-Added Tax
VC	Variable Costs
VOCs	Volitile Organic Compounds
WHO	World Health Organization

WEIGHTS AND MEASURES

Gcal	Gigacalorie (10^9 calories)
GJ	Gigajoule (10^9 joules)
GW_t	Gigawatt thermal (10^9 watts)
GWh	Gigawatt-hour (10^9 watt-hours)
kg	Kilogram (10^3 grams)
kWh	Kilowatt-hour (10^3 watt-hours)
Mt	Million tons
MW_e	Megawatt electricity (10^6 watts)
MW_t	Megawatt thermal (10^6 watts)
MWh	Megawatt-hour (10^6 watt-hours)
Tcal	Teracalorie (10^{12} calories)
TJ	Terajoule (10^{12} joules)
TWh	Terawatt-hour (10^{12} watt-hours)

CONVERSION FACTORS

1 Gcal = 4.187 GJ = 1,163 kWh

Executive Summary

Introduction

Combined-heat-and-power (CHP) plants are an important source of heat for district heating (DH) systems and electricity for energy markets, especially in the larger cities of Eastern and Central Europe and the Former Soviet Union (FSU). In many countries of Eastern and Central Europe and the FSU, the allocation of expenses in the joint production of heat and electricity in CHP plants has generally resulted in the benefits of the joint production being allocated by the regulators to electricity rather than in a sharing of the benefits also with heat, which has typically been considered by the regulators to be a cross-subsidy. This results in prices for heat from the CHP plants most likely to be too high currently, as the prices are usually at the same level as heat produced in heat-only boiler plants or even higher.

The deficiencies of this pricing method are beginning to be recognized in a number of Eastern European and FSU countries, especially since payments for DH are typically the highest or next highest expenditure in the budget of the average household, and consumers now have other alternatives to DH. By sharing some of the cogeneration benefits and thereby reducing the cost of DH and improving the affordability of heating and hot water services, the consumer base of the DH systems can better be sustained and access to these services by the poor households can be improved and better ensured.

At the same time, a number of countries in Western, Eastern and Central Europe are liberalizing their electricity markets and are concerned about ensuring the competitiveness of their CHP plants when the benefits of the joint production are shared to a greater extent with heat.

Thus, there is a need to examine what is the more correct way to allocate costs/benefits and market risks between the two products so that both electricity and heat are competitive in the market and affordable to consumers and stranded costs to the economy of existing infrastructure are avoided. This study was undertaken in order to review the state-of-the-art in the application of CHP cost allocation methodologies and regulation of heat and electricity under CHP production in order to increase awareness and understanding by the regulators and industry specialists in Eastern and Central Europe and FSU countries of the more appropriate cost allocation and regulatory practices that can be applied.

Benefits of CHP

CHP plants offer significant benefits over the separate production of heat and electricity. Most importantly, CHP allows the absolute amount of fuel used for production of the same quantity of heat and electricity to be reduced through increased efficiency of the cogeneration process. Fuel savings of up to 37% have been achieved in various locations. Since the cost of fuel typically ranges from 50-80% of total energy supply costs and is usually the most important cost factor in electricity and DH production costs, reducing the amount of fuel can have a substantial impact on the cost of supply.

More economic advantages of using CHP can be found in the fuel flexibility that it provides, as many plants are often designed to burn more than one fuel. Moreover, the assortment of fuels that can be utilized is wider in case of CHP as compared to building-level boilers. In addition to premium fuels such as gas or oil, biofuels, such as waste from wood processing industries and forestry operations, can be utilized.

The emissions per unit of useful energy output, including greenhouse gases, can be greatly reduced through the use of CHP as compared with the separate production of heat and electricity, and these benefits have been realized in many locations and countries.

Use of CHP plants also results in avoided transmission costs. Because CHP plants are sited at the location of heat and electricity load, they are downstream from any constraints on electricity transmission lines and this eases the constraints, thereby freeing capacity. From 5% to as much as 20% (during peak periods) of conventional power is lost to transmission resistance, compared to none for CHP electricity when used locally.

Furthermore, CHP plants can reduce the risk to consumers that electricity supply will be disrupted, since energy is produced locally and the impact of any major failures in the national electricity supply system can therefore be reduced. The reduced fuel requirements in CHP plants could contribute to reducing the dependency on imported fossil fuels.

Overview of the Current CHP Situation

Liberalization, or the development of electricity markets so that there is meaningful competition in the generation and supply of electricity, is at different stages of development in the countries of Europe and the FSU. Liberalization is advanced in all the EU Member States, but generally is just beginning in the EU Candidate Countries which are in process of harmonizing their energy sector policies with that of the EU. On the other hand, while Russia and other FSU countries have indicated the aim to liberalize their electricity sectors and open their markets to competition, so far there has been little development of market mechanisms allowing competition between entities.

CHP plants account for a significant share of total electricity generation in some EU countries, but account for a more substantial share in the EU Candidate Countries of Eastern and Central Europe and the FSU. The role of the CHP has historically been greatest in the areas with cold climates.

The EU has acknowledged that CHP is one of the few technologies that can offer a significant contribution to meeting the three central tenets of EU Energy Policy, i.e., competitiveness, environmental protection and security of supply. As a result of the substantial benefits that CHPs allow, the EU's current strategy aims to double the CHP market share from 9% of gross electricity generation in 1994 to 18% by 2010. The latest statistics show that the overall share of CHP electricity in total EU electricity generation was 13% in 2000. The strategy underlines the need for all Member States to set specific objectives for CHP.

A number of schemes to support and promote CHP are currently used in EU Member States, including: regulated tariffs, rather than bid-based tariffs, for CHP electricity fed into the grid; a preferential gas price for cogeneration; fiscal measures; investment subsidies, production support or introducing CHP certificates; and voluntary agreements on energy efficiency. A number of these measures, however, result in unfair competition and should be avoided in liberalized electricity markets.

Most of the Candidate countries have special regulations concerning the promotion of CHP. A factor driving CHP developments is their accession to EU. Despite this support, the cost allocation methods in use in Eastern and Central European Countries for determining CHP heat and electricity prices are contradicting such political support and make it difficult for both heat and electricity to remain competitive in their respective markets. While FSU countries generally

lack specific policies to promote CHP, the concept of energy efficiency has become one of great importance encouraging also CHP development. However, the regulators may establish tariffs for customers in such a way that utilities have little opportunity to allocate CHP costs to heat and electricity so that both products would be competitive in their respective markets. These practices do not support the further competitive development of CHP.

The EU Member States, EU Candidate Countries and FSU Countries face a number of barriers of an economic, legal, regulatory and institutional nature that need to be overcome in order to sustain and increase the share of CHP. Charges for access to and use of the grid, authorization and permitting requirements, lack of internalization of environmental costs in energy prices, uncertainty in tariffs and energy prices, low availability of natural gas networks, taxation policies, current overcapacity of generation in the European energy markets, lack of growing heat load, and existing electricity and heating infrastructure development are among the key factors that act as barriers to further CHP development. In addition, barriers for further development result from the fact that CHP plants, especially in Eastern Europe and the FSU, are oversized, are in poor condition, are often unprofitable and may not be the least-cost long-run alternative for heat supply. The study provides suggestions as to how to overcome or reduce the impact of a number of these barriers.

How heat and power produced in CHP plants are priced can affect the competitive situation of DH and electricity. Where CHP plants are operating in a liberalized electricity market and in a monopolistic heat market, the CHP plants' actions with regard to these two different markets may raise questions of cross-subsidization, as CHP plants may have an incentive to lower electricity prices in order to improve the competitiveness of electricity. It is also possible that electricity produced by a CHP plant can subsidize the selling price of heat, as is the case in some EU Candidate Countries where DH prices have been decreased in order to secure the position of DH which is facing unfair competition from individual building-level heating boilers fired by natural gas. Competition from natural gas is unfair because gas prices for small and large consumers are not differentiated to reflect the costs of supply, with gas prices at about the same level for both. In those countries, the distribution of CHP costs has been in favor of DH, and electricity has had to bear most of the costs from the cogeneration process. Energy policies of some countries have included incentives to promote CHP plants, and, in some cases, these incentives could have a negative impact on electricity prices.

CHP Technologies

The study explains the key characteristics of typical CHP plants, including the newer combined-cycle CHP plants, and how they differ from condensing power plants which produce electricity only and CHP plants which operate in condensing mode. It is important to take these distinctions into consideration when applying the methodologies for allocating costs to heat and power in CHP plants.

Cost Allocation Methodologies

Because there are typically substantial costs fixed and common to both products in a multi-product enterprise, such as a CHP plant, and there is no way to determine what share of those costs is attributable to one or the other product, the allocation of costs in a multi-product enterprise is always arbitrary. The result is that various methods can be used to apportion these costs arbitrarily. In addition, any joint cost allocation between a pure stand-alone cost and marginal cost of production can be proved to be cross-subsidy free. On this basis, therefore, at least in strict economic terms, there is considerable leeway to allocate costs to one of the products

or the other. However, if the allocation of costs does not consider the different demand conditions faced by the joint products, the prices often prove to be uncompensatory. Therefore, cost allocation must also consider the demand conditions faced by the joint products if the prices are to be sufficient to allow both products to remain profitable and competitive with other alternatives in their respective markets.

When considering how to allocate the costs of a CHP plant's production to heat and electricity, it is important also to distinguish between the plant's fixed and variable costs, which typically are handled separately by the different cost allocation methodologies. The cost allocation methodologies for variable costs (VC) available today include: (a) thermodynamic methods (i.e., energy method, work method and exergy method), (b) the methods of the alternative way of energy supply, (c) the proportional method and (d) the benefit distribution method. The cost allocation methodologies for fixed costs (FC) include: (e) the methods of the alternative way of energy supply, (f) the benefit distribution method and (g) the capacity sharing method.

The most important variable cost is the fuel cost which typically accounts for 50-80% of the total cost of producing heat and electricity. The study compares different cost allocation methods for allocating variable costs by applying them to two typical types of CHP plants operating in Europe, i.e., a combined-cycle gas turbine (CCGT) CHP plant and a coal-fired CHP plant. The method of the alternative way of electricity supply, which allocates all the benefits of CHP production to heat, and the method of the alternative way of heat supply, which allocates all the benefits of CHP production to electricity, define the upper and lower boundaries for benefit sharing. The cost allocation methods which fall between these boundaries are practicable for cost allocation of CHP, because there is no cross-subsidy of the different products.

A number of methods are not recommended to be used for variable cost allocation. These include: (a) the work method and the method of alternative way of electricity supply, because they allocate all the benefits from cogeneration to heat, which leads to high CHP electricity prices that are not likely to be competitive in the electricity market; (b) the energy method and the proportional method, because in some CHP plant types they cross-subsidize CHP electricity resulting in a higher cost for CHP heat than the cost of heat-only boilers; and (c) the exergy method, because of its complexity. This leaves the following methods as practicable for allocating variable costs: (d) the method of the alternative way of heat supply because a heat-only boiler is the alternative way of heat supply in all markets; and (e) the benefit distribution method, because it results in the sharing of CHP benefits with both heat and electricity products.

The variable cost allocation method generally determines which fixed cost allocation method is utilized.

Recommendations for Applications of Cost Allocation Methodologies

The type of market will have an important impact on the choice of cost allocation methodology.

For EU Candidate Countries and FSU Countries which have markets in transition where gas prices are often distorted with lower prices for small consumers than prices for large consumers such as CHP plants and DH systems, a key driver in determining the more appropriate cost allocation methodology is the need to ensure the competitiveness of DH as compared to other heating alternatives (especially gas-fired building boilers). The selected methodology must also ensure that electricity costs are lower than in separate electricity generation. The following

methods can be considered suitable for markets in transition: (a) the method of the alternative way of heat supply (VC+FC); and (b) the benefit distribution method (VC+FC).

In transition markets, as mentioned above, cross-subsidies between consumer groups are common in the structure of gas prices and also in DH and electricity prices. The objective of most countries in transition is to gradually reduce the cross-subsidies. Some CHP cost allocation methods, which are theoretically correct under normal market conditions, can be modified to take account of distortions in the market by adjusting the prices of CHP heat and CHP electricity as cross-subsidies are decreased. In many cases, cost allocation methods in use today are already being modified. A systematic approach can be achieved, for example, by modifying the cost allocation method of the alternative way of heat supply by utilizing a higher efficiency factor than the actual efficiency for the calculation of the alternative heat supply, which is gradually decreased as cross-subsidies are phased out.

In EU Member States which have liberalized markets, electricity is produced for a competitive electricity market and heat is produced for a monopoly market or to a market which is in a dominant position. There are several risks in the electricity market, of which the most significant is the risk that prices will vary substantially in the market from year to year. To take into account not only the benefits but also the risks for CHP in liberalized electricity markets, a new cost allocation method called the benefit and risk sharing method (VC+FC) has been developed recently. This method, as well as the method of the alternative way of heat supply (VC+FC), are recommended for use in liberalized markets.

Regulatory Framework for CHP

There are no common rules or guidelines for the regulation of heat and electricity produced in CHP plants. CHP heat and electricity are typically regulated by independent regulators or heat may not be regulated at all. In some of the countries, regulation of both products has been brought under the responsibility of a single regulator. DH plays an important role in CHP generation, and therefore it is typically reviewed along with CHP in national regulations.

In EU Member States, there are only few regulations concerning the cost allocation of electricity and heat in CHP plants. The main regulation is contained in the EU Electricity Directive which forbids cross-subsidization, but it does not provide instructions as to how to allocate the costs of CHP to ensure that cross-subsidization does not take place between heat and electricity. As a result, there are almost as many cost allocation methodologies used inside the EU as there are companies. The most common cost allocation methods used inside the EU are the alternative energy supply methods and versions of the benefit distribution method.

In most EU Candidate Countries, regulation of DH is typically under the jurisdiction of the municipalities, and regulation of electricity from CHP plants is typically under the jurisdiction of state authorities or the electricity regulator. The settlement of clear pricing principles for heat and electricity from CHP plants and establishment of rational CHP electricity purchase procedures are of crucial importance for the profitability of heat production in CHP plants and will have a significant influence on the development of DH systems. Currently, there are various methods used to allocate costs to heat and electricity in CHP plants including the alternative energy supply methods, energy method and proportional method.

In FSU Countries, while there has been some deregulation of electricity markets, the DH sector is still regulated by either an independent regulator or local authorities. The pricing and

cost allocation of CHP plants is, in some cases, strictly regulated leaving little possibilities for the utilities to manage the pricing of heat and electricity in the two market situations. Generally, the benefits of the joint production are given to electricity rather than attempting to share the benefits with the two products. The energy method (also known as the physical method) and proportional method are normally used for cost allocation in CHP plants. This has resulted in prices for heat from the CHP plants to be at the same level as heat produced in heat-only boilers or even higher. The deficiencies of these pricing methods are being recognized in a number of countries in this region, especially as consumers now have other alternatives to DH.

In countries with markets in transition, the cost allocation method adopted in the regulation of heat and electricity prices from CHP plants can have a significant impact on the affordability of DH and improving access of this essential service by the poor. In cities where CHP plants provide a substantial share of heat to DH systems, sharing the benefits of the cogeneration process, rather than pricing heat at the same price as in heat-only boilers, can significantly lower the price of heat to consumers. This has been shown in selective locations. Any possible increases in the price of CHP electricity as a result of a change in the cost allocation methodology to allow a sharing of cogeneration benefits with heat will, in many countries, have only a small or negligible impact on the electricity prices to consumers. In places where the impact on electricity prices is more significant, the electricity price increase would be justified if it better allows DH to compete more fairly with gas or other alternative heating options and thus helps to secure the heat load for CHP plants, considering the national and global benefits derived from CHP plants, i.e., the reduction of energy imports or fuel usage and significant reduction of environmental emissions. It is important that adequate social protection be available for low-income households and vulnerable groups to mitigate the impacts of possible increases of electricity or DH tariffs that may arise as a result of a change in cost allocation methodologies.

Cost allocation is an issue that has not yet been clearly regulated and is under debate now in many countries. The key recommendations for regulators when considering the pricing of heat and electricity from CHP plants can be summarized as follows:

(a) Regulators should acknowledge that there is a range of CHP benefits which can be allocated either to heat or electricity or shared by both, and sharing of benefits can be undertaken without cross-subsidization;

(b) Regulators need to ensure that the CHP benefits are shared with both electricity and heat so that both products have an opportunity to become profitable and remain competitive in their respective markets;

(c) Regulators may wish to review the cost allocation methods employed currently to consider the future trends in energy price reforms and market liberalization and establish regulations and rules for CHP that fit in with the overall direction of the energy sector;

(d) Regulators should ensure that cross-subsidies in the structure of energy prices, including gas, electricity, heat and other energy forms, be eliminated as soon as possible in order to create a level playing field among competing energy forms;

(e) The separate regulators in the different energy sectors within a country should work together to harmonize all the regulations concerning the energy sector (electricity, gas, heat, other energy forms) so that they are in line with each other;

(f) In order to facilitate the mobilization of private capital needed for rehabilitation and construction of CHP and DH systems, regulators should specify the selected cost allocation method or the path if gradual changes are envisioned, so that lenders, investors, producers and consumers know what to expect in the future;

(g) For energy markets in transition, consideration should be given to establishing the responsibility for the regulation of the cost allocation methods for CHP heat and electricity by the same regulator;

(h) For liberalized energy markets, it is recommended that guidelines for cost allocation of CHP heat and electricity be provided by the regulators but that CHP utilities be allowed to determine the cost allocation method, taking into account prices, incomes, demand and other market conditions; and

(i) As there is not one correct way to allocate the benefits of CHP between heat and electricity that is suitable for all market situations, regulators need to allow adequate flexibility in the choice of cost allocation methods for CHP producers that will allow them to manage the two separate markets of heat and electricity in their particular circumstances.

Prospects for CHP

The prospects for increasing the use of CHP varies considerably across countries in Europe and the FSU. The political decisions on closing nuclear power plants in some Western European countries, if implemented, will have a significant impact on the demand for new CHP capacity construction in areas where there is adequate heat demand. In Eastern and Central Europe and the FSU, the possible closing of nuclear power plants would create an even larger potential for CHP plants. In line with power market liberalization, as old condensing power plants in Europe are retired, the power plants could partly be replaced by CHPs in areas where adequate heat demand is available.

The goals for CO_2 emissions will play an increasing role in Western European energy policies and could lead to a larger utilization of CHP to reduce fossil fuel consumption. If the internalization of environmental costs are implemented in tax policies, CHP and DH would fare especially well in comparison to other alternatives to heat and electricity production.

In Western Europe, the future expansion of DH is more likely to shift from existing networks to smaller-scale systems where the distances over which heat is transported are limited. Recent technical development of small CHP units, which can be sized to meet the thermal load of the building where they are located, may make a new option practical and could support the development of the smaller DH or building-level heating systems.

Further opportunities for increasing the efficiency of existing CHP plants will arise from implementation of a combined cycle, gas-fired process which would increase the power-to-heat ratio, allowing more electricity to be produced without increasing heat production. This technology will be particularly attractive in areas where the market for heat is no longer growing as it will allow for an improvement in the economic viability of the present DH systems.

CHP plants can and should exist without support in the medium to long term. The competitiveness of new CHP plants in the short term depends on the specific market situation. In markets where new electricity capacity is needed and where there is adequate heat load, CHP

plants are considered to be most feasible type of new power generation plant, and, in this case, support measures for CHP are not necessary. Generally in most of the electricity markets in Europe today, however, there exists excess electricity generation capacity. Thus, in the short term, new CHP development is not feasible without support mechanisms and therefore it may be desirable to design support mechanisms for CHP if the targets of individual countries' energy policies are to increase efficiency, decrease emissions or promote renewables. With liberalization of the electricity markets, supportive measures should be avoided, however, if they result in unfair competition. Experience has shown that energy policies promoting CHP result in increasing CHP capacity and production.

REGULATION OF HEAT AND ELECTRICITY PRODUCED IN COMBINED-HEAT-AND-POWER PLANTS

I. Introduction

A. Background

1.1 Combined-heat-and-power (CHP) plants are an important source of heat for district heating (DH) systems and electricity for energy markets, especially in the larger cities of Eastern and Central Europe and the Former Soviet Union (FSU). In many countries of Eastern and Central Europe and the FSU, the allocation of expenses in the joint production of heat and electricity in CHP plants has generally resulted in the benefits of the joint production being allocated by the regulators to electricity rather than in a sharing of the benefits also with heat, which has typically been considered by the regulators to be a cross-subsidy. This results in prices for heat from the CHP plants most likely to be too high currently, as the prices are usually at the same level as heat produced in heat-only boiler plants or even higher.

1.2 The deficiencies of this pricing method are beginning to be recognized in a number of Eastern European and FSU countries, especially since payments for DH are typically the highest or next highest expenditure in the budget of the average household, and consumers now have other alternatives to DH. By sharing some of the cogeneration benefits and thereby reducing the cost of DH and improving the affordability of heating and hot water services, the consumer base of the DH systems can better be sustained and access to these services by the poor households can be improved and better ensured.

1.3 At the same time, a number of countries in Western, Eastern and Central Europe are liberalizing their electricity markets and are concerned about ensuring the competitiveness of their CHP plants when the benefits of the joint production are shared to a greater extent with heat.

1.4 Heat and electricity are typically regulated by separate regulators: heat regulation is usually under the responsibility of local authorities and electricity under the responsibility of an independent regulator. However, in a few countries, regulation of both products have been brought under the responsibility of a single regulator.

1.5 Several studies have been carried out about 10 years ago on the thermodynamics in CHP and how costs can be allocated based on different principles. The existing theories and cost allocation methods, however, were developed prior to the liberalization of energy markets and competition. In the meantime, no comprehensive studies have been carried out on this subject. The European Union has also not yet taken a position on the issue of cost allocation of CHPs, neither in the new CHP Directive proposal nor in other directives concerning competition or electricity and gas markets.

1.6 Thus, there is a need to examine what is the more correct way to allocate costs/benefits and market risks between the two products so that both electricity and heat are competitive in the market and affordable to consumers and stranded costs to the economy of existing infrastructure are avoided. A key question remains as to whether heat should be priced according to alternative (competing) heating systems or according to cost (as regulators usually tend to do) but which is not possible to define unambiguously. It is important to now review how existing cost allocation methods and market conditions can be combined and taken into account by the regulators and whether the regulation rules should be adjusted.

1.7 The World Bank is therefore undertaking a review the state-of-the-art in the application of CHP cost allocation methodologies and regulation of heat and electricity under CHP production in order to provide the regulators and industry specialists in Eastern and Central Europe and FSU countries with the necessary background to determine the more appropriate cost allocation and regulatory practices to be applied.

B. Objectives

1.8 The main objectives of this report are:

(a) to provide an overview of the state-of-the-art of usage of CHP and of allocating costs to electricity and heat in CHP production in various countries under different market conditions;

(b) to demonstrate how benefits of CHP production can be shared and costs can be allocated between heat and electricity in order to improve the competitiveness and affordability of both power and heat and thus the acceptability of CHP, taking into account the issue of cross-subsidization related to this; and

(c) to provide an overview of the possible changes needed in the regulatory frameworks to achieve the improved competitiveness and affordability of both power and heat.

1.9 The report has been organized into eight chapters, including this first introductory chapter. The second, third and fourth chapters provide background information for the discussion on cost allocation methodologies and regulatory frameworks which follow. The second chapter explains the key benefits of CHP heat and electricity production as compared with separate production of heat and electricity. The third chapter provides an overview of the environment in which CHP plants are operating by examining the status of market liberalization among countries in Europe and the Former Soviet Union and the extent of CHP usage in these countries. This chapter also reviews the energy policies of the various countries which generally call for greater use of CHP plants and then examines the promotion schemes utilized to increase their use as well as the barriers that limit the further development of CHP plants. Effects of CHP pricing on the competitive situation of DH and electricity are explained as well. The fourth chapter provides a brief explanation of the types of CHP plants and how these differ from condensing power plants which produce electricity only.

1.10 The key topics of cost allocation, regulatory frameworks and prospects for CHP development are then examined in the remaining chapters. The main cost allocation methodologies in use today are explained and compared in the fifth chapter which also establishes the range for sharing benefits of CHP plants with heat and electricity and provides a clear definition as to when cross-subsidization takes place. The sixth chapter provides recommendations for applications of cost allocation methodologies for energy markets in transition and for liberalized energy markets. The regulatory frameworks for CHP for the various countries are examined in the seventh chapter, along with the social impacts of CHP pricing. In addition, general recommendations for the regulators in these countries are provided. The eighth and last chapter of the report discusses the prospects for increasing the use of CHP plants in the countries under discussion and evaluates whether promotion and other support mechanisms are necessary for their further development.

C. What is a CHP Plant?

1.11 A CHP plant is a power plant which produces simultaneously both electricity and heat from one production process, also known as "cogeneration." The electricity produced is either used locally or fed into the national transmission grid, while heat energy can be used either for DH (or district cooling) or for industrial processes. CHP plants offer dramatic advantages in efficiency and much lower air pollution than conventional technologies. By contrast, conventional generation of electric power throws away much of the heat generated in production, and conventional thermal energy production often misses an easy opportunity to generate power.

II. Benefits of CHP

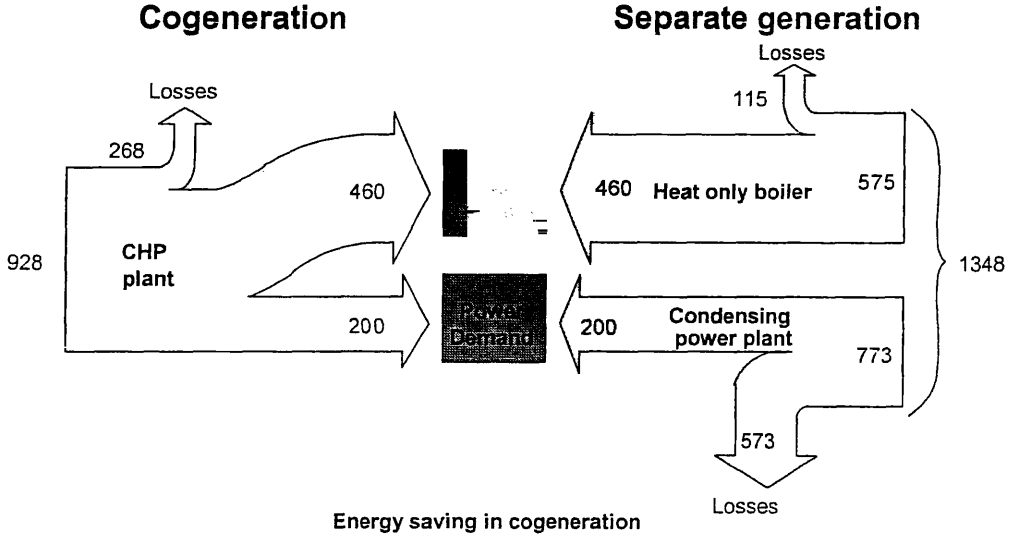
2.1 CHP plants offer a number of benefits related to fuel savings over separate production of heat and electricity, flexibility in the use of fuels, reduced environmental emissions including greenhouse gases (GHGs), avoided transmission costs and increased security of supply.

A. Fuel Savings

2.2 Significant savings in use of fuel can be achieved in CHP plants over separate production of heat and electricity. CHP allows several types of fuel savings: (a) the absolute amount of fuel used for production of the same quantity of heat and electricity is reduced through increased efficiency of the cogeneration process, (b) economies of scale are obtained in fuel purchases in large quantities by CHP plants as compared with small fuel purchases under decentralized heating options, and (c) the kinds of fuels burned can be switched away from premium or imported fuels to more desirable and lower cost choices such as biomass.

2.3 Figure 2.1 below shows an example of how much energy could be saved by using the same fuel more efficiently in a CHP plant. The figure shows the total fuel consumption in two cases: (a) where electricity is produced in a large condensing steam turbine and heat is produced separately in heat-only boilers with a total fuel consumption of 1,348 energy units; and (b) where heat and electricity are produced in a large steam turbine CHP plant with a fuel consumption of 928 energy units. The fuel savings which can be achieved by CHP operation is, in this case, 31%. The benefits in fuel savings will vary significantly for different CHP plants, depending on the efficiency of the existing plant and fuel alternatives.

Figure 2.1: Fuel Savings for Heat and Electricity Supply from CHP



Energy saving in cogeneration

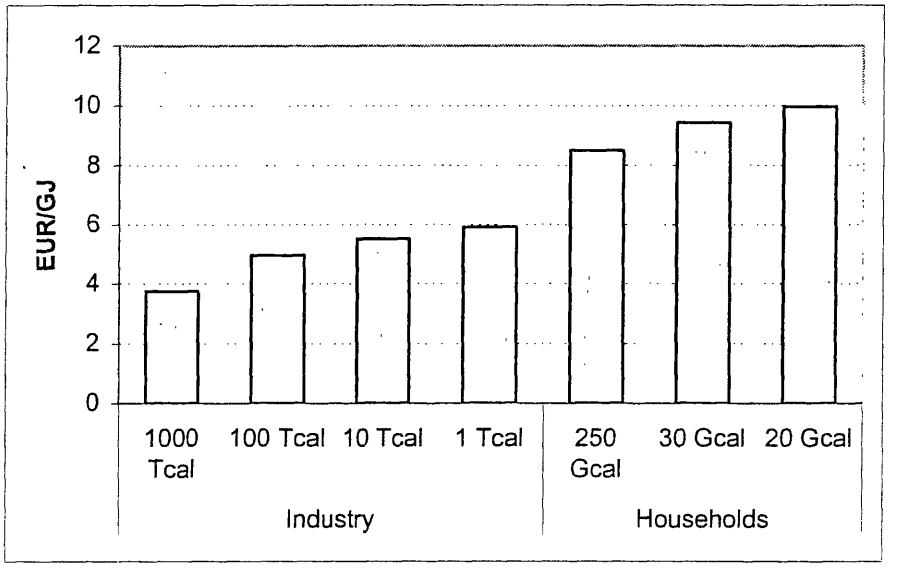
$$= \frac{1348 - 928}{1348} * 100\ \% = 31\ \%$$

2.4 The fuel savings depend largely on the temperature at which the thermal energy is removed from the steam expansion process in the turbine. Low temperature DH will offer greater savings, and 150°C pressurized water, which is the typical design temperature in DH systems in

Eastern Europe, will result in smaller savings. The savings also depend on the assumed efficiency of the boilers replaced by CHP. If the boilers are old and operate at high temperature, their efficiency could be as low as 65%, and the fuel savings would then amount to 37%. It should be noted, however, that in order to achieve these savings, the size of the CHP plant should be optimized such that it can be operated as a base load plant in CHP-mode most of the year.

2.5 The cost of fuel, typically ranging from 50-80% of total energy supply costs, is usually the most important cost factor in electricity and DH. In the West, fuel costs for large consumers, such as DH enterprises and CHP plants, are usually much lower than for small consumers, such as building owners utilizing mini-boilers, since fuel costs reflect the actual costs of supply. For example, the costs of gas for large and small consumers in Dusseldorf, Germany in 2002 are presented in Figure 2.2 below, with gas prices for small consumers around 2-2.5 times that of gas prices for large consumers. However, today in many Eastern and Central European countries and especially the FSU, gas prices for large and small consumers are not differentiated with small consumers paying about the same as large consumers. This has the result that, in some places, consumers are abandoning DH in favor of building-level gas-fired boilers. Reducing the price distortions in gas and other fuels would have a major impact in favor of DH and CHP, since it would be the least-cost long-run heating option in high-density population areas.

Figure 2.2: Gas Prices for Large and Small Consumers in Dusseldorf, Germany, 2002[1]



B. Fuel Flexibility

2.6 More economic advantages of using CHP can be found in the fuel flexibility that it provides. CHP plants make it possible to change into another fuel more flexibly compared to other heating forms, as many plants are often designed to burn more than one fuel. Moreover, the assortment of fuels that can be utilized is wider in case of CHP as compared to building-level boilers. For example, in addition to premium fuels such as gas or oil, biofuels, such as waste

[1] Eurostat. Gas prices for EU Industry and Households, July 2002.

from wood processing industries and forestry operations, can be utilized. However, in gas-fired combined cycle plants, the only fuel utilized is gas.

2.7 The use of biofuels would allow CO_2 emissions to be reduced remarkably, and opportunities for Joint Implementation and Emissions Trade may open up in the near future. The use of biofuels also creates permanent employment opportunities often in rural areas. Biofuels are indigenous and therefore contribute to reducing dependence on energy imports and increasing security of supply.

C. Reduced Emissions

2.8 The emissions per unit of useful energy output can be greatly reduced through the use of CHP as compared with the separate production of heat and electricity, and these benefits have been realized in many locations and countries. The use of primary energy (fuels) has been significantly reduced due to CHP production and DH use in Sweden, Finland, Denmark, China and Korea, for example. Reduction in fuel use has led to substantial environmental benefits.[2] In 1990, the city of Helsinki received the United Nations Air Award for efficient energy generation. Increased use of CHP and DH has been the main factor for improvement in the air quality during the last three decades. In the densely populated cities of China and Korea, abating air pollution has been one of the major reasons to introduce CHP and DH during the 1970's and 1980's. In China, for instance, the pollution from small, coal-fired, individual heating units caused a marked rise in mortality due to respiratory illnesses, which are estimated to be reduced now that DH based on large coal-fired CHPs, equipped with flue-gas cleaning, has been and is further being introduced in China's larger cities.

2.9 Expected emissions reductions resulting from use of a CHP plant as compared with heat-only boiler plants with 65% and 80% efficiencies are described in Table 2.1 below. The emissions are specific to the fuel utilized and technology; the plants are assumed to burn #2 oil, a light oil with low sulphur content. As can be seen, CHP provides dramatic reductions in emissions, especially CO_2, for a given supply of thermal energy.

Table 2.1: Emissions and Emissions Reductions from CHP

	CHP	Boilers (80%)		Boilers (65%)	
Type of Emissions	**Emissions**	**Emissions**	**CHP Reduction**	**Emissions**	**CHP Reduction**
Fuel use -MW_t	311	692	55%	852	64%
SO_2	111	377	71%	465	76%
NO_x	21	165	87%	203	90%
VOCs	1.1	1.2	8%	1.5	27%
Particulates	8.8	16	45%	20	56%
CO_2	41	192	79%	236	83%

Emissions are in kg/hour.
VOCs are volatile organic compounds, essentially fuel which has been only partially burned.
Systems provide 554 MW of thermal energy (steam or hot water).
CHP fuel and emissions are incremental above those from power generation alone.

[2] Euroheat and Power, Yearbook 1997.

2.10 In addition, CHP plants are often equipped with more advanced flue gas cleaning systems than heat-only boilers, including such systems as electric precipitators and desulphurization plants, which would result in even larger reductions of emissions.

2.11 Stockholm, Sweden offers further evidence that these calculations are not simply theoretical. As the amount of heat supplied to Stockholm by DH has increased by a factor of ten from 1965 to 1990, SO_2 emissions have been reduced by 95% and particulates by 82%. The reduction is due both to increased efficiency and to cleaner combustion in the larger, centralized boilers and CHP plants. Similar results can be found in many cities with large DH and CHP systems, such as Copenhagen, for example.

2.12 It is now widely accepted in the scientific community that burning fossil fuels has increased the CO_2 content of the atmosphere and that these increasing amounts of CO_2 and other GHGs, such as methane and fluoro- and halocarbons, will lead to significant and possibly devastating climate change over the next few decades. Two global conferences have been held in Rio de Janeiro, Brazil in 1992 and in Kyoto, Japan in 1997, with the goal of beginning to address this problem. The "Kyoto Protocol" to the United Nations Framework Convention on Climate Change requires industrialized countries to reduce emissions of GHGs by an average of about 5% below 1990 levels by 2010. The Protocol will take force after 55 countries, that cover 55% of total GHG emissions within countries covered by the Protocol, have ratified it. The ratification process is currently ongoing, and by April 2003, 84 countries had signed and 31 countries had ratified the Protocol.[3]

D. Avoided Transmission Costs

2.13 Because CHP plants are sited at the location of heat and electricity load, they are downstream from any constraints on electricity transmission lines and this eases the constraints, thereby freeing capacity. Use of CHP plants reduces the need for new high-voltage electricity transmission lines which oftentimes face landowner and environmental opposition. From 5% to as much as 20% (during peak periods) of conventional power is lost to transmission resistance, compared to none for CHP electricity when used locally.[4]

E. Improved Security of Supply

2.14 CHP plants can reduce the risk to consumers that electricity supply will be disrupted, since energy is produced locally and the impact of any major failures in the national electricity supply system can therefore be reduced.

2.15 The European economy is essentially based on fossil fuels (oil, coal and natural gas), which make up four-fifths of its total energy consumption and almost two-thirds of its imports. The EU's own energy supply covers barely half of its needs. If current trends continue, by 2030 the share of fossil fuels will increase, and energy imports would amount to 70% of total needs.[5] Import dependence and rising shares of imported fuels may lead to concern about the risk of

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[3] Carolyn Gochenour, District Energy Trends, Issues, and Opportunities – The Role of the World Bank, 2001.

[4] United States Combined Heat & Power Association, Brochure, May 1, 2003.

[5] Commission of the European Communities. Green Paper: Towards a European Strategy for the Security of Energy Supply, June 26, 2002.

interruption to or difficulties in supply. The reduced fuel requirements in CHP plants could contribute to reducing the dependency on imported fossil fuels.

2.16 The diversification of the fuel mix which CHP plants have brought about, along with increased regional self-sufficiency and increased physical security through decentralized energy production in various places, has resulted in CHP plants contributing to greater security of supply, one of the key objectives of European energy policy.

III. Overview of the Current CHP Situation

A. Liberalization and Extent of CHP Usage

European Union (EU) Countries

3.1 Liberalization, or the development of electricity markets so that there is meaningful competition in the generation and supply of electricity, has begun in all the European Union Member States, although the pace of market opening varies among the Member States. The new EU Electricity Directive adopted in June 2003 requires that market opening be accelerated to allow all non-household consumers to freely choose their electricity suppliers from July 1, 2004 and all remaining consumers from July 1, 2007. Most of the EU countries have opened their markets faster than required by the latest Directive. At present, around 70% of the electricity market in the EU is open to competition. The following Table 3.1 presents the declared market opening and levels of CHP production in the EU Member States.

Table 3.1: Declared Market Opening and CHP Production in EU Member States

EU Member States	Market opening	Beginning of market opening	Full opening [6]	Electricity generation, TWh in 2000	CHP production, TWh_e in 2000 [7]
Austria	100%	1999	2001	60	14
Belgium	70%	2000	2003/2007	80	4.8
Denmark	100%	1997	2003	35	26 1)
Finland	100%	1995	1997	67	25
France	35%	2000	2007	517	0.9 2)
Germany	100%	1998	1999	534	70
Greece	35%	1999	2007	50	5.7
Ireland	40%	2000	2005	23	0.5
Italy	70%	1999	2007	264	58
Luxembourg	72%	2000	2007	1.1	0.4
Netherlands	63%	1998	Oct 2003	86	49 1)
Portugal	45%	1995/1997	2004	42	4.6
Spain	100%	1997/1998	2003	215	25
Sweden	100%	1996	1998	142	8.5
United Kingdom	100%	1990	1998	357	23

1) Also lower figures have been presented
2) Also figures over 10 times higher have been presented in some statistics.

3.2 CHP plants are common in some EU countries, such as in Denmark, Finland and the Netherlands, and account for a significant share of total electricity generation, as shown in Table

[6] Commission of the European Communities. Second Benchmarking Report on the Implementation of the Internal Electricity and Gas Market (Updated Report incorporating Candidate Countries), April 7, 2003.
[7] Based mainly on Eurelectric's Statistics and Prospects for the European Electricity Sector (1980-1999, 2000-2020).

3.1 above. According to Euroheat, however, current EU statistics have a tendency to show a too high contribution of CHP electricity to EU electricity production, as they partly include condensing power generation. Therefore, the figures for CHP electricity production, especially in Denmark and the Netherlands, are most probably too high.

3.3 The EU has introduced a proposal for a Directive for the Promotion of CHP. One of the objectives of the proposal is to create a common understanding of CHP technology by clarifying a definition of electricity produced from CHP. The proposal defines "high efficiency cogeneration" for existing plants when energy savings of more than 5% are achieved and for new plants when energy savings of more than 10% are achieved. In order to determine the primary energy savings from cogeneration as compared with separate production of heat and electricity, the proposal introduces adoption of harmonized reference values to be used for separate production of heat and electricity. The harmonized reference values should be established not later than two years after the Directive comes into force and should be based on comprehensive studies including consultations with the sector considering the different factors such as technology used, fuel types, load curves, size of plants, and climatic differences. Where CHP plants are equipped to generate separate electricity or heat, such production should be excluded from the definition of cogeneration.[8]

EU Candidate Countries

3.4 EU Candidate Countries have begun to open their markets, with the exception of Cyprus and Malta which have special provisions due to their small isolated systems. The timetable of market opening in the Czech Republic, Poland and Slovenia has been the fastest. In the discussion following, Cyprus and Malta will be disregarded due to their special status in the EU and small amount of electricity production. The following Table 3.2 presents the declared market opening and levels of CHP production in the EU Candidate Countries.

[8] Commission of the European Communities. Amended Proposal for a Directive of the European Parliament and of the Council on the Promotion of Cogeneration Based on a Useful Heat Demand in the Internal Energy Market, July 23, 2003.

Table 3.2: Declared Market Opening and CHP Production in EU Candidate Countries

EU Candidate Country	Market opening	Beginning of market opening	Full opening [9]	Electricity generation, TWh in 2000	CHP production, TWh_e in 2000 [10]
Bulgaria	10%	2002		44	4.0
Cyprus	0%	-	-	3.6	0
Czech Republic	40%	2002	2006	75	16
Estonia	10%	2001	2012	7.6	1.0
Hungary	33%	2003	2010	36	3.7
Latvia	10%	2000	2007	4.1	1.2
Lithuania	20%	2002	2010	13	1.4
Malta	0%	-	-	1.9	
Poland	51%	1999	Dec 2005	146	30
Romania	35%	2000		51	23
Slovakia	26%	2002		30	3.4
Slovenia	63%	2001		13	4.2

3.5 In the EU Candidate Countries of Eastern and Central Europe, CHP plants supply a significant proportion of electricity to the grid and heat for DH systems. A large proportion of the plants are old, especially those providing heat to the DH sector. The capacity is mainly coal-fired, with most of the remainder fuelled by gas or heavy fuel oil.

Former Soviet Union (FSU) Countries

3.6 Russia and other FSU countries have indicated the aim to liberalize their electricity sectors and open their markets to competition, but there is still little restructuring and a persistent lack of investment in the corporate sector which would lead to development of market mechanisms allowing competition between entities. Russia intends to begin its market liberalization in 2004. The Russian government has decided to reform the power sector because the existing utilities cannot meet the investment challenge alone and the investment climate has been relatively unattractive for new investors. The government has also determined that changing the ownership, structure, and regulation of the sector would have the added benefit of improving the efficiency of the sector.

3.7 The Ukrainian electricity sector begun the restructuring process already in 1994, unbundling generation, transmission and distribution assets and establishing a wholesale market administration entity to increase transparency and accountability and to allow for the development of a competitive market for electricity. Ukraine was modeled on the former United Kingdom system, with a pool arrangement for short-term electricity trading. However, the high level of non-payment for electricity was the key impediment preventing competition in electricity generation until recently.

[9] Commission of the European Communities. Second Benchmarking Report on the Implementation of the Internal Electricity and Gas Market (Updated Report incorporating Candidate Countries), April 7, 2003.
[10] Based mainly on Eurelectric's Statistics and Prospects for the European Electricity Sector (1980-1999, 2000-2020).

3.8 The management of the power industry in Belarus is undertaken by the state-run enterprise Belenergo, a vertically integrated utility responsible for electricity generation, transmission, distribution and supply to end-customers. No significant restructuring of the power market has taken place yet, and reforms have been focused on standardizing the tariffs for electrical energy throughout the country.

3.9 In Moldova, the reorganization of the energy sector has begun and a privatization program is underway, where emphasis is placed on the open and transparent privatization of the energy utilities. In early 2000, about 70% of electricity distribution was privatized. The creation of a competitive electricity trading market is planned to be made by maintaining the legal and regulatory framework in the energy sector and by adopting market rules for electricity trading conducive to private sector involvement.

3.10 Due to the many similarities of the countries, only the FSU countries in Europe, i.e. Belarus, Moldova, Russia and Ukraine, will be analyzed more thoroughly in this report. The following Table 3.3 presents the declared market opening and levels of CHP production in the FSU Countries in Europe.

Table 3.3: Declared Market Opening and CHP Production in FSU Countries in Europe

FSU Country	Market opening	Beginning of market opening	Full opening	Electricity generation, TWh	CHP production, TWh_e in 1999 [11]
Belarus	0%			27	13
Moldova	0%			3.5 [1)]	0.8 [1)]
Russia	0%	2004		845	560
Ukraine	0%			170 [2)]	12.1 [2)]

1) World Bank statistics.
2) The figures are for year 2002 from the Ukraine Power Sector Guidebook, 2003.

3.11 CHP plants have played an important role in energy production in the FSU and account for a significant share of total electricity generation. However, current statistics have a tendency to show a too high contribution of CHP electricity to total electricity production, as they partly include condensing power generation. Therefore, the figures for CHP electricity production, especially in Russia, should be considered too high.

3.12 A large proportion of existing CHP plants and adjoining DH networks are old and inefficient. Due to the considerable decrease in both power generation and consumption during the 1990s, there is excess electricity generating capacity in many countries, and CHP plants may be oversized for the current heat loads, leading to low operating capacities. Therefore, the competition situation of old CHP plants may be difficult when the energy markets are liberalized. However, refurbished and new CHP capacity, which is better dimensioned to the heat loads, will be in a better competitive position.

[11] Based on International Energy Agency's Energy Balances of Non-OECD Countries.

B. Policies to Promote CHP

EU Member States

3.13 The successful development of CHP and DH in Western Europe was driven, at least originally, by reaction to the oil shocks of the early 1970's and before and the realization that energy security could only be ensured by reducing dependence on imported products. Moving into the 1990's and the present millennium, an equal driver has been the recognition of environmental crises in the making and of the major role that CHP and DH can play in averting or minimizing them.

3.14 The EU has promoted the concept of CHP since 1974. In 1977, the Council recommended that Member States establish advisory bodies and committees to encourage CHP and heat transport schemes. In 1988, another recommendation encouraged the removal of legal and administrative obstacles in the co-operation between public utilities and electricity auto-producers which would use renewables, waste fuels and CHP.[12] In 1992, obstacles for CHP development were still found. The main problems identified were the still undeveloped relationship between auto-producers and electricity production utilities, although the situation had somewhat improved, and the lack of progress in achieving a competitive internal market in electricity in EU Member States.[13]

3.15 Since 1992, additional steps have been taken which support the development of CHP and DH use. The first directives concerning the liberalization of the internal electricity and gas markets became effective in 1996 and 1998, respectively. The EU Electricity Directive identified ways to promote CHP by providing rules concerning access to the electricity system and by allowing EU Member States to give priority in the dispatch of CHP to the electricity grid. New directives for electricity and gas markets were recently adopted in June 2003. The latest Electricity Directive provides Member States with the possibility, in the interest of environmental protection and promotion of infant technologies (such as CHP), to tender for new capacity on the basis of public criteria. Thus, whenever there is a necessity for new generation capacity based on infant technologies, an independent body may draw up an inventory for the new means of production and the requisite capacity will be allocated by a tendering procedure. Also, a new proposal for restructuring the community framework for the taxation of energy products was adopted in 1997. This framework offers Member States a possibility to grant fiscal advantages to renewable energy sources and cogenerated heat.[14]

3.16 DH and heat production, including heat production in CHP plants, are subject to three different kinds of taxes: (1) value-added tax (VAT), (2) special fuel excise taxes or energy taxes, and (3) environmental taxes. VAT may be flat (e.g. Denmark, Finland, the Netherlands, Norway and Sweden) or may be lower for DH (e.g. Italy). If fuel excise taxes are applied (e.g. Denmark, Finland, France and Sweden), they typically are lower for biomass and natural gas to encourage greater use of these preferable fuels. Environmental taxes, usually based on carbon and/or sulphur content of fuels, are applied in several countries.[15] The environmental benefits that can be achieved through the use of renewables and CHP can be supported by using such taxes.

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[12] Carolyn Gochenour, 2001.
[13] European Commission, 1992 and 1997.
[14] COM (97) 30 final; European Commission, 1997.
[15] Euroheat and Power, Yearbook 1998.

3.17 The 1995 White Paper "An Energy Policy for the European Union" outlines three central tenets: (1) competitiveness of European businesses in the global markets; (2) environmental protection; and (3) security of supply. CHP is considered an important and cost effective contributor to all three. In the White Paper, the Commission committed itself to present a strategy offering a coherent approach for the promotion of CHP within the EU. The strategy was presented by the Commission to the Council and the European Parliament in 1997 in the form of a policy document "A Community Strategy to Promote Combined Heat and Power and to Dismantle Barriers to its Development." A key finding of the strategy is that CHP is one of the few technologies that can offer a significant short or medium-term contribution to improving energy efficiency in the EU. CHP is also recognized as making a positive contribution to the environmental policies, especially in fulfilling the Kyoto requirements.[16] The strategy aims at doubling the CHP market share from 9% of gross electricity generation in 1994 to 18% by 2010 in the EU. Achieving this target would reduce CO_2 emissions more than 65 Mt per year. According to the latest cogeneration statistics from Eurelectric, the overall share of CHP electricity in total EU electricity generation was 13% in 2000 compared with 9% in 1994. The strategy underlines the need for all Member States to set specific objectives for CHP.

3.18 A proposal for a Directive for the Promotion of CHP has recently been introduced which, in addition to the objective of creating a common understanding of the CHP technology, would have the objective to motivate Member States to remove barriers and create favorable conditions for CHP capacity. The latest version of the proposal includes a requirement for Member States to ensure that support for CHP is based on a useful heat demand. The Member States should avoid encouragement of increased heat demand in order to avoid an increase of fuel consumption and CO_2 emissions and they should take steps to prevent public financial support for electricity from cogeneration from being used to subsidize heat production, thereby creating incentives for being less careful about the proper use of the heat output. They should also ensure that support for CHP is provided in a non-discriminatory way, i.e. irrespective of operators and of the use of the electricity, mechanical energy or heat generated in the CHP plant. The proposal also states that grid connection costs and tariffs related to the transmission and distribution of electricity from cogeneration and tariffs related to the purchase of additional electricity should be set according to objective, transparent and non-discriminatory criteria, taking into account the costs and benefits of cogeneration. The proposal sets the timeframe to the year 2010 for doubling the share of CHP electricity to 18% of total EU electricity generation.[17]

3.19 There have been several Community programs to support CHP technology development. The Fourth Framework Program (1994-1998) provided support to CHP, among other things, through the JOULE and THERMIE programs which included cost sharing of projects implementing innovative energy technologies and accompanying measures such as studies, seminars, conferences and training. The Fifth Framework Program provided further assistance through its Energy, Environment and Sustainable Development Program which included support for feasibility studies, demonstration projects and investments. CHP can also be supported in a similar way through the SAVE program which has the aim to promote energy efficiency.

3.20 The EU gives recommendations and has some authority over the Member States, but each Member State formulates its own national energy policies. Typical goals include energy savings,

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[16] European Commission. White Paper for a Community Strategy and Action Plan, 1997.

[17] Commission of the European Communities. Amended Proposal for a Directive of the European Parliament and of the Council on the Promotion of Cogeneration Based on a Useful Heat Demand in the Internal Energy Market, July 23, 2003.

improved energy efficiency both in production and use in all sectors, use of indigenous energy sources, increased use of renewable energy, diversity in use of fuels, security of supply and addressing emergency issues and environmental acceptability. The priorities vary country by country, but all EU countries stress the importance of energy savings and improved energy efficiency. CHP and DH have been considered as important tools in the realization of energy policies.

3.21 In EU Member States, state aid is, in principle, forbidden, in order to ensure the correct functioning of the internal markets. However, exceptions may be made in virtue of, for example, environmental protection. Revised state aid guidelines give extensive power to Member States to provide support to CHP and renewable energy projects. These powers include investment aid, operating subsidies and tax exemptions.

3.22 A number of schemes to support CHP are currently used in Member States. Guaranteed purchase of qualified CHP electricity, that is, a mechanism to ensure that CHP plants have the option to generate electricity and receive priority dispatch by system operators, exists in Austria, Belgium, Denmark, France, Germany, Greece, Italy, Luxembourg, the Netherlands, Portugal and Spain. Country-specific definitions exist for qualified CHP including criteria related to capacity or efficiency. Tariff support, including fixed tariffs for electricity from qualified CHP plants, fixed bonus on top of the market price for electricity and/or minimum purchase price, are used in Austria, Belgium, Denmark, France, Finland, Germany, Luxembourg, Portugal and Spain. Discounts or exemptions on various taxes such as energy taxes and environmental taxes are used in Denmark, Germany and the United Kingdom. Also, Finland and Sweden provide small tax relief for CHP heat. Capital incentives are given for certain CHP investments in Belgium (Flanders), Denmark, Finland, Greece, Luxembourg, Sweden and the United Kingdom as a form of grants and subsidies as well as tax discounts.[18]

3.23 Green certificate markets exist in a number of countries. A green certificate represents the renewable, or "green" attribute of a unit of electricity (e.g., one megawatt hour) generated from a renewable source. These markets may be voluntary (i.e., not driven by a compliance requirement) or mandatory. Examples of voluntary green certificate markets include the European Renewable Energy Certification System (RECS) and the Dutch green certificates market. Mandatory markets are being created in connection with rules requiring generators to generate a certain minimum percentage of their electricity from renewable sources (i.e. renewable portfolio standards). For example, a mandatory renewable portfolio standard has been established by the state of Texas in the United States, a regional green certificate market is being developed in the Northeastern United States, a market in Renewables Obligation Certificates (ROCs) is being established in the United Kingdom in connection with the government's renewables obligation, a green certificate system was introduced in Sweden in 2003, a green certificate system has been introduced for CHPs in Belgium (Wallonia), and an EU-wide market in green certificates is anticipated as the EU Renewable Directive is implemented. Other terms, such as "renewable energy certificates" (RECs), may be used to refer to green certificates, depending on the market or jurisdiction, and the definition of eligible energy sources being used. Green certificates can be marketed and sold separately from the underlying physical electricity generated from the renewable energy source. Green certificates markets can help to support CHPs directly, as in the Belgium example, or those CHP plants which use renewable fuel sources.

[18] Combined Heat and Power Association. Response to the Public Consultation Draft of the Government's Strategy for Combined Heat and Power to 2010, August 2002.

3.24 In the future, natural gas consumption is expected to increase significantly in Europe. Thus, natural gas-based CHP, as in the case of a combined-cycle gas turbine (CCGT) for example, will play an important role in the development of the energy sector. The power-to-heat ratio of a CCGT is high compared to other energy production technologies, and thus more electricity can be produced based on the existing heat load. Therefore, how competitive natural gas-based CHP production in liberalized energy markets can be will be an important question for the implementation of the EU strategy to promote CHP.

3.25 The key policies pursued by the individual EU Member States are described in Annex 1.

EU Candidate Countries

3.26 The energy policies applied today throughout Eastern and Central Europe reflect the need for introduction of energy efficiency and conservation measures and a reduction in energy intensity, especially in end-use applications. In addition, the energy policies stress the importance of energy market liberalization, security of supply, diversification of fuel use, increased use of indigenous and renewable fuels, and economic efficiency combined with social acceptability. Generally, energy sector liberalization is just beginning in the region, and the EU Candidate Countries are in process of harmonizing their energy sector policies with that of the EU. Some of the largest sources of energy wastage in Eastern and Central Europe are the outdated and badly maintained DH systems, including CHP plants. Reducing losses in DH systems and increasing the efficiency of CHP generation are being promoted in the national energy policies of most countries in this region.

3.27 At this time, tax policies encouraging energy savings and environmental improvements in Eastern and Central Europe are in the early stages of development. DH and heat production, including heat production from CHP plants, are usually subject only to value-added tax (VAT). VAT may be flat (e.g. Czech Republic, Poland and Romania) or favorable for DH (e.g. Estonia and Slovenia). Fuel taxes and environmental taxes are usually not collected. Slovenia has been the first country to apply an environmental tax on CO_2 emissions starting from 1997. Some countries, such as Poland, also apply emission charges. Generally, environmental taxes in Eastern Europe, where levied, are low.[19]

3.28 A significant potential either from the EU Emission Allowance Trading Scheme for CO_2 or making use of the Joint Implementation mechanism of the Kyoto Protocol exists in the EU Candidate Countries where it is less expensive to reduce emissions and there are opportunities to sell emission allowances. National GHG emissions reductions are not generally an issue, as the economies of most of the Eastern and Central European countries have contracted significantly since 1990, thereby automatically allowing them to achieve their GHG emissions targets. A significant potential for increasing cogeneration and decreasing emissions in Eastern and Central European countries exists, with the majority of the growth expected to be fuelled by natural gas.

3.29 Most of the Candidate countries have special regulations concerning the promotion of CHP. A framework of an obligation to buy CHP-based electricity from qualified plants has been stablished in Bulgaria, Czech Republic, Hungary, Latvia, Lithuania, Poland, Slovakia and

[19] World Energy Council. Towards Local Energy Systems: Revitalizing District Heating and Co-Generation in Central and Eastern Europe. Present Situation and Current Trends in Restructuring the District Heating Sector in Poland and Other CEE Countries, 2002.

Slovenia.[20] Despite this support, the cost allocation methods in use in Eastern and Central European Countries for determining CHP heat and electricity prices are contradicting such political support and make it difficult for both heat and electricity to remain competitive in their respective markets.

3.30 National energy strategies of the Candidate countries promote liberalization, restructuring, and commercialization of the energy sector. The countries all have a common interest in the opening of markets to competition, security of energy supplies at affordable prices, and reasonable pricing policies with the phasing out of subsidies, all of which may indirectly support CHP. Another factor driving CHP developments is their accession to EU. The key policies pursued by the individual EU Candidate Countries are described in Annex 2.

FSU Countries

3.31 The role of CHP has been significant in FSU countries, but currently it is facing many problems in these countries. CHP is today generally inefficient, unprofitable and poses governance problems. The CHP sector in FSU countries is affected by national policies regarding, for example, licensing, tariffs and fuel use.

3.32 CHP plants connected to DH systems may not be competitive in comparison with direct use of gas or electricity for heating by building owners due to the poor condition of the DH systems and the low efficiencies of CHP plants. The allocation of the costs of CHP to heat and electricity is typically biased in favor of ensuring the competitiveness of electricity where electricity and heat markets are under different regulatory regimes. The regulators may establish tariffs for customers in such a way that utilities have little opportunity to allocate CHP costs to heat and electricity so that both products would be competitive in their respective markets. These practices do not support the further competitive development of CHP.

3.33 In some of the countries, the rise of DH tariffs and the distortion of gas and electricity prices for households resulted in a tendency for households to disconnect from DH systems and to prefer individual heating based on natural gas and electricity. In the same way, CHP growth was affected by distorted gas prices.

3.34 The FSU countries manage the electric utility industry to satisfy national interests. Models now are being developed following the international trend of deregulation and market mechanisms. The reforms are directed to the development of market relations in the electric utility industry, the de-monopolization of industry and the promotion of competition between energy producers. Significant changes in the power industry have already taken place in Moldova, Ukraine and Russia.

3.35 Besides deregulation, the energy policies of the FSU countries are aiming to improve energy efficiency and reduce GHG emissions in the energy sector. While specific policies to promote CHP generally do not exist, the concept of energy efficiency has become one of great importance encouraging also CHP development. Thus, attractive options for FSU countries include retrofitting existing plants, fuel switching from coal or heavy fuel oil to natural gas, constructing generation capacity in the form of CHP plants, and applying the Kyoto mechanisms for reducing emissions. Possibilities for CHP are positive, since the infrastructure for heat distribution is mostly well developed or can be significantly improved. The obstacles for the

[20] COGEN Europe. The Future of CHP in the European Market – The European Cogeneration Study, 2001.

development of CHP relate mostly to current market structures, large surplus generation capacities in some countries and limited access to investment resources. The key policies pursued by the individual FSU Countries which are supportive of CHP are provided in Annex 3.

C. Barriers to Sustaining and Increasing the Share of CHP

3.36 A number of barriers of an economic, legal, regulatory and institutional nature need to be overcome in order to sustain and increase the share of CHP in the EU Member States, EU Candidate Countries and FSU Countries. The most important barriers still result from the relationship between co-generators and electricity utilities.

Access to and Use of the Grid

3.37 A key barrier for CHP plants concerns the charges for gaining access to the electricity grid. Charges are related to ensuring adequate frequency control and stand-by and back-up power and for allowing CHP plants to sell their electricity. The barriers exist both in the connection to the grid as well as in the use of transmission and distribution services. The interconnection to the network can be a long process whereby the CHP plant owner may need to pay costs for adjustments, reinforcements and upgrades necessary to facilitate the integration of a generator into the grid. Information on grid connection costs is seldom publicly available, so new entrants will face uncertainty with regard to the costs of connection.

3.38 CHP plants are also facing barriers in the use of the grid if grid use tariffs favor large-scale generation, as CHP plants are typically smaller than other types of power plants. CHP plants which operate according to the heat load cannot always adjust their electricity output to the agreed load as defined in bilateral power contracts or by bids into the spot markets. This results in penalty payments in the settlement process, and these imbalance costs can be extremely high, as has been the case in the United Kingdom under the New Electricity Trading Arrangement (NETA) and the balancing mechanism.

3.39 Network operators may also charge high prices to CHP plants for back-up and balancing services. They may also charge for the use of all voltage levels even if the electricity of a CHP plant is produced and consumed at a lower voltage level. Distribution companies may not have an incentive to connect CHP plants into their networks since it may diminish the distribution fees charged to the consumers and the return on network investments of the distribution companies may decrease as a result of the reduced amount of electricity to be distributed.[21]

3.40 The connection of CHP plants, however, may also bring benefits to the grid company in the form of avoided transmission network upgrades and expansion, decongestion, avoided transmission losses, improved local reliability, and the provision of ancillary services to the grid. Most grid companies in the EU are subject to regulation which does not usually consider the benefits that CHP plants bring to the grid. In some countries, discussions are taking place as to what would constitute reasonable charges for CHP plants for access to the grid, taking into account the benefits that they provide and the need to promote greater use of CHP. Differences exist as a result of the stage and maturity of market opening in different countries.

[21] Energy Research Centre of the Netherlands ECN, IZR Institut for Futures Studies and Technology Assessment, COGEN Europe, and RISO National Laboratory. Decentralised Generation: Development of EU Policy. Report in the framework of the DECENT Project, October 2002.

3.41 Today tariffs for use of the grid differ widely among European countries, with generators, including CHPs, in some countries charged significant tariffs for supplying electricity to the grid, in addition to the charges for access to the grid, while in other countries generators are not charged for supply to the grid. These differences result in unequal competition conditions and distort the electricity market on a European level. According to a comparison made by the European Association of Transmission Operators (ETSO) in February 2003 on transmission pricing in Europe, in the Netherlands, generators are charged some 25% of the transmission costs while in Germany, generators are not charged at all for these costs. The proposal for a European Parliament and Council regulation on conditions for use of the grid for cross-border exchanges of electricity provides, in principle, for the transmission charge to be mainly paid by the consumers. However, a partial charge to generators is allowed (in the proposal up to 50%) in order to give Member States which want, by means of different regional charges, to achieve particular locational incentives for the building of power stations, the opportunity to do so. The principle of allocation of transmission costs is thus decided by each Member State, so the level of harmonization of tariffs inside the EU for use of the grid may remain low.[22]

3.42 In addition, in some countries, charges favor the connection of large-scale rather than small-scale generation, such as small CHPs. The United Kingdom is an example of such policies. In order to overcome the barrier related to access to the grid by small CHPs, the charges for connecting large and small-scale generation should be established on a similar basis or even include a discount for CHP plants. In Finland, there are areas where small-scale power generation in the distribution network is promoted with negative charges for input to the grid, meaning that a generator will receive payments for the usage of the distribution network by avoiding transmission costs.

Authorization and Permitting

3.43 Authorization and permitting can cause substantial delays and transaction costs to CHP projects and can act as a barrier to entry. A variety of authorizations, licenses, consents, or permits are required, usually issued or granted by various authorities, and can be slow and expensive, especially for small CHP projects. In most Member States there is ample scope for improvement in this respect by: (a) improving the transparency and efficiency of permitting or licensing procedures; (b) introducing fast-track authorization procedures; (c) pre-selection of potential sites for CHP development in spatial plans which would help to avoid conflicts between CHPs and other uses; and (d) instituting training programs to familiarize local authorities with the needs and requirements of CHPs. These provisions could be part of the proposed CHP Directive, and the European Commission could also require Member States to conduct feasibility studies for CHP in regional and local spatial planning procedures. Through its energy framework program, the European Commission could foster international exchange programs on best practice in authorization procedures.[23]

Lack of Internationalization of Environmental Costs in Energy Prices

3.44 Although CHP is widely recognized as the only means by which to increase fossil-fired generation to support economic growth while decreasing overall emissions, environmental costs and benefits are almost never included in energy prices. If such environmental costs and benefits

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[22] European Transmission System Operators. ETSO Task Force. Benchmarking on Transmission Pricing in Europe: Synthesis, February 2003.

[23] Emiel van Sambeek and Martine Uyterlinde. "Decentralized Generation – Development of EU Policies," Cogeneration & On-Site Power, May-June 2003, pp. 63-68.

were acknowledged and included in energy prices, this would benefit the situation of CHPs since the plants are environmentally more efficient than plants for separate production of electricity and heat. The limited application of the internalization of the environmental costs in energy prices therefore acts as a barrier to CHP. With the application of environmental taxes or other tax incentives, it is possible to overcome this barrier. The Commission proposes various measures such as tax incentives and portfolio requirements for purchase of a minimum fraction of annual energy from CHP plants burning biomass as compensation for these very real environmental externalities.

3.45 The Kyoto Protocol, which calls for the reduction of GHGs through fuel savings and other more efficient uses of energy, will provide incentives to encourage CHP investments. CHP plants are especially attractive investments with regard to the Kyoto Protocol when a change from a harmful fuel such as coal to a more environmentally-friendly fuel such as biomass or gas is involved.

Uncertainty in Tariffs and Energy Prices

3.46 Volatility and uncertainty in tariffs and prices may act as a barrier to deter potential investors, because CHP plants require an expensive capital investment, leading to the need to take a relatively long-term view. The economics of CHP plants are sensitive to the level of energy prices, and especially to the fuel price and the income received from the generated electricity and heat. In order to assist investors to evaluate the impact of price changes, energy markets require that clear, transparent and sustainable policies are used in their operation and regulation, leading to relatively stable and predictable energy price dynamics.

3.47 Liberalized electricity markets have brought new barriers, at least in the short term. With liberalization, in many countries, electricity prices tend to decrease in the immediate years following liberalization due to overcapacity and competition, and these prices, as well as general uncertainly due to changes in the market, therefore act as a barrier to invest in new CHP. In Finland, for example, some municipalities invested in new heat-only boilers for their DH systems for some years following liberalization instead of in new CHP plants, because new CHP plants were not feasible when such low electricity prices were prevailing. In Germany, where liberalization also led to reductions in electricity prices, CHP production dropped from 9% to 7.5% of gross electricity generation between 1994 and 1998. In response, Germany implemented a CHP Support Law at the beginning of 2000 to improve the economic position of public CHP plants. Electricity market prices in the European internal market since then have been increasing, now making the prospects for new CHP investments more attractive.

3.48 International liberalization of electricity trade as well as increased cross-border transmission capacity from Scandinavia to continental Europe should decrease the electricity price differences between European countries. In a number of European countries, some co-generators fear that they will not survive on the open electricity market. This will be the case if the scheme itself is uneconomical and has been based on a monopoly supply position or subsidies. On the other hand, in some European countries including Scandinavian countries, this fear does not generally exist since the schemes have traditionally been based on competitive principles. Investments have only been made in such cases where the economic viability compared to other options has been proven.

Low Availability of Natural Gas Networks

3.49 Depending on the country or the region within a country, the low availability of natural gas through well-developed networks may be an obstacle to development of gas-fired CHP plants. In remote areas, for example, where the electricity transmission network is not sufficiently extended, and which would be a priority target area for cogeneration, natural gas networks are usually not extended, thereby limiting the development of CHPs. Until recently, the limited development of the gas network infrastructure in such countries as Greece and Portugal has been an obstacle for CHP development.[24] In these areas, the possibility to use biofuels as a primary or secondary fuel should be analyzed in order to identify the opportunities for introduction of CHP plants.

Taxation Policies

3.50 Taxation policies can also restrain the further development of CHP plants, if, for example, DH and CHP is subject to a full VAT rate while electric heating and natural gas are subject to lower VAT rates, as is the case in France. The lack of energy or carbon taxes in some countries and low taxation policies do not favor and encourage the development of energy efficient technologies. In some cases, the structure of the tax itself is unfavorable for encouraging CHP development; for example, if heat from a CHP plant is taxed but the waste heat of conventional generators is not. The EU has also made several proposals regarding an EU-wide system of carbon/energy taxation that will require the introduction of minimum levels of energy taxation for all energy products (i.e. coal, natural gas and electricity) in Member States. When adopted, the system of taxation should favor more energy efficient production such as CHP.

Current Overcapacity of Generation in the European Electricity Markets

3.51 Current overcapacity of generation plants in the European electricity markets has led to decreasing electricity prices at a time when gas prices have been rising, thereby substantially weakening the prospects for new CHP investments. This situation, however, is expected to improve with the decommissioning of old inefficient plants starting in the near term. New CHP investments based on gas are, in many cases, more profitable than, for example, coal-fired plants due to their higher efficiency and higher power-to-heat ratio. However, if gas prices are very high and coal production is subsidized, new CHP investments may not be competitive.

Lack of Growing Heat Load

3.52 The lack of growing heat load is a clear obstacle towards CHP. In Western Europe, although electricity consumption is growing, the total market for heating is somewhat stagnant, partly due to improving building standards and insulation. In these conditions, existing DH networks are not likely to grow very much larger. New CHP plants with higher power-to-heat ratios, such as combined cycle plants, might have the possibility to improve the economic viability of the present DH systems.

Existing Electricity and Heating Infrastructure

3.53 Existing electricity and heating infrastructure is also a barrier for further development of CHP. If there already exists a substantial level of inexpensive hydropower or nuclear power in

[24] European Environment Agency. Share of CHP Electricity in Gross Electricity Generation, EU15, Factsheet, September 2001.

the market, the investment in a CHP plant may appear unprofitable until the electricity market is open and price levels are high enough. The large contribution of nuclear and hydropower in France and Sweden, for example, has left little opportunity for the development of CHP up to recently. However, after Sweden announced a change in its energy policy to close down its nuclear capacity and also due to the growth in demand, now many new CHP plants are planned and under construction. Similarly, if the heating systems are already located in individual buildings and based on an existing gas network or on electric heating, introduction of DH with CHP would require expensive reconstruction and therefore impedes the further development of CHP.

Other Factors

3.54 A number of other factors act as barriers to development of CHP. Lack of availability of information and limited understanding of the CHP technology and its existing commercial potential are factors opposing CHP. Existing CHP plants are, in some cases especially in Eastern Europe and the FSU, oversized compared to the present heat demand, which dropped dramatically after the break-up of the Soviet Union. Those CHP plants are also often unprofitable due to high rates of non-payment and low, subsidized tariffs to end-consumers who cannot control heat intake and be billed according to usage. Due to the poor condition of CHP and DH systems in some areas and low heat load densities, some present CHP and DH systems may not be the least-cost long-run alternative for heat supply and would be better to replace with alternative heat supply systems or to replace with new CHP plants and DH systems sized to the present heat demand. Price distortions in favor of gas and electricity are weakening the position of cogeneration-related DH. CHP plants provide a local service and therefore problems may result in cases where the national government plays a substantial role in licensing, tariffs and fuel usage. Biases against ensuring the competitiveness of CHP may exist in countries where electricity, heat and gas markets are under different regulatory regimes.

D. Effects of CHP Pricing on the Competitive Situation of District Heating and Electricity

3.55 How heat and power produced in CHP plants are priced can affect the competitive situation of DH and electricity. There are several cost allocation methods to divide the costs of heat and power produced in CHP plants. The methods are based either on thermodynamic principles, on alternative production methods or on purchase prices of electricity from the market. The methods can lead to cross-subsidization if the benefits from producing heat and electricity in the cogeneration process are not shared both with heat and electricity. It is more usual that power is cross-subsidized by heat, but in some cases heat is also cross-subsidized by power. In liberalized markets, the problem of pricing heat and power from CHP production becomes even more complicated, because power is sold in a competitive market and heat in a, at least partly, regulated market.

3.56 The laws on competition forbid a company's abuse of dominant position. One form of the abuse of dominance is utilizing cross-subsidies to limit the competition of other commodities in production and marketing. A company should not use resources which are obtained by dominance in one industry to affect the market situation in another industry. If, as a result of this, the operation of other companies in an industry is prevented or the competition becomes distorted, abuse of dominance has taken place. For example, if a product is sold at a price which is less than its production cost and the loss is financed by an increase in the price of another product, which is in dominant position, this would be considered an abuse.

3.57 Where CHP plants are operating in a liberalized electricity market and in a monopolistic heat market, the CHP plants' actions with regard to these two different markets may raise questions of cross-subsidization from the point of view of abuse of dominant position. In a liberalized electricity market, CHP plants may have an incentive to lower electricity prices in order to improve the competitiveness of electricity.

3.58 It is also possible that electricity produced by a CHP plant is subsidizing the selling price of heat. For example, in some of the EU Candidate Countries, DH prices have been decreased in order to secure the position of DH which is facing unfair competition from individual building-level heating boilers fired by natural gas. This situation has arisen because large gas consumers, such as DH and CHP plant, pay higher unit prices for gas than small consumers, such as individual building residential consumers, even though the cost of delivering gas to small consumers served by costly distribution networks is higher than the cost of delivering gas to large consumers connected to the large transmission mains. In those countries, the distribution of CHP costs has been in favor of DH, and electricity has had to bear most of the costs from the cogeneration process. This situation has been possible because electricity markets have not yet been liberalized, and the government has played a strong role in pricing policy. In Western European countries this situation has not occurred, since there are no cross-subsidies in the structure of gas prices among consumer groups. However, natural gas has, in many cases, been the competitive heating form to DH in cases where the price of DH is at about the same level as the price of heating with natural gas.

3.59 Another incentive to subsidize one business activity against another is the possibility to avoid taxes by evening out the revenues and expenditures from the separate business activities. The EU Electricity Directive has tried to prevent this type of subsidization with the requirement to unbundle or separate the different business activities and their accounting. However, neither the Electricity Directive nor the legislation applied in most countries give clear directions as to how to allocate the costs between the CHP activities and therefore a lot of approaches can be used to allocate the costs of CHP plants.

3.60 Energy policies of some countries have included incentives to promote CHP plants, and these incentives have had a negative impact on electricity prices. In the Netherlands, for example, the Electricity Act from 1989 contained many incentives in favor for CHP including (a) an obligation on the centralized grid to buy surplus electricity from CHP plants at avoided cost, (b) subsidies for CHP investments, (c) favorable natural gas pricing for small-scale CHP, and (d) exemption of CHP plants from paying for reserve capacity and ancillary services. The support measures increased investments in decentralized CHP facilities throughout the 1990s. The number of new CHP plants was such that output from the existing and more economic base-load plants were to be limited to accommodate the capacity from the more expensive new CHP plants. This led to underutilized capacity of lower-cost power plants and higher unit costs. Prices, which would normally fall due to over-capacity in the market instead rose to recover higher unit costs. These incentives expired along with the Act in 1998.

3.61 It is not unusual to find examples in many EU Candidate Countries and FSU countries of energy policies which favor residential consumers at the expense of industrial consumers, especially in energy pricing. For example, in Hungary, until 1995 DH companies were able to benefit from subsidized fuel prices, especially natural gas, for residential consumers, whereas the Hungarian Power Company had to pay a much higher industrial gas price for its CHP plants. This led to a situation in which the municipalities could maintain otherwise uneconomic capacity in DH production plant as CHP plants were operated only on partial loads or not operated at all. Although the DH companies no longer have access to subsidized fuel prices for residential

consumers, the issue of price discrepancies and cross-subsidies led to consideration of a uniform, national regulatory framework for DH. A District Heating Law was effectively adopted by the Hungarian Parliament in March 1998.

3.62 In the Hungarian example, as has been the similar case in many countries, cross-subsidies in gas pricing meant also that DH costs were up to 30% more than the cost of heat produced in gas boilers in individual buildings. Many households therefore switched to natural gas for their heat and hot water requirements. Industrial customers also tended to switch away from DH in large numbers, further damaging the financial viability of CHP and DH. The most recent changes in gas pricing should have eliminated the cross-subsidy to households.

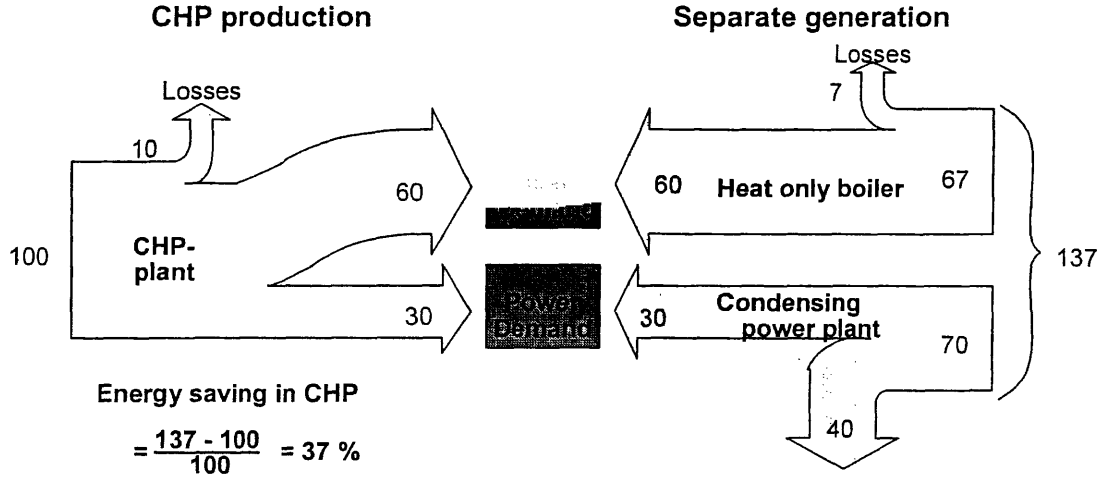
IV. CHP Technologies

A. General CHP Characteristics

4.1 CHP production or "cogeneration" is the simultaneous generation of power and heat from one production process. The electricity produced is either used locally or fed into the national transmission grid, while heat energy can be used either for DH (or district cooling) or for industrial processes. In DH systems, it is most common to distribute the heat as pressurized hot water, and industrial process heat is normally in the form of low-pressure steam. Since the fuel is used for production of both electricity and heat in a CHP plant, the overall efficiency can be very high. Typical CHP plants have a high overall efficiency of up to 70-90% compared to conventional condensing power plants which typically have an efficiency of 30-40% and combined-cycle condensing power plants which typically have an efficiency of about 55%.

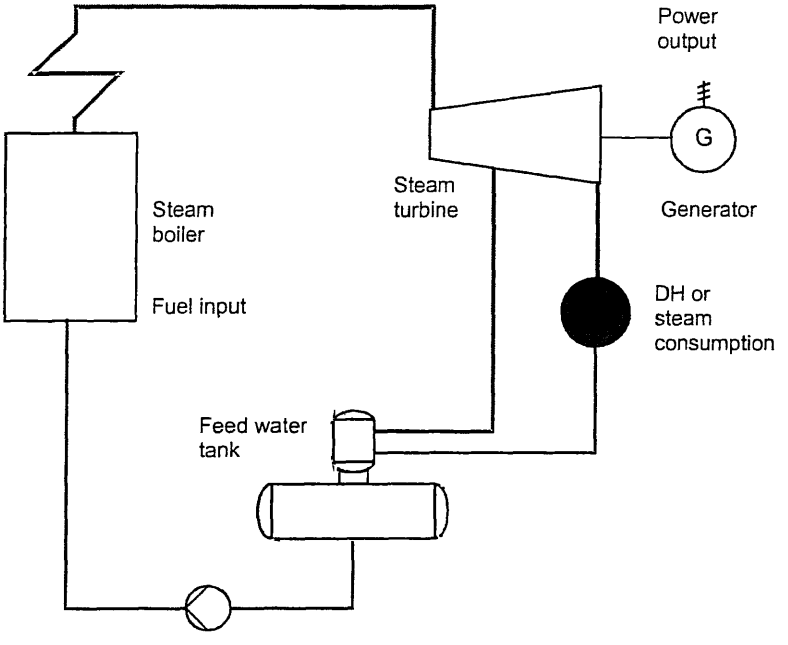
4.2 As depicted in Figure 4.1 below, for a typical CHP plant, 100 energy units of fuel would be required to produce 60 energy units of heat and 30 energy units of electricity with 10 energy units of losses. However, under separate electricity and heat production processes, 137 energy units of fuel would be required to produce the same 60 energy units of heat and 30 energy units of electricity, because the losses due to the separate production processes would be higher, i.e., 40 energy units of losses in electricity production and 7 energy losses in heat production.

Figure 4.1: Efficiency of Combined-Heat-and-Power Generation Compared to Separate Generation



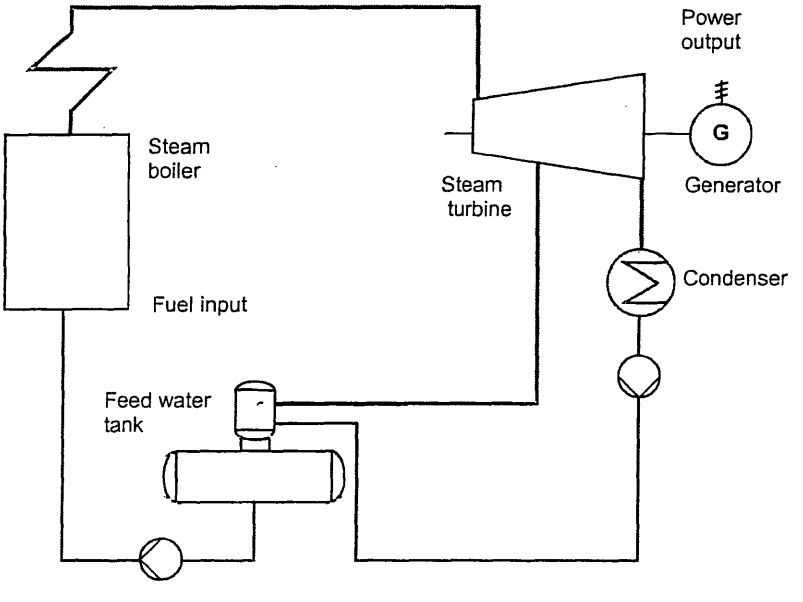
4.3 Historically, the most common CHP plants have consisted of boilers and steam turbines arranged in a typical water-steam cycle. Normally, in a CHP plant, fuel is utilized by the boiler to heat water and produce high pressure steam which rotates the turbine to produce electricity in the generator, and the steam after the turbine (back-pressure steam) is condensed by water to produce DH, as shown in Figure 4.2 below.

Figure 4.2: Typical Flow Diagram of a Back-Pressure CHP Plant



4.4 In a condensing power plant, on the other hand, the process is the same except that the steam after the turbine is cooled in a condenser and not utilized, as shown in Figure 4.3 below.

Figure 4.3: Typical Flow Diagram of a Condensing Power Plant

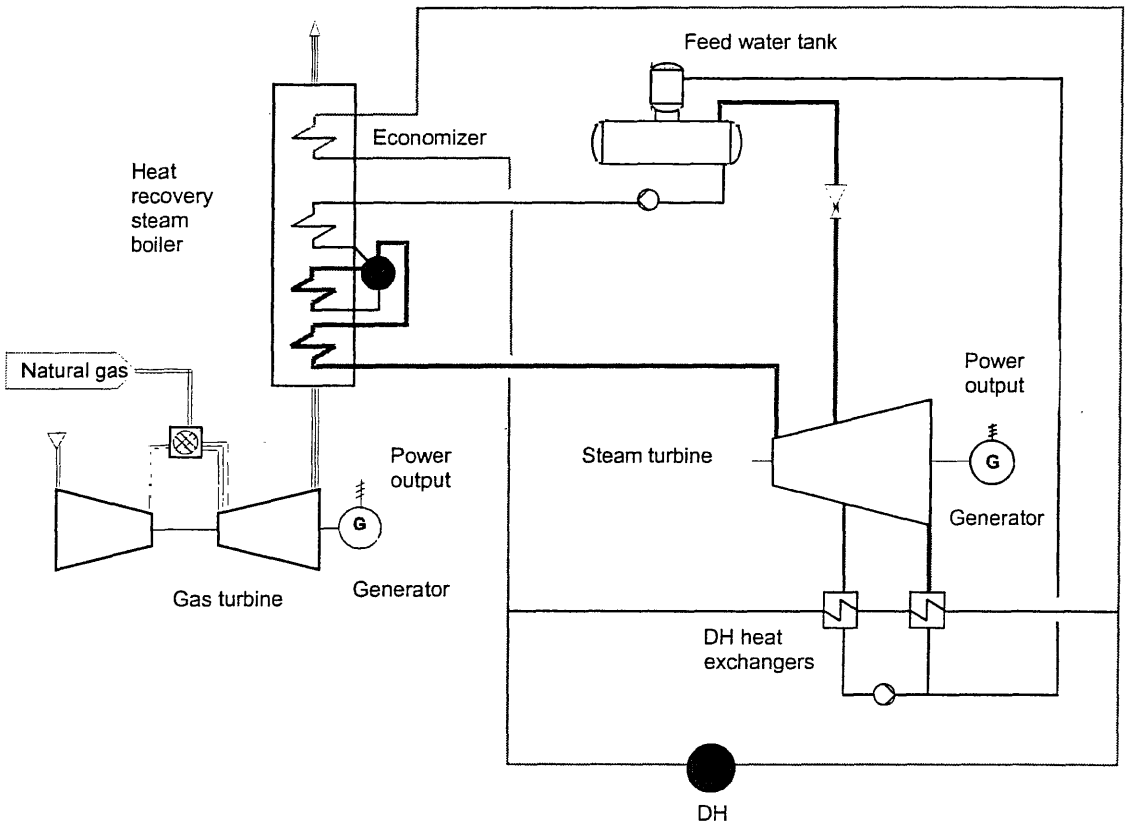


B. Combined-Cycle and Other Types of CHP Plants

4.5 In recent years, a number of new CHP concepts have developed. The most rapidly growing technology has been the combined-cycle CHP plant. In addition, on a smaller scale, gas engines, Otto or diesel engines can also be used as CHP units. The most typical fuels utilized are gas and oil, and, in some cases, limited applications of gasified biofuels.

4.6 In a combined-cycle CHP plant, natural gas, oil, gasified biofuel or coal is utilized in a gas turbine process, and electricity is produced in the generator attached to the gas turbine. The hot flue gases from the gas turbine are then used for producing steam in a heat recovery boiler, and that steam is converted into electricity and DH in a steam turbine process similar to a typical CHP plant. Some additional heat for DH can normally be recovered from flue gases in an economizer located in the heat recovery boiler. A typical combined-cycle CHP plant scheme is shown in Figure 4.4 below.

Figure 4.4: Typical Flow Diagram of a Combined-Cycle CHP Plant

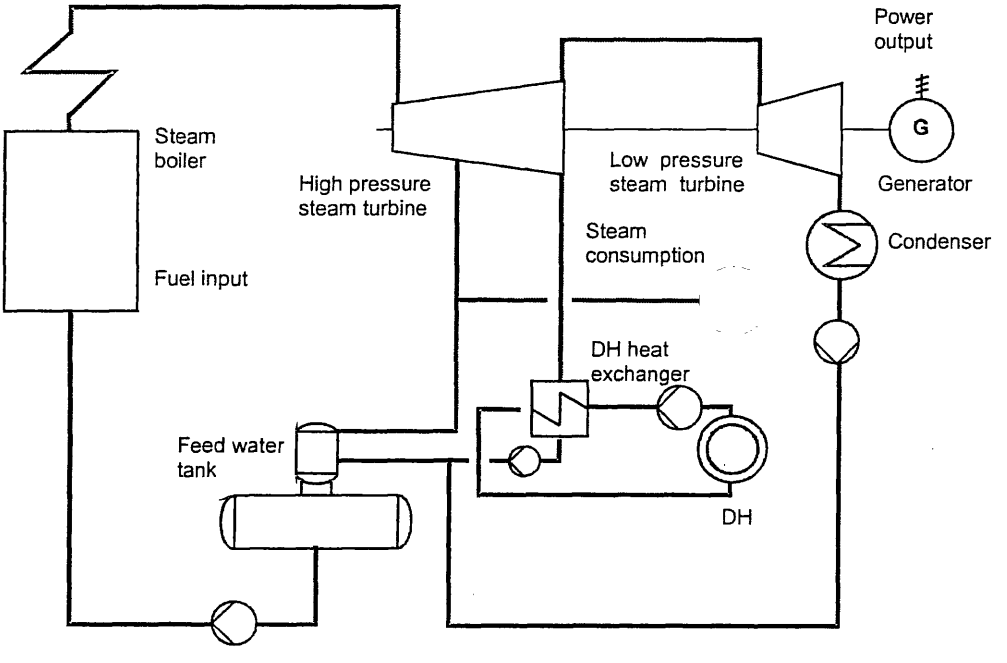


4.7 The main advantages of combined-cycle CHP plants are the very high efficiency of electricity generation and the high share of electricity produced compared to the heat produced.

C. CHP Plants Operating in Condensing Mode

4.8 Some CHP plant configurations can operate in a mode where part of the steam after the high-pressure turbine is led to a low-pressure turbine in order to produce more electricity. CHP plants which have turbines with steam extraction and which are equipped with low-pressure turbines (condensing tails) can alter their mode of operation between full CHP-mode where all heat can be utilized and full condensing-mode where no heat is utilized. In the condensing mode, the plant is not operating as a CHP plant, and the produced electricity cannot be considered as CHP electricity. Only when the plant is operating in full CHP-mode, all the produced electricity can be considered as CHP electricity. When the operation mode is between full CHP-mode and condensing-mode, only electricity produced along with the heat can be called CHP electricity. The advantage of this type of plant is that it provides a high level of flexibility to produce heat and electricity in response to demand which may vary seasonally. Flexibility is also an advantage when operating in a deregulated electricity market where electricity market prices may vary substantially. The efficiency of a CHP plant operating in full condensing-mode is lower than that of a pure condensing power plant. A typical scheme is shown in Figure 4.5 below.

Figure 4.5: Typical Flow Diagram of a Conventional Condensing Power Plant with Extractions



4.9 Different practices are used by the various countries to define CHP electricity. In some countries, such as Denmark and the Netherlands, where a large number of condensing power plants have small steam extractions for heat production, all the electricity output is classified as CHP electricity, even though theoretically the electricity is mainly produced in condensing-mode. This gives the appearance of very large electricity output in CHP-mode. It is therefore important to take these distinctions into consideration when comparing the current statistical figures from different countries. The EU proposal for a Directive for the Promotion of CHP, when adopted, would eliminate the different practices used to define CHP electricity by the various EU Member States.

V. Cost Allocation Methodologies

A. Background

5.1 Because there are typically substantial costs fixed and common to both products in a multi-product enterprise, such as a CHP plant which produces heat and electricity, and there is no way, based on the pertinent facts, to determine what share of those costs is attributable to one or the other product, the allocation of costs in a multi-product enterprise is always arbitrary. The result is that various methods can be used to apportion these costs arbitrarily.[25] In addition, any joint cost allocation between a pure stand-alone cost and marginal cost of production can be proved to be cross-subsidy free.[26] On this basis, therefore, at least in strict economic terms, there is considerable leeway to allocate costs to one of the products or the other. However, if the allocation of costs does not consider the different demand conditions faced by the joint products, the prices often prove to be uncompensatory.[27] Therefore, cost allocation must also consider the demand conditions faced by the joint products if the prices are to be sufficient to allow both products to remain profitable and competitive with other alternatives in their respective markets.

5.2 When considering how to allocate the costs of a CHP plant's production to heat and electricity, it is important to distinguish between the plant's fixed and variable costs, which typically are handled separately by the different cost allocation methodologies. Fixed costs usually include capital costs (installments and interest on loans), labor costs, fixed maintenance and repair costs, and power reserve costs, insurance, etc. Variable costs usually include fuel costs and other costs of production, such as lubricants, chemicals, variable maintenance and repair costs. The most significant fixed cost is the annual cost of the investment in the power plant considering the interest rate on loans utilized to finance the investment and the expected lifetime of the plant. The most important variable cost is the fuel cost which typically accounts for 50-80% of the total cost of producing heat and electricity.

5.3 Cost allocation is an important issue for CHP plants producing DH for the surrounding community and electricity for the grid. Cost allocation is not dependent on type of CHP ownership, as municipal-owned CHP plants may utilize the same cost allocation methods as privately-owned CHP plants. Cost allocation is not considered an issue for industrial CHP plants which are producing process steam and electricity for their own particular industrial use.

5.4 Many DH systems, which purchase heat from a CHP plant, are often viewed as a monopoly or in a dominant market position. Heat prices are therefore usually regulated in many countries or at least recommendations on pricing are provided. On the other hand, DH can face competition from other heating alternatives, such as individual building gas-fired boilers. In these cases, CHP and DH prices need to be established at competitive levels. The type of market will have an important impact on the choice of cost allocation methodology.

5.5 In liberalized electricity markets, bids of the generators in the spot-market are typically based on variable production costs and a desired margin. Therefore, the cost allocation methodology that is to be applied for competing CHP plants is an important question for ensuring

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[25] William J. Baumol, "Privatization, Competitive Entry and Rational Rules for Residual Regulation," University of Tasmania, Department of Economics, Occasional Paper No. 2, September 1997, pp 7-8.
[26] Gerald R. Faulhaber, "Cross-Subsidization: Pricing in Public Enterprises," American Economic Review, Vol. 65, No. 5, December 1975, pp 966-977.
[27] William J. Baumol, September 1997.

their competitiveness and will depend on the degree of market liberalization and market conditions. The main principle is that cross-subsidization should not be allowed between heat and electricity in any case.

5.6 As mentioned above, the different cost allocation methodologies typically handle fixed costs and variable costs of heat and electricity production separately. The cost allocation methodologies for variable costs (VC) available today include: (a) thermodynamic methods (i.e., energy method, work method and exergy method), (b) the methods of the alternative way of energy supply, (c) the proportional method and (d) the benefit distribution method. The cost allocation methodologies for fixed costs (FC) include: (e) the methods of the alternative way of energy supply, (f) the benefit distribution method and (g) the capacity sharing method. These methods are explained in the following sections below.

B. Thermodynamic Methods

Energy Method (VC)

5.7 In the energy method, also known as the physical method, variable costs are allocated to electricity and heat in relation to the produced energy products (or power-to-heat ratio). The variable costs allocated to electricity VC_e can be calculated as follows:

$$VC_e = \frac{E}{E+H} * VC$$

Correspondingly, the variable costs allocated to heat VC_{th} can be calculated as:

$$VC_{th} = \frac{H}{E+H} * VC$$

where E is the electricity production in the CHP plant, H is the heat production in the CHP plant, and VC are the variable costs of CHP plant.

5.8 The separate production of condensing power and its fuel consumption is subtracted before utilizing this allocation method in the case where the CHP plant can operate also partly in condensing mode.

5.9 In this method, an energy unit (MWh) of electricity and an energy unit of heat produced are valued equally when determining the proportion of variable costs which should be allocated to heat and electricity. The advantage of this method is that it is easy to use. The main disadvantage is that it can lead to higher variable costs for heat than would be the case in a heat-only boiler because of the possible higher efficiency of a heat-only boiler (which could be as high as 95%) as compared with the efficiency of a CHP plant (which could be up to 90%).

Work Method (VC)

5.10 The work method is applicable only for CHP plants with extraction steam turbines that can operate in condensing-mode. In the work method, the fuel consumption allocated to heat is based on the power generation loss in CHP-mode as compared to full condensing-mode. When

the CHP plant is operating in CHP-mode, both heat and electricity are produced. When the CHP plant is operating in condensing-mode, no heat is produced but a larger share of electricity is produced. Fuel consumption is thus allocated to electricity in proportion to the amount of electricity produced in CHP-mode as a share of electricity that could be produced in condensing-mode. Fuel consumption is allocated to heat in proportion to the amount of extra electricity produced in condensing-mode as a share of total electricity that could be produced in condensing-mode.

5.11 Separate production of condensing power and its fuel consumption is subtracted before utilizing this allocation method in the case where the CHP plant can operate also partly in condensing mode.

5.12 The application of this method requires data on thermodynamic process values and is therefore rather complicated to utilize. Another disadvantage of this method is that it may result in higher electricity production costs than in condensing power production because the method allocates all the CHP benefits to heat.

Exergy Method (VC)

5.13 In the exergy method, the allocation of costs is based on exergy flows of the energy products (electricity and heat). Exergy is a thermodynamic term which defines the quality of energy. As energy is used in a process, it loses quality and its exergy decreases. Exergies of thermodynamic process flows in power plants can be calculated, when their entalpies (the degree of energy content depending on pressure, temperature and humidity) and entropies (the degree of disorder or uncertainty in a closed thermodynamic system depending on absolute temperature) are known.

5.14 The application of this method requires profound knowledge of thermodynamics and power plant processes and is therefore rather complicated to utilize. However, the method is judged the fairest method from a thermodynamic point of view for dividing the benefits of CHP production between electricity and heat.

C. Method of the Alternative Way of Heat Supply (VC+FC)

5.15 In the method of the alternative way of heat supply, the costs of CHP heat are fixed at the same level as separate production of heat (e.g., in a heat-only boiler which uses the same fuel and has the same heat production capacity as the CHP plant) and the rest of the CHP costs are allocated to electricity. The variable costs to heat VC_{th} are defined as the variable costs in a heat-only boiler plant:

$$VC_{th} = VC_{a,th}$$

where $VC_{a,th}$ is the variable cost of heat-only boiler. The variable costs to electricity VC_e can then be calculated as:

$$VC_e = VC - VC_{th}$$

where VC is the variable costs of CHP plant. Correspondingly, the fixed costs can be allocated in relation to the fixed costs of the alternative energy supply forms. The fixed costs are defined for the alternative heat production method, which is typically a heat-only boiler.

5.16 The separate production of condensing power and its fuel consumption is subtracted before utilizing this allocation method in the case where the CHP plant can operate also partly in condensing mode.

5.17 The method of alternative way of heat supply gives almost the same results as the energy method (there is only a minor difference due to the usual slightly higher efficiency of separate heat production compared to CHP). This method allocates all the CHP benefits to electricity.

D. Method of the Alternative Way of Electricity Supply (VC+FC)

5.18 In the method of the alternative way of electricity supply, the costs of CHP electricity are fixed at the same level of separate production of electricity (e.g., condensing power plant which uses the same fuel and has the same electricity production capacity as the CHP plant) and the rest of CHP production costs are allocated to heat. The variable costs to electricity VC_e are defined as the variable costs of the separate production of electricity (e.g., condensing power plant):

$$VC_e = VC_{a,e}$$

where $VC_{a,e}$ is the variable cost of the separate production of electricity. The variable costs to heat VC_{th} are:

$$VC_{th} = VC - VC_e$$

where VC is the variable costs of CHP plant. Correspondingly, the fixed costs can be allocated in relation to the fixed cots of alternative energy supply forms.

5.19 The method of the alternative way of electricity supply allocates a high proportion of the plant's costs to electricity due to the much lower efficiency of condensing power production compared to CHP. Thus, all the benefits of CHP production are allocated to heat.

E. Proportional Method (VC)

5.20 In the proportional method, the allocation of variable costs is based on given fuel consumption ratios of different energy products (also for separate production of condensing power). Thus, the theoretical fuel consumption of different energy products is calculated by using those fuel consumption ratios. If necessary, the theoretical fuel consumption is normalized to the level of actual fuel consumption by using a correction factor.

5.21 The fuel consumption ratio for heat k_h can be assumed to be equal to the inverse of the heat-only boiler's efficiency η_h:

$$k_h = \frac{1}{\eta_h}$$

5.22 Then, the fuel consumption ratio for electricity k_e can be calculated as follows:

$$k_e = \frac{E + H - \eta * k_h * H}{\eta * E} = \frac{F}{E} - k_h * \frac{H}{E}$$

where F is fuel consumption of the CHP plant, E is electricity production in the CHP plant, H is the heat production in the CHP plant, η is the total efficiency of the CHP plant, and VC the variable costs of CHP plant.

5.23 The variable costs to electricity VC_e can be calculated as follows:

$$VC_e = VC * k_e * \frac{E}{F}$$

Then the variable costs to heat VC_{th} can be calculated as follows:

$$VC_{th} = VC * k_h * \frac{H}{F}$$

5.24 This method gives almost the same results as the method for the alternative way of heat supply whereby the variable costs are allocated to heat according to the alternative heat production and the rest of variable costs are allocated to power. This results in an allocation of all the CHP benefits to electricity.

F. Benefit Distribution Method (VC+FC)

5.25 The benefit distribution method is a relatively new method having been developed at the beginning of the 1990s. In this method, the fuels used in CHP production are allocated to electricity and heat in the proportion of fuel consumption for the alternative energy supply forms. The alternatives used are condensing power production and heat-only boilers with the same fuel and energy output capacities as the CHP plant. The fuel consumption of the alternative forms of energy supply, $F_e^{'}$ for electricity and $F_h^{'}$ for heat, can be calculated according to the equations below.

$$F_e^{'} = \frac{E}{\eta_e}$$

$$F_h^{'} = \frac{H}{\eta_h}$$

where E is the electricity production in the CHP plant, η_e is the efficiency of the alternative form of electricity production (condensing power), H is the heat production in the CHP plant, and η_h is the efficiency of the alternative form of heat production (heat-only boiler).

5.26 The fuel consumption in the CHP plant F is divided between electricity and heat in accordance with the ratio of the fuel consumption of the alternative electricity and heat supply forms $F_e^{'}$ and $F_h^{'}$ as follows:

$$F_e = \frac{F_e'}{F_e' + F_h'} * F$$

$$F_h = \frac{F_h'}{F_e' + F_h'} * F$$

5.27 The variable costs are allocated to electricity and heat by using the same ratio which is used above for allocating fuel consumption for heat and electricity. Correspondingly, the fixed costs can be allocated in relation to the fixed costs of alternative energy supply forms.

5.28 The separate production of condensing power and its fuel consumption is subtracted before utilizing this allocation method in the case where the CHP plant can operate also partly in condensing mode.

5.29 By using the benefit distribution method, the benefits of CHP production are divided between both electricity and heat. Thus, both products receive some benefit from the cogeneration process as compared with the corresponding separate production. One advantage of this method is that it is relatively easy to use.

G. Capacity Sharing Method (FC)

5.30 In the capacity sharing method, the CHP plant's fixed costs are allocated to electricity and heat in relation to their share of the boiler capacity. If the annual hours of utilizing the CHP plant at peak load ("peak load hours") are equal for electricity and heat production, the method gives same results as the energy method used for allocation of variable costs, i.e., the shares of electricity and heat in boiler capacity are then equal to their shares on energy production.

H. Comparison of Different Cost Allocation Methodologies

5.31 Different cost allocation methods for allocating variable costs can be compared by making a simple calculation example for two typical types of CHP plants operating in Europe, i.e., a combined-cycle gas turbine (CCGT) CHP plant and a coal-fired CHP plant. The calculations are based on input data for typical size CHP plants presented in Table 5.1 below and are included in Annex 7.

Table 5.1: Input Data for Allocation of Variable Costs of Two Examples of CHP Plants

		Natural gas (CCGT)	Coal
P_e	Electricity output, MW	120	60
Q_{th}	Thermal output, MW	120	120
η	Efficiency	90%	88%
α	Power-to-heat ratio	1.0	0.5
Q_F	Fuel input, MW	267	205
t_{pl}	Peak load hours, h/a	5,000	5,000
E	Electricity generation, GWh	600	300
H	Heat generation, GWh	600	600
F	Fuel consumption, GWh	1,333	1,023
η_H	Efficiency of separate heat production	92%	90%
η_E	Efficiency of condensing power production	56%	39%

5.32 In the following Figures 5.1 and 5.2, the variable costs for electricity and heat are presented according to the various cost allocation methodologies for the two example CHP plants.

Figure 5.1: Comparison of Different Methods for Allocating Variable Costs, CCGT Plant

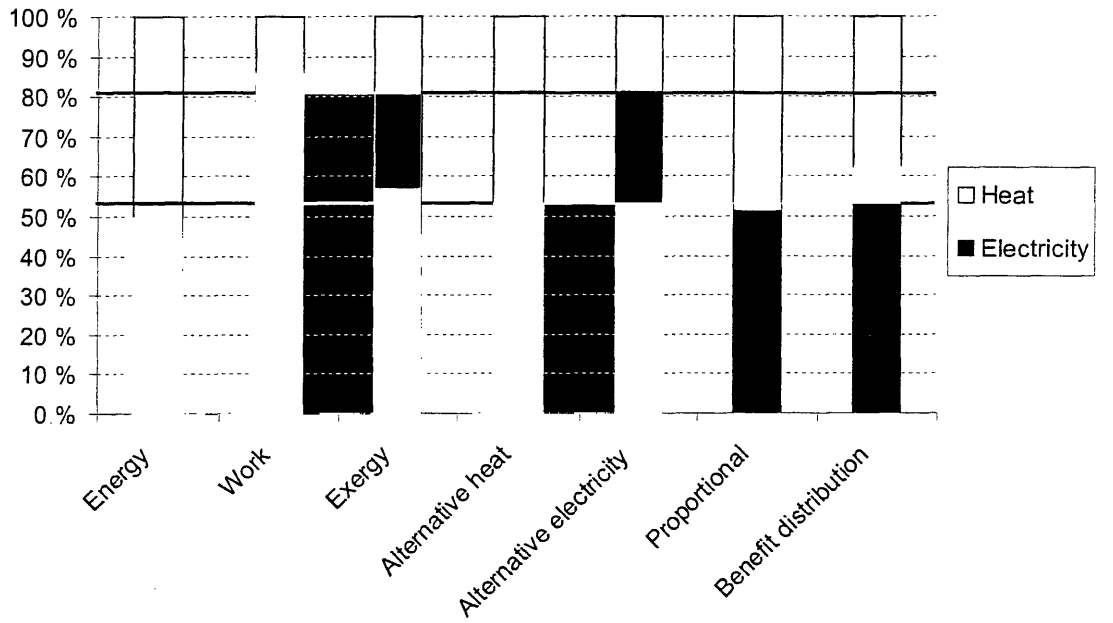
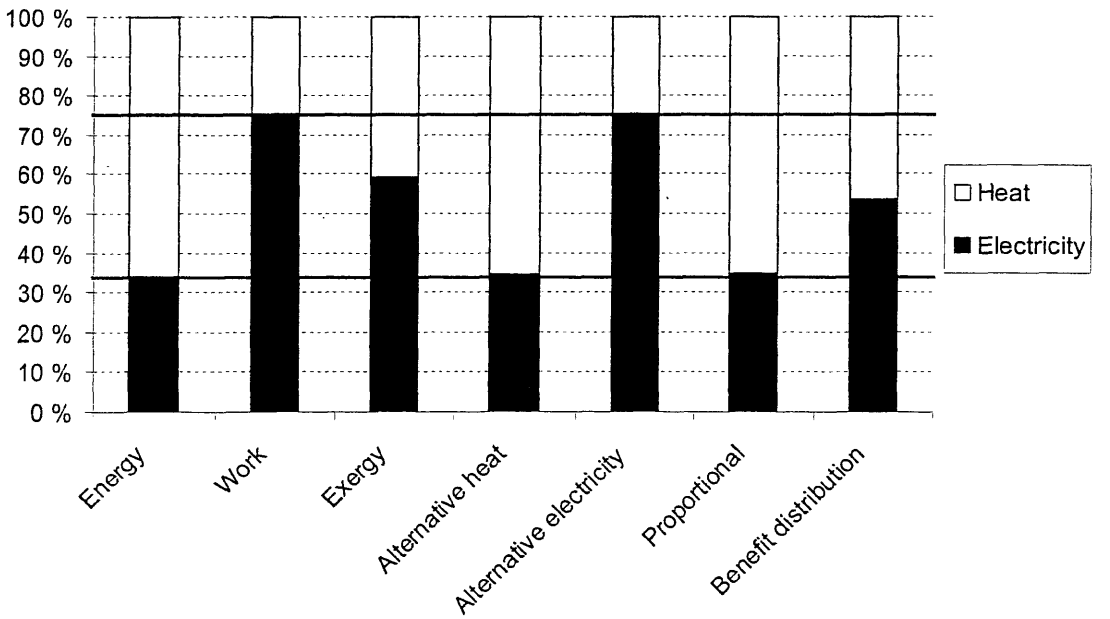


Figure 5.2: Comparison of Different Methods for Allocating Variable Costs, Coal-Fired Plant



5.33 As shown by the horizontal lines in the two figures above, the method of the alternative way of electricity supply, which allocates all the benefits of CHP production to heat, and the method of the alternative way of heat supply, which allocates all the benefits of CHP production to electricity, define the upper and lower boundaries for benefit sharing. The cost allocation methods which fall between the horizontal lines are practicable for cost allocation of CHP, because there is no cross-subsidy of the different products. The exergy method and the benefit distribution method share the benefits with both products. The proportional method is similar in its results to the alternative way of heat supply. However, the work method and the energy method allocate even more costs to one product than would be the case under separate production of the products, which would be considered as cross-subsidization.

5.34 A number of methods are not recommended to be used for variable cost allocation. These include: (a) the work method and the method of alternative way of electricity supply, because they allocate all the benefits from cogeneration to heat, which leads to high CHP electricity prices that are not likely to be competitive in the electricity market; (b) the energy method and the proportional method, because in some CHP plant types they cross-subsidize CHP electricity resulting in a higher cost for CHP heat than the cost of heat-only boilers; and (c) the exergy method, because of its complexity. This leaves the following methods as practicable for allocating variable costs: (d) the method of the alternative way of heat supply because a heat-only boiler is the alternative way of heat supply in all markets; and (e) the benefit distribution method, because it results in the sharing of CHP benefits with both heat and electricity products.

5.35 The methods for fixed cost allocation have not been compared for typical CHP plants in a similar way as for variable cost allocation. The main fixed cost, the annual investment cost, of the different types of CHP plants varies considerably among countries and types of plants, as do the fixed labor costs. Thus, a presentation of the comparison of the percentages of fixed costs allocated to heat and electricity may be misleading. The variable cost allocation method generally determines which fixed cost allocation method is utilized, as explained below.

5.36 Table 5.3 below shows the typical combinations of fixed cost allocation methods with variable cost allocation methods. Most often, fixed costs are allocated to heat and electricity by using the method of the alternative way of energy (electricity/heat) supply or the benefit distribution method. Typically, the capacity sharing method is used with thermodynamic cost allocation methods of variable costs. Other combinations are possible as long as they avoid cross-subsidies.

Table 5.3: Typical Combinations of Variable and Fixed Cost Allocation Methods

	Fixed costs		
Variable costs	Alternative way of energy supply	Benefit distribution method	Capacity sharing method
Energy method			X
Work method			X
Exergy method			X
Alternative way of energy supply	X		
Proportional method	X		X
Benefit distribution method		X	

VI. Recommendations for Applications of Cost Allocation Methodologies

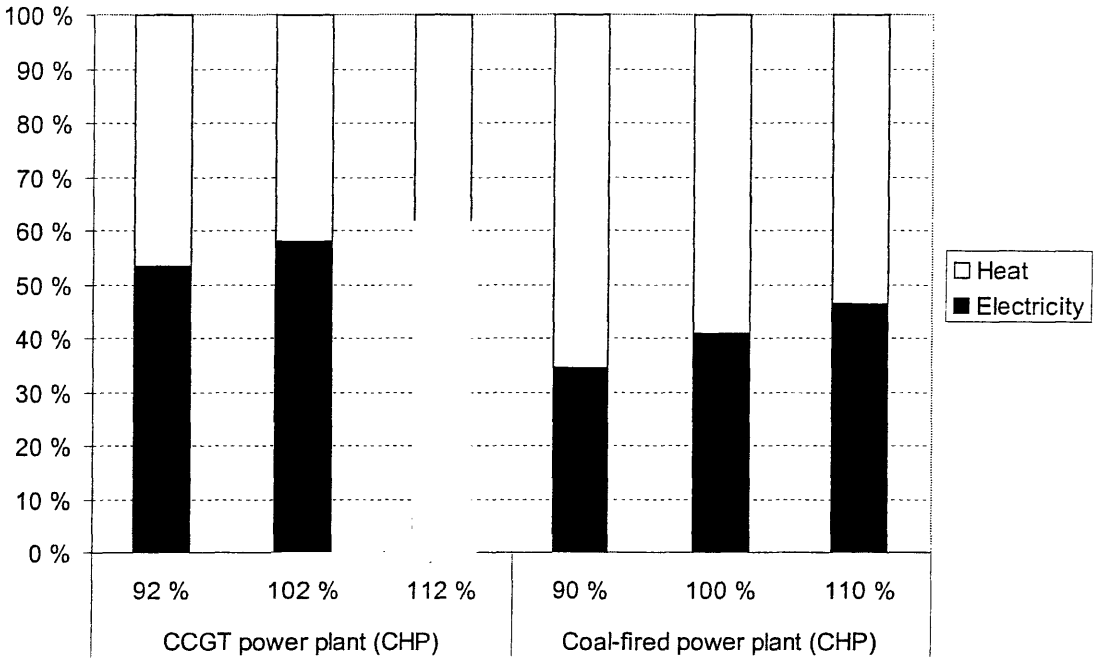
B. For Markets in Transition

6.1 For the EU Candidate Countries and the FSU Countries which have markets in transition and where gas prices are often distorted with lower prices for small consumers than prices for large consumers such as CHP plants and DH systems, a key driver in determining the more appropriate cost allocation methodology is the need to ensure the competitiveness of DH as compared to other heating alternatives (especially gas-fired building boilers). The selected methodology must also ensure that electricity costs are lower than in separate electricity generation.

6.2 The following methods can be considered suitable for markets in transition: (a) the method of the alternative way of heat supply (VC+FC); and (b) the benefit distribution method (VC+FC). In the allocation of variable costs, the method of the alternative way of heat supply allocates all the benefits of the cogeneration process to electricity whereas the benefit distribution method shares the benefits between the two products.

6.3 In transition markets, as mentioned above, cross-subsidies between consumer groups are common in the structure of gas prices and also in DH and electricity prices. The objective of most countries in transition is to gradually reduce the cross-subsidies. Some CHP cost allocation methods, which are theoretically correct under normal market conditions, can be modified to take account of distortions in the market by adjusting the prices of CHP heat and CHP electricity as cross-subsidies are decreased. In many cases, cost allocation methods in use today are already being modified. A systematic approach can be achieved, for example, by modifying the cost allocation method of the alternative way of heat supply by utilizing a higher efficiency factor than the actual efficiency for the calculation of the alternative heat supply, which is gradually decreased as cross-subsidies are phased out. The efficiency factor can be adjusted to even exceed 100%. This is illustrated in Figure 6.1 below.

Figure 6.1: The Method of Alternative Way of Heat Supply with Varying Alternative Heat Efficiencies



6.4 The efficiency factor of alternative heat is varied in Figure 5.1 above for a CCGT CHP plant from an actual efficiency of 92% to 112% and for a coal-fired CHP plant from an actual efficiency of 90% to 110%. When an efficiency factor of 112% is chosen for the alternative heat supply of CCGT, the share of variable costs for heat is about 38% (with electricity at about 62%) of total variable costs. When the efficiency factor for the alternative heat supply decreases to a value of 102%, the share of variable costs for heat increases to about 42% (with electricity at about 58%). When the actual efficiency for the alternative heat supply of 92% is utilized, the share of variable costs for heat increases to 47% (with electricity at about 53%). In so doing, it is possible to allocate a larger share of the variable costs to electricity so that CHP and DH prices can better compete with the alternative of gas-fired individual building boilers until gas prices are rationalized. Thus, the modified cost allocation method of the alternative way of heat supply can provide flexibility in the transition market. However, it must be kept in mind that when adjusting the alternative heat efficiency factors, the competitiveness of CHP electricity must also be taken into account.

6.5 The benefit distribution method is also suitable for markets in transition, because alternative heat and power supply methods can be defined. The benefit distribution method is fair in that it allocates benefits of the cogeneration process to both heat and power. However, it does not allow flexibility in cost allocation when CHP heat is facing unfair competition from other heating alternatives such as gas-fired building boilers. Flexibility is limited by the fact that both electricity and heat have an alternative that already exists in the market. This limits the flexibility compared to the modified alternative heat supply method in which the efficiency factor for heat modifies the share of costs allocated to electricity.

B. For Liberalized Markets

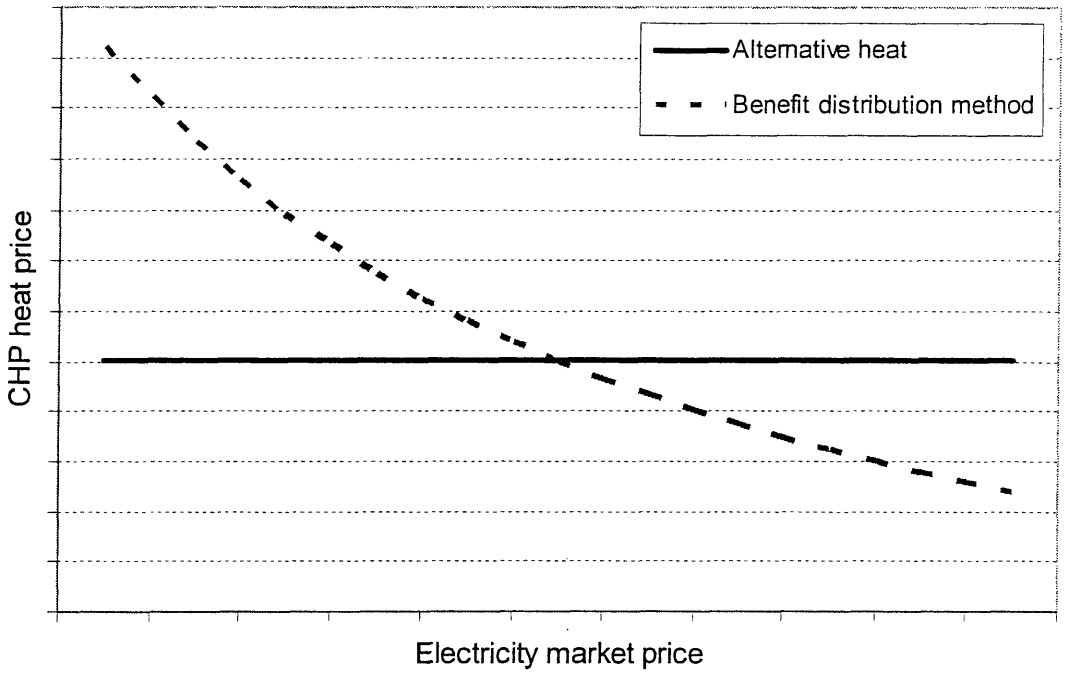
6.6 In the EU Member States which have liberalized markets, electricity is produced for a competitive electricity market and heat is produced for a monopoly market or to a market which is in a dominant position. There are several risks in the electricity market, of which the most significant is the risk that prices will vary substantially in the market from year to year. For example, in the Nordic electricity market, the yearly average electricity price has varied between 13-27 €/MWh during 2000-2002. When markets are opened to competition, there is generally a requirement for a publicly available price index to illustrate the market price level. This price indication can be published by the power exchange, as is the case in the Nordic market, or it can be an obligation under bilateral over-the-counter contracts to provide such price information, as is the case in Germany. When customers have freedom of choice and the public price reference exists, the contracts for power sales and purchase tend to follow this reference. Power producers can and should hedge their power production with financial contracts or by making long-term bilateral contracts. Thus, it is possible to reduce the effect of the market price variations based on the chosen risk policy.

6.7 CHP plants operate both in a competitive electricity market and in a monopolistic heat market, and these facts should be considered when applying cost allocation methods. The following methods are considered and discussed below for liberalized markets: (a) the method of the alternative way of heat supply (VC+FC); and (b) the benefit distribution method (VC+FC).

6.8 In the method of cost allocation based on the alternative way of heat supply (FC+VC), all the benefits of the cogeneration process, but also all the risks of the electricity market, are allocated to CHP electricity. It is usually desirable to allocate some of the benefits also to heat, which is possible by using a higher efficiency factor when computing the alternative heat production as presented previously in Figure 6.1 above. In this case, CHP heat is thus allocated some benefits but the CHP heat production cost is not affected by the risks in electricity market.

6.9 The benefit distribution method (VC+FC) is, in principle, also theoretically applicable in liberalized markets. A key problem with the benefit distribution method in liberalized markets, however, is in defining the alternative way of electricity supply and its price. If the alternative way of electricity supply is defined to be the electricity market price, then the CHP heat price will be sensitive to the electricity market price. This is illustrated in Figure 6.2 below.

Figure 6.2: CHP Heat Price (VC+FC) as a Function of Electricity Market Price Which is Assumed to be the Alternative Price for CHP Power



6.10 As illustrated in Figure 6.2 above, if the method of the alternative way of heat supply is used, the CHP heat price is stable and does not depend on, or is influenced by, the electricity market price. On the other hand, if the benefit distribution method is used where the alternative power price is defined to be the electricity market price, the CHP heat price will vary. In this case, if the electricity market price is very low, the CHP heat price will be quite high, and even higher than the alternative heat price. When an electricity market is liberalized, it is usual for electricity prices to decrease due to overcapacity and competition, which would cause CHP heat prices to increase to high levels. Under these circumstances, use of the benefit distribution method would result in unfair CHP heat prices. Characteristic of the benefit distribution method is also non-linearity, i.e., with a low electricity market price, the CHP heat price increases rapidly, but with a high electricity market price, the CHP heat price does not decrease at same pace.

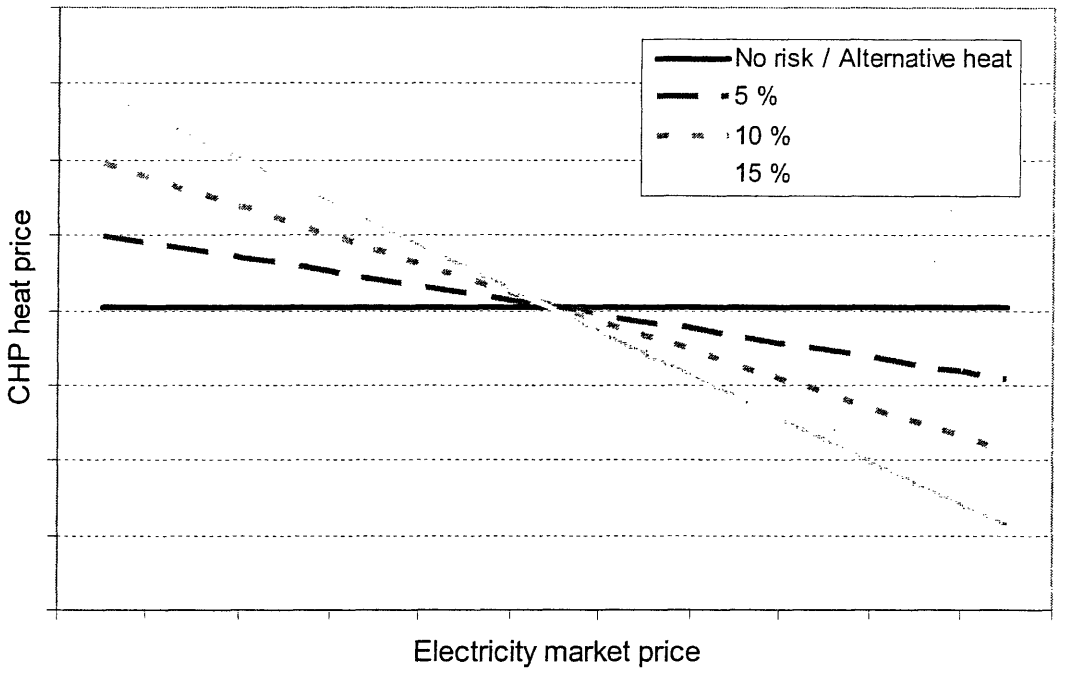
Benefit and Risk Sharing Method

6.11 To take into account not only the benefits but also the risks for CHP in liberalized electricity markets, a new cost allocation method has been developed recently.[28] The method is called the benefit and risk sharing method. In the benefit and risk sharing method, the total costs of the alternative way of heat supply are defined similarly as in the alternative heat supply method. Then, a benefit and risk that CHP heat is willing to take is defined, based on CHP total production cost. Benefit and risk is defined as a percentage of CHP electricity production costs which are allocated to heat. After revenues are received from the sale of electricity, then the same percentage of CHP electricity sales revenue is allocated to heat. The defined benefit/risk percentage remains unchanged.

[28] By an energy consulting firm, Electrowatt-Ekono in its Finnish office, Electrowatt-Ekono Oy.

6.12 Cost allocation according to the benefit and risk sharing method is depicted in Figure 6.3 below.

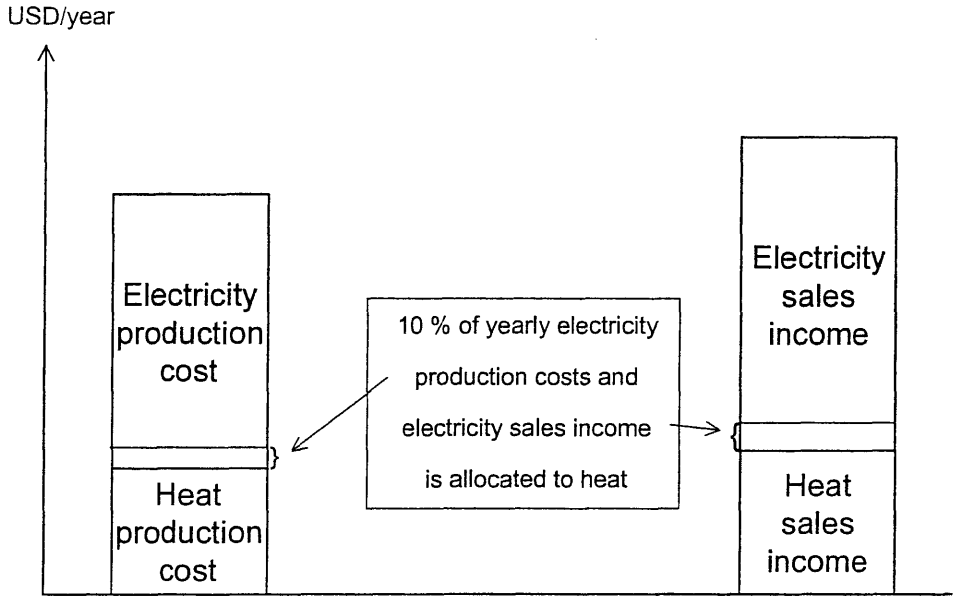
Figure 6.3: CHP Cost Allocation by Benefit and Risk Sharing Method



6.13 In the case that CHP heat is not taking any risk of the electricity market, CHP heat price is the same as is the heat price of alternative heat supply regardless of the electricity market price. If heat is allocated risk and benefit, the risk and benefit curve is a linear function of the electricity market price. The more benefit and risk that is allocated to heat, the more CHP heat prices are varying as a function of the electricity market price. However, the variation is controlled, and even high electricity market variation causes only a modest effect on the CHP heat price.

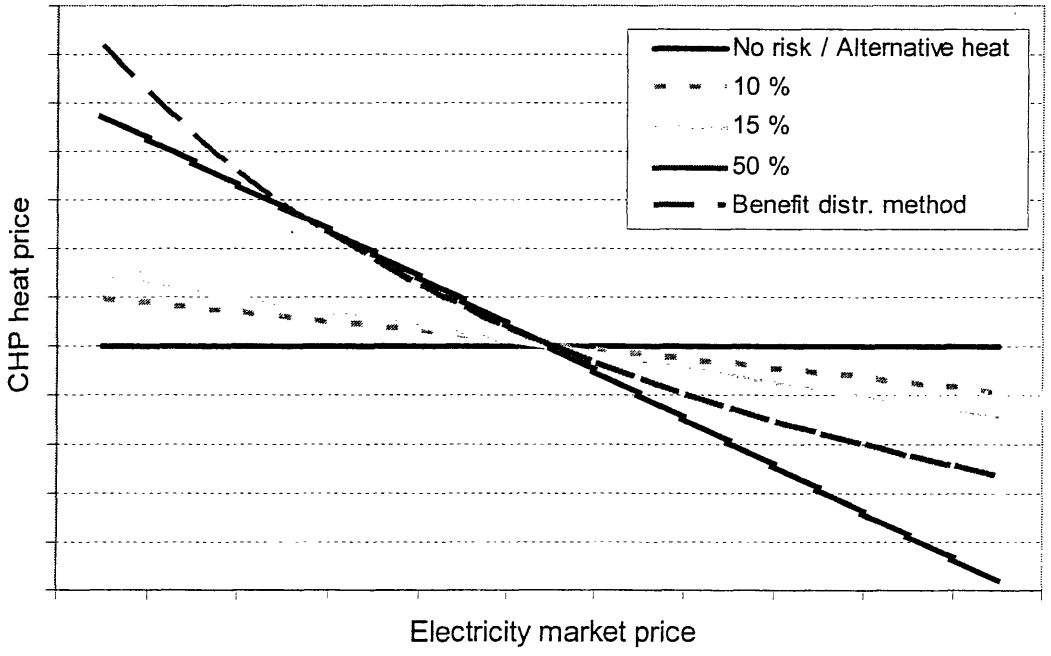
6.14 Benefit and risk sharing method in practice is described in the following Figure 6.4. On a yearly basis, CHP costs are first allocated to heat and electricity. Heat is allocated costs according to the alternative heat supply method. Based on the benefit and risk percentage for heat (e.g., 10%) which has been defined, the defined percentage of yearly electricity production costs is allocated to heat. Respectively, the same percentage of electricity sales income (10%) is also allocated to heat on a yearly basis. The benefit and risk percentage to heat has to be defined over the long term to be a constant percentage – at least ten years period is recommended.

Figure 6.4: CHP Cost Allocation by Benefit and Risk Sharing Method on a Yearly Basis



6.15 The benefit and risk sharing method has been compared to the benefit distribution method in the following Figure 6.5. The benefit distribution method corresponds best to about the 50% benefit and risk percentage, which can be considered to be a high percentage. The non-linear feature of the benefit distribution method is disadvantageous to CHP heat in extreme electricity market situations, such as when electricity prices are very low under liberalized markets.

Figure 6.5: Benefit and Risk Sharing Method Compared to Benefit Distribution Method



6.16 As a conclusion, the method of the alternative way of heat supply (VC+FC) and the benefit and risk sharing method (VC+FC), with a modest percentage for benefit and risk for CHP heat, are recommended for use in liberalized markets, but the benefit distribution method is not. The method of the alternative way of heat supply can use either the actual heat efficiency for alternative heat or a slightly higher heat efficiency for alternative heat. The benefit and risk sharing method can also use a higher efficiency factor for alternative heat to allocate some benefit of CHP production to heat without the risks of the electricity market.

VII. Regulatory Framework for CHP

A. Introduction

7.1 Regulation of the electricity supply industry is changing in response to market liberalization. Many new regulatory bodies have been established in recent years and more are planned.

7.2 There are no common rules or guidelines for the regulation of heat and electricity produced in CHP plants. CHP heat and electricity are typically regulated by independent regulators or heat may not be regulated at all. In some of the countries, regulation of both products has been brought under the responsibility of a single regulator. DH plays an important role in CHP generation, and therefore it is typically reviewed along with CHP in national regulations.

7.3 The role of the CHP has historically been greatest in the areas with cold climates and in the Central and Eastern European countries, and therefore the regulatory framework for CHP is usually quite detailed. In many of the EU countries, the role of CHP has been smaller and thus many of these countries lack specific regulations for CHP. The regulatory framework for CHP for EU Member States, EU Candidate Countries and FSU Countries is described below for the situation prevailing today. The rules and regulations in many of these countries, however, are changing at a rapid pace.

B. EU Member States

7.4 In all EU Member States, liberalization of electricity markets has either been initiated or fully realized. All the EU Member States (except Germany) have established an electricity sector regulator to monitor whether competitive market conditions are being achieved and to regulate monopoly operations.

7.5 The situation in the heat markets of the Member States varies a lot among the countries. DH is in some countries (such as Denmark) viewed as a natural monopoly in its service areas having reached a dominant market position as a consequence of its development, with strict regulations on pricing. In most of the EU Member States, however, DH is viewed as operating in a competitive market with other heating forms such as electric heating, individual gas boilers or building boilers utilizing light fuel oil or even biofuels. In these cases, DH is not subject to regulation by regulatory authorities, as it is judged to be regulated by the market where the alternative heating method has created the upper limit for DH prices. Regulated tariffs exist if a consumer connection to a DH network has been made compulsory, as is the case in Denmark and France. Questions relating to restraints of competition are usually dealt by the national competition authority.

7.6 There a only few regulations concerning the cost allocation of electricity and heat in CHP plants in EU Member States. The main regulation is contained in the EU Electricity Directive which calls for unbundling of generation, transmission and distribution accounts in order to prevent discrimination, cross-subsidization and distortion of competition. If energy utilities conduct business in other, non-electricity sectors, such business activities also must be accounted for separately.

7.7 EU legislation forbids cross-subsidization, but it does not provide instructions as to how to allocate the costs of CHP to ensure that cross-subsidization does not take place between heat and electricity. As a result, there are almost as many cost allocation methodologies used inside the EU as there are companies. However, some countries, such as Denmark, have developed guidelines as to how to allocate the costs of CHP between heat and electricity. The most common cost allocation methods used inside the EU are the alternative energy supply methods and versions of the benefit distribution method.

7.8 Deregulation of electricity markets is having an impact on cogeneration. Own production capacity, which initially was strategically important for the electric utilities, has become more risky. For example, in some European countries such as Germany and Denmark, energy sector deregulation has resulted in stranded electricity generation assets, including CHPs. In the past, there was a tendency to overextend DH systems due to the practice of allocating benefits from CHP in the opposite way as in Eastern Europe, i.e., by allocating all the benefits to heat. This made heat artificially cheap and, conversely, electricity from CHP artificially expensive.

7.9 The regulatory framework for CHP is described for the individual EU Member States in Annex 4.

C. EU Candidate Countries

7.10 Electricity markets are being liberalized in all Candidate Countries, whereby specific regulations are being developed and independent regulators are being established to monitor the electricity sector.

7.11 Regulation of DH in most of the Candidate Countries is typically under the jurisdiction of the municipalities, and regulation of electricity from CHP plants is typically under the jurisdiction of state authorities or the electricity regulator. DH has traditionally been viewed as a "natural monopoly," as it has been in many other parts of the world, and has been brought under the same kind of regulatory control as other utilities. Regulation usually attempts to establish prices for heat on a "cost plus" basis, and the concept of pricing of heat based on its market value is still a novel idea. Oftentimes, municipalities do not allow tariffs to fully cover the costs of DH supply.

7.12 During the transition period to market economies, DH has been affected by the gradual liberalization of both electricity and fuel prices as well as by the privatization of heat sources and DH networks. Regulated DH systems in EU Candidate Countries are often facing unfair competition from gas-fired building boilers because the structure of gas prices often includes cross-subsidies of small consumers by large consumers. In some cases, DH systems have been overextended, are in very poor technical condition and heat load densities are too low to justify continuation of these heating systems.

7.13 Many DH and CHP utilities in the Candidate Countries show poor financial performance, largely due to the establishment of heat prices which do not fully reflect the actual costs of supply and which include cross-subsidies between consumer groups. In several countries, heat prices are planned to be gradually increased and adjusted to cover actual production, transmission and distribution costs, and cross-subsidies are planned to be eliminated. In some countries (e.g. Czech Republic), it has been suggested in the future to include environmental costs into the heat prices through the introduction of environmental taxes.

7.14 Most of the EU Candidate Countries are seeking to modernize their existing DH systems. This would result in a reduction of heat losses and a better quality of service as well as a decrease in average heat demand in buildings. Such investments would in turn lead to a reduction of operating costs and thus to an improvement in the profitability of DH companies.

7.15 The settlement of clear pricing principles for heat and electricity from CHP plants and establishment of rational CHP electricity purchase procedures are of crucial importance for the profitability of heat production in CHP plants and will have a significant influence on the development of DH systems. Currently, there are various methods used to allocate costs to heat and electricity in CHP plants, i.e., alternative energy supply methods, energy method and proportional method . In some countries (e.g., Bulgaria, Hungary, Latvia and Romania), there are specific regulations on the allocation of costs, while in other countries, the specific regulations are on their way (e.g., Czech Republic). In some countries (e.g., Lithuania, Slovakia), several methods can be used.

7.16 The regulatory framework for CHP is described for the individual EU Candidate Countries in Annex 5.

D. FSU Countries

7.17 CHP is widely developed in FSU countries for industrial and DH systems. While there has been some deregulation of electricity markets, the DH sector is still regulated by either an independent regulator or local authorities. Generally, heat tariffs do not fully cover the full costs of heat supply and the heat tariff structures usually involve cross-subsidies of residential customers by industrial and commercial customers.

7.18 The current situation of CHP plants in the markets is difficult. Heat consumption by industries has decreased due to the decreased production resulting from the general economic downturn, and heat usage by households and public facilities has decreased because of limited ability to pay. CHP plants may be unprofitable and suffer from competition from other heating sources which are suppling heat at lower prices. The pricing and cost allocation of CHP plants is, in some cases, strictly regulated leaving little possibilities for the utilities to manage the pricing of heat and electricity in the two market situations.

7.19 The allocation of costs in the joint production of heat and electricity in CHP plants in FSU countries has generally been carried out according to administrative principles which allocate the benefits of the joint production to electricity rather than attempting to share the benefits with the two products. This has arisen primarily because of the stronger position of the power sector than the heating sector in these countries. The energy method (also known as the physical method) and proportional method are normally used for cost allocation in CHP plants. This has resulted in prices for heat from the CHP plants to be at the same level as heat produced in heat-only boilers or even higher. The deficiencies of these pricing methods are being recognized in a number of countries in this region, especially as consumers now have other alternatives to DH. As a result, the allocation of costs is starting to be made in favor of heat during the past few years in some areas. Changes to the allocation of expenses in CHP plants have been introduced in a number of places, such as Kiev, Ukraine.

7.20 The regulatory framework for CHP is described for the individual FSU Countries in Annex 6.

E. Social Impacts of CHP Pricing

Affordability of DH

7.21 CHP heat is typically utilized by DH systems where affordability of DH by households remains difficult today in many countries in Eastern and Central Europe and the FSU, but affordability of DH by poor households[29] remains particularly difficult. While the situation has improved since the early 1990's, nevertheless by 1996, in such countries as Russia, Estonia, Lithuania and Ukraine, the cost of heat and hot water supply for a typical apartment still represented a rather high level of about 20-40% of the disposable income of an average household. The share of household income devoted to heat and hot water services by poor households was even higher. Often households in the bottom per capita expenditure quintile spend 4-5 times the share of expenditures that households in the top quintile spend for DH and hot water, as has been shown in more recent surveys in Latvia and Ukraine. These figures can be compared with the figure of no more than 8% of average household expenditures which telecommunications, water and domestic energy represent in EU countries.[30] Expenditures for heat and hot water represent still today, in many cases, the largest single expenditure in household budgets or the next highest expenditure after food in the countries of Eastern and Central Europe and the FSU. Expenditures for electricity, on the other hand, represent a much smaller share of household expenditures, typically in the range of about 5% or less for an average household.

7.22 Poor households, i.e., those households in the bottom expenditure quintile, use most of their expenditures for food, housing, and utility services. By contrast, households in the top quintiles are able to use a much larger share of their expenditures for goods and services that are neither food items nor expenditures for housing and utilities. For very poor households, non-food expenditures tend to shrink to expenditures for housing and utilities only. In extreme cases, the poorest of the poor may have to reduce their expenditures for food in order to be able to pay charges for housing and utilities. Alternatively, they may fail to pay for housing and utilities and become indebted to house owners, utility companies or municipal housing maintenance organizations.

7.23 Although DH tariffs have stabilized in those countries in transition which have passed on the price increases of energy inputs and have adopted policies of full cost recovery, DH tariffs still represent a burden on household budgets and an even larger burden on household budgets of the poor. In other countries, such as Russia, where cost recovery will only be gradually introduced over a number of years, the burden of DH tariffs on household budgets will continue to grow. Thus, lowering the costs of supply of DH and hot water services in order to improve their affordability is a major political issue and one of the highest priorities of local governments, the main owners of DH systems and the main providers of subsidies for households utilizing communal services, such as DH.

Impacts of DH on the Poor

7.24 The high cost of imported fuels for DH systems has led to a situation in many countries of Eastern and Central Europe and the FSU whereby heat and hot water services are being rationed, due to the poor affordability and non-payments problems which in turn do not allow utilities to purchase the necessary fuel for heat production. In countries with DH cities where the

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[29] Defined as the 20-25% of households with the lowest per capita expenditures.

[30] Joint UNDP and ESMAP. Increasing the Efficiency of Heating Systems in Central and Eastern Europe and the Former Soviet Union, August 2000.

ambient temperature drops to –10°C or more, heating is a basic necessity of life as is food. The poor households suffer disproportionately from deficient heating and hot water service, as they have practically no margin for coping with the insufficient provision of these essential services. Higher income households are able to supplement DH with individual space heaters and by making improvements in windows and insulation, which the poor cannot afford. The deficient heating and hot water services are a contributing factor to the poor having generally higher sickness rates and lower productivity.

7.25 To protect poor and vulnerable households against hardships in cold winters, a reliable and affordable provision of DH, or alternative heating, and hot water at satisfactory levels of quality is needed. Reducing heating costs for households is an important factor in ensuring adequate access, especially by the poor, to this basic energy service, by improving its affordability and thus the ability of DH utilities to secure necessary fuel supplies for sufficient service levels. Introduction of metering and consumption-based billing together with consumer control would help poor households to lower their bills. The current limited affordability of DH in some countries, such as Armenia, for example, has led to a policy of reverting back to traditional fuels for heat and abandoning DH.

Implications for CHP Pricing

7.26 In countries in transition, the cost allocation method adopted in the regulation of heat and electricity prices from CHP plants can have a significant impact on the affordability of DH and improving access of this essential service by the poor. DH systems are predominantly an urban phenomenon connected with high population density, and CHP plants, serving DH systems, are usually located in the larger cities of Eastern and Central Europe and the FSU. In cities where CHP plants provide a substantial share of heat to DH systems, sharing the benefits of the cogeneration process, rather than pricing heat at the same price as in heat-only boilers, can significantly lower the price of heat to consumers. This has been shown in cities such as Kyiv, Ukraine, where a revision of the cost allocation methodology in 1998 to share the cogeneration benefits resulted in a reduction of the heating tariffs to consumers by around 25-30%.

7.27 Sharing cogeneration benefits with heat consumers is facilitated if the CHP plant is under the same ownership as the DH system. However, sharing cogeneration benefits can be achieved when CHP plants are under different ownership than DH systems if the regulators require more appropriate cost allocation methodologies to be adopted.

7.28 Any possible increases in the price of CHP electricity as a result of a change in the cost allocation methodology to allow a sharing of cogeneration benefits with heat will, in many countries, have only a small or negligible impact on the electricity prices to consumers. This is true in cases where CHP plants feed their electricity into the national grid and provide a small share of total electricity. In other cases where CHP plants serve electricity consumers in their local service area, the electricity price increases resulting from a sharing of cogeneration benefits with heat would be justified if it better allows DH to compete more fairly with gas or other alternative heating options and thus helps to secure the heat load for CHP plants. Under these circumstances, electricity tariffs are still likely to be lower than electricity tariffs of consumers served by the national grid elsewhere in the country since they exclude the costs of the use of the national transmission system. In cases where CHP plants feed their electricity into the national grid and provide a more substantial share of total electricity, increases in the price of CHP electricity as a result of lowering the price of CHP heat may also be justified if this helps to secure the heat load for CHP plants. This justification is based on the national and global benefits

derived from CHP plants, i.e., the reduction of energy imports or fuel usage and significant reduction of environmental emissions.

7.29 Changes in heat or electricity tariffs as a result of a change in the cost allocation methodology will have various impacts on the consumption of heat and electricity by the residential consumer groups. If DH tariffs are adjusted to levels that are below the tariffs of competing heating alternatives, all residential income groups are more likely to stay connected to DH. However, if DH tariffs are not adjusted to levels that are lower than the tariffs of competing heating alternatives, high income residential consumers are likely to disconnect from DH, as has been observed in various locations in the Baltic states, Hungary and Romania. This would leave the poor and middle-income consumers, who do not have the means to invest in other heating alternatives, to carry a larger share of the fixed costs of the DH and CHP systems, resulting in even higher DH tariffs. If electricity tariffs increase as a result of lowering DH tariffs, households can reduce their consumption of electricity more easily than consumption of heat, because heat is a necessity of life in countries with cold climates and heat intake cannot generally be regulated at the building level. Higher electricity tariffs do not necessarily result in higher utility bills because price increases tend to encourage conservation in electricity usage.

7.30 It is important that adequate social protection be available for low-income households and vulnerable groups to mitigate the impacts of possible increases of electricity or DH tariffs that may arise as a result of a change in cost allocation methodologies. In many Eastern European and FSU countries, social protection is provided for low-income households in order to mitigate adverse social impacts from increasing prices for DH and hot water services as well as housing and other utility services, including, electricity, gas, cold water, housing maintenance and garbage removal. Some countries also utilize lifeline tariffs for electricity to ensure that households utilizing only low levels of this service, such as poor households, would have lower expenditures.

F. General Conclusions

7.31 If the price of a product, such as heat or electricity, is determined in the market based upon the agreement of the parties involved in the transaction and resulting from the interaction of supply and demand, the price is considered to be a market price reflecting the existing price level. However, subsidies and fixed tariffs for the products may change the situation. There are also areas of economic activity in which market imperfections exist, such as natural monopolies. In such cases, the market may fail to yield efficient pricing solutions, and intervention by a third party, such as an independent regulatory body, may be required to establish principles that lead to efficient and competitive outcomes.

7.32 The liberalization status of the markets has a major impact on the required level of regulation in order to create functioning markets for energy products and especially for CHP. In countries where the electricity and gas markets have been liberalized and where a countrywide natural gas network exists, there is only a limited need for regulation. In such markets, CHP plants using gas are free to choose their gas supplier, and network charges for gas transport should be at an appropriate level as a result of network tariff regulation.

7.33 When considering the pricing of heat generated in CHP plants for DH systems, such heat has to be competitive with other heating forms in order to attract consumers. If the gas network is extensive, customers have a good price reference for DH from the price of natural gas heating options. Alternatively, a reference price can be found in other building-level fuel or electrical heating. However, the connection costs to the DH network are usually quite high, and after a

customer has been connected, he will not likely pay for the investments needed to change to another heating alternative. This is especially true in countries lacking an extensive gas distribution network (e.g. Finland and Sweden) where the costs of changing from DH to, for example, electric heating can be significant and prevent real competition. In liberalized and functioning markets, cost-reflective price levels will be created for both power and heat by a CHP plant, so CHP utilities (rather than the regulator) should be allowed to determine the cost allocation method, taking into account prices, incomes, demand and other market conditions. However, there may still be a need for limited regulation in cases of consumer complaints and where compulsory connections to the DH network have been introduced in order to protect consumers from unfair pricing practices.

7.34 In markets in transition, more regulatory authority appears to be needed to address existing subsidies and tariff policies which are restraining the introduction of real competition in the electricity and heat markets. A priority is to ensure that cross-subsidies are eliminated so that small-scale customers do not have lower gas tariffs than large-scale customers, such as CHP plants, in order to avoid the loss of DH consumers due to unfair competition with gas. The regulator should also ensure that the benefits from CHP are allocated to both electricity and heat so that both have an opportunity to become profitable in their markets. A harmonization of regulations should also be carried out so that all the regulations concerning the energy sector (electricity, heat, gas) are in line with each other. Separate regulators in different energy sectors should work together to ensure that the competitive position of CHP is not endangered, for example, through the establishment of too low tariffs for CHP heat that would require too high tariffs for CHP electricity, thus threatening the ability of CHP electricity to be sold in the electricity market.

7.35 A key question in markets in transition concerns whether the cost allocation of CHP heat and CHP electricity should be regulated by separate or same regulators. In general, it is recommended that the same regulator be involved in the allocation of costs of these two products. However, in liberalized markets, the heat market is not generally regulated as it must be competitive and is judged to be regulated by the market. It is not recommended that the heat market be regulated more than nowadays. However it is recommended that guidelines for cost allocation of CHP heat and electricity be provided by the regulators in liberalized markets.

7.36 Many CHP and DH systems in Eastern and Central Europe and, in particular, in FSU countries will need new investments in order to remain operational, but central and local governments do not have sufficient funds to redress the huge backlog of maintenance, rehabilitation and reconstruction needs. These public agencies will find it difficult or impossible to attract investors or private capital unless reasonable security can be provided, including guaranteed pricing formulas for heat and power. Regulatory predictability with a sound pricing structure that provides the proper incentives for rehabilitation of existing CHP plants or construction of new ones is expected by all the parties. Regulators should therefore try to make decisions so that they are consistent in the foreseeable future and are made in light of market conditions and expected changes. Regulators should thus specify the selected cost allocation method or the path if gradual changes are envisioned, so that producers and consumers know what to expect. This would greatly help to facilitate the mobilization of private capital needed.

7.37 The choice of the cost allocation method will have an effect on the competitiveness of CHP. For markets in transition, it is important to create a move level playing field for CHP heat and DH as compared to the alternative heat supply if the alternative heat supply is cross-subsidized or competing unfairly. In liberalized markets, the market opening will present a challenge to CHP electricity from low electricity market prices due to overcapacity of generation

and competition. There is no general cost allocation method suitable for all market situations. Adequate flexibility for choosing a cost allocation method should be available for CHP producers to manage the two separate markets of heating and electricity.

7.38 As discussed above, cost allocation is an issue that has not yet been clearly regulated and is under debate now in many countries. The specific nature of CHP brings about the question of how the products, heat and electricity, should be priced so that they can compete in the market. The question of cross-subsidization arises from market liberalization and the demand for fair competition between players. Therefore the body that ensure that competition is existing and fair should provide the rules for the marketplace. Thus, the key recommendations for regulators when considering the pricing of heat and electricity from CHP plants can be summarized as follows:

(a) Regulators should acknowledge that there is a range of CHP benefits which can be allocated either to heat or electricity or shared by both, and sharing of benefits can be undertaken without cross-subsidization;

(b) Regulators need to ensure that the CHP benefits are shared with both electricity and heat so that both products have an opportunity to become profitable and remain competitive in their respective markets;

(c) Regulators may wish to review the cost allocation methods employed currently to consider the future trends in energy price reforms and market liberalization and establish regulations and rules for CHP that fit in with the overall direction of the energy sector;

(d) Regulators should ensure that cross-subsidies in the structure of energy prices, including gas, electricity, heat and other energy forms, be eliminated as soon as possible in order to create a level playing field among competing energy forms;

(e) The separate regulators in the different energy sectors within a country should work together to harmonize all the regulations concerning the energy sector (electricity, gas, heat, other energy forms) so that they are in line with each other;

(f) In order to facilitate the mobilization of private capital needed for rehabilitation and construction of CHP and DH systems, regulators should specify the selected cost allocation method or the path if gradual changes are envisioned, so that lenders, investors, producers and consumers know what to expect in the future;

(g) For energy markets in transition, consideration should be given to establishing the responsibility for the regulation of CHP heat and electricity by the same regulator;

(h) For liberalized energy markets, it is recommended that guidelines for cost allocation of CHP heat and electricity be provided by the regulators but that CHP utilities be allowed to determine the cost allocation method, taking into account prices, incomes, demand and other market conditions; and

(i) As there is not one correct way to allocate the benefits of CHP between heat and electricity that is suitable for all market situations, regulators need to allow adequate flexibility in the choice of cost allocation methods for CHP producers that will allow them to manage the two separate markets of heat and electricity in their particular circumstances.

VIII. Prospects for CHP

A. Opportunities for Increasing the Use of CHP

8.1 The national energy legislation in each EU Member State will continue to follow the corresponding EU legislation and international agreements. The energy policy of individual EU states will concentrate on the energy economy as a whole, different energy sources and forms as well as their mutual shares, without attempting to regulate in detail the construction of separate power plants, as before. In most Western European countries, the energy policy measures will focus on the following: (a) global GHG emissions reduction by, on average, 5% from 1990 levels by the year 2010; (b) promotion of an energy production structure towards one with an energy balance utilizing less coal; (c) promotion of bio-energy; (d) promotion of other renewable energy sources such as wind and solar; (e) flexible and least-cost energy supply; (f) promotion of energy market liberalization; (g) integration of separate national markets; (h) promotion of efficient use of energy and energy savings; (i) promotion of high level energy technology; and (j) security of energy supply and promotion of energy from indigenous sources.

8.2 The political decisions on closing nuclear power plants in some Western European countries, if implemented, will have a significant impact on the demand for new CHP capacity construction in areas where there is adequate heat demand. Closing nuclear power plants will eventually lead to the need to produce the same electricity in other power plants, and therefore it is important that this new generation takes place in plants such as CHPs that comply with the policy goals to produce the minimum amount of CO_2 emissions. In Eastern and Central Europe and the FSU, the possible closing of nuclear power plants would create an even larger potential for CHP plants.

8.3 In line with power market liberalization, as old condensing power plants in Europe are retired, the power plants could partly be replaced by CHPs in areas where adequate heat demand is available. The differences in the development potential of new CHP plants between the countries in Europe are large. In Western Europe, the United Kingdom, Italy, Turkey, Spain and Portugal offer the best potential, while Poland, Hungary and the Czech Republic could lead the development in Central Europe. The liberalized power markets in Finland and Sweden are also likely to result in some new CHP capacity, although the DH market is already largely saturated.

8.4 Environmental aspects are becoming ever more important in making decisions in the energy sector. There is a growing awareness of the impacts of air pollution on health and the risks of climate change. Climate change is feared to have a significantly deteriorating impact on living conditions. The World Health Organization (WHO) has estimated that, on average, every person in Europe loses one year of life due to air pollution. A number of driving factors related to environmental issues will have a significant impact on the market share and development of CHP/DH systems in the future. For one, consumers are becoming more conscious of environmental issues, and environmental arguments are commonly used in marketing in the energy sector. The pressure from different interest groups, such as customers, owners, investors and authorities, has led to companies implementing voluntary programs and supporting management systems in order to improve the level of environmental performance even above legislative requirements.

8.5 The goals for CO_2 emissions will play an increasing role in Western European energy policies and could lead to a larger utilization of CHP to reduce fossil fuel consumption. International agreements, of which possibly the most important is the Kyoto Protocol on Climate

Change, will also have an impact on the future of CHP and DH. Increased use of CHP in connection with DH is one of the main alternatives to increase the efficiency of fuel use and reduce GHG emissions. As a general guideline, in many Western European countries will be the requirement for increased use of natural gas, bio-energy and CHP (using also renewables and biofuels) in order to fulfil their commitments in terms of decreasing GHG emissions stipulated in international agreements.

8.6 In the context of EU's Fifth Environmental Action Programme, the internalization of environmental costs and benefits in the energy sector, by making the polluters pay for the damage they cause, through tax incentives is a key priority for the integration of the environment into other Community policy areas.[31] Significant interest in these principles exists and the practical applications are being discussed in different countries, also outside the EU. However, significant uncertainties, especially regarding the costs involved with climate change, slow down practical implementation. If the internalization of environmental costs are implemented in tax policies, CHP and DH would fare especially well in comparison to other alternatives to heat and electricity production.

8.7 In Western Europe, the future expansion of DH is more likely to shift from existing networks to smaller-scale systems where the distances over which heat is transported are limited. These small systems may involve only a few MW_e in terms of power capacity which might gradually be interconnected as the heat load increases.[32] Recent technical development of small CHP units, which can be sized to meet the thermal load of the building where they are located, may make a new option practical and could support the development of the smaller DH or building-level heating systems. This would eliminate the need for thermal transmission and distribution systems, although auxiliary boilers might be required in some or all buildings. Alternatively, these in-situ sources could be coupled with thermal transmission and distribution systems to provide load balance and control. The technologies making this possible are, for example, new small modular gas engines and microturbines.

8.8 Coal has been the dominant fuel for power plants in Western Europe, but its use has decreased slightly whereas the use of natural gas has increased dramatically as more gas is being used for CHP production. Natural gas is a "cleaner fuel" when compared with other fossil fuels and contributes substantially to the solution of several environmental problems (climate change, local air quality problems, acidification). However, until recently, there have been several factors that have slowed down the growth of gas use. The reasons were mainly political; it was only in 1990 that the EU invalidated the directive that prohibited the use of gas for electricity production and consequently CHP production. The prognoses of three major institutions, the International Energy Agency, the United States' Department of Energy and the EU, on the development of natural gas use are surprisingly similar; the use will increase faster than that of any other fuel, by 2.7% per year. This is a general estimate and is not limited to the use of natural gas for DH and CHP production.

8.9 Further opportunities for increasing the efficiency of existing CHP plants will arise from implementation of a combined cycle, gas-fired process which would increase the power-to-heat ratio, allowing more electricity to be produced without increasing heat production. This technology will be particularly attractive in areas where the market for heat is no longer growing as it will allow for an improvement in the economic viability of the present DH systems.[33]

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[31] European Commission, 1997.
[32] European Commission, 1997.
[33] Carolyn Gochenour, 2001.

8.10 CHP plants using fuels, including wood-based and waste-based fuels, will contribute remarkably to climate change mitigation.

B. CHP Support Mechanisms

8.11 CHP plants can and should exist without support in the medium to long term. This is particularly true for large-scale CHP plants using conventional fuels and existing technology which should allow them to be competitive in the liberalized electricity market. It may also be true for small and micro-scale CHP serving individual buildings, whereby customers buy a CHP system as one package with a "plug-in" feature. Their competitiveness would require the removal of subsidies of competing forms of energy supply, adequate heat loads for CHP plants and optimally dimensioned CHP plants.

8.12 The competitiveness of new CHP plants in the short term depends on the specific market situation. In markets where new electricity capacity is needed and where there is adequate heat load, CHP plants are considered to be most feasible type of new power generation plant, because there are very limited opportunities for new hydro and nuclear power plants and condensing power plants have higher energy production costs. In this case, support measures for CHP are not necessary. Generally in most of the electricity markets in Europe today, however, there exists excess electricity generation capacity. Thus, in the short term, new CHP development is not feasible without support mechanisms. If the targets of the individual countries' energy policies are to increase efficiency, decrease emissions or promote renewables, then it may be desirable to design support mechanisms for CHP.

8.13 In designing programs to promote CHP, countries may not wish to focus on only one policy measure but rather may wish to consider a range of policy measures. Long-term perspectives in policy should be adopted in order to secure the situation of CHP in the markets. The key methods used in Europe today to promote CHP include: (a) regulated tariffs, rather than bid-based tariffs, for CHP electricity fed into the grid; (b) a preferential gas price for cogeneration; (c) fiscal measures; (d) investment subsidies, production support or introducing CHP certificates; and (e) voluntary agreements on energy efficiency.

8.14 With liberalization of the electricity markets, supportive measures should be avoided if they result in unfair competition. Measures such as guaranteed regulated feed-in tariffs and preferential gas prices for CHP should be abolished for this reason. However, there is scope for revision of the system of transmission tariffs or tariffs for access to the grid in the cases where they are unfavorable or unfair for CHP. In the cases where CHP plants are charged with relatively high gas tariffs because of the large share of fixed (capacity) fees which do not consider seasonal variations in gas usage, the fixed fees could be reduced generally by increasing the variable (energy) charges.

8.15 Several additional measures are judged appropriate to promote CHP and to improve its cost-effectiveness. One fiscal measure would be an exemption of CHP either partially or wholly from fuel taxes or environmental taxes, such as carbon and sulphur taxes. In Sweden, for example, fuels used in heat generation in CHP plants are taxed at half the rate of the energy taxes. The EU Directive on Taxation of Energy Products, which is due to enter into force from January 1, 2004, will allow Member States to offer companies tax incentives in return for specific undertakings to reduce emissions.

8.16 One of the options being considered in the Netherlands would be a specific certificate for CHP, similar to the system of green certificates, implying that end-consumers purchasing such a certificate from CHP plants can apply for a reduction of the energy consumption tax.

8.17 Investment subsidies for new CHP plants could also be allowed to a certain extent, since they do not affect the competitive position of the various generation technologies in the electricity market and they could be used to construct capital-intensive adjoining DH networks. One of the obstacles for CHP development has been a lack of investment financing which could be improved by projects where investments are being paid back by the savings in energy and maintenance expenses and by the savings in emissions.

8.18 Also considered appropriate are subsidies to support the project development phase of new CHP plants (e.g. consultancy, pre-feasibility and feasibility studies).

8.19 Experience has shown that energy policies promoting CHP result in increasing CHP capacity and production.

Annex 1

Policies and Methods to Promote CHP in EU Member States

Austria

CHP is a widespread technology in Austria supplying 77% of thermal electricity. A lot of CHP plants are used to supply DH and heat for industrial purposes. Most of the CHP and plants are based on natural gas, but also oil and coal-fired power stations exist. Future development is limited due to the already wide usage of CHP.[34]

Austria relies on a combination of market forces and government actions to achieve a well-balanced energy market for CHP and DH by removing market imperfections. The driving force has been the opportunity to produce heat with or without power, either in CHP plants or heat-only boiler plants, which have been supported through various schemes. CHP and DH projects launched before the end of 1993 have been supported by financial support given in the form of grants in co-operation with the Länder (the state or county). Grants were given for energy saving measures, for example, for heat recovery systems, for improvement of thermal insulation, for CHPs, for fuel switching to DH and activities related to climate protection and the reduction of CO_2 emissions. For small and medium enterprises, the grants covered up to 35% of the investment costs, for large enterprises up to 30 %. Grants were managed by the "Österreichische Kommunalkredit" on behalf of the Austrian Ministry of the Environment, Youth and Family. The grant system for promotion of CHP and DH ended in 1998. A sound basis has been set up for the further development of CHP and DH in a competitive energy market.

The importance of CHP and DH is also reflected in the Austrian Energy Liberalization Act approved December 1, 2000 (ELWOG 2000). The Act establishes that the Länder can impose the obligation on grid companies to purchase electricity from CHP plants provided that they serve public DH supply and that a minimum payment per kWh can be granted to CHP generated electricity also provided that they serve public DH supply.

The new Green Electricity Act was passed in July 2002 and most of its clauses came into effect on January 1, 2003. The Green Electricity Act governs the aid for green energy and CHP production throughout the country, establishing one CHP tariff for the entire country. This means that end-users and electricity dealers in Austria contribute to an equal extent to the financing of the aid required. However, neither the Liberalisation Act nor the Green Electricity Act make provisions for the continuation of this system after 2004.[35]

Belgium

Gross electricity production by CHP plants is about 5% of total electricity generation. Current CHP capacity is mainly located in the industrial sector, with some large-scale commercial applications. The majority of the industrial plants are located in Flanders. Cogeneration capacity is primarily gas-fired or multi-fuelled. The quality of cogeneration is an important factor and its use should lead to an overall reduction in primary energy consumption. CHP plants are economically competitive compared to separate electricity and heat production only if they operate with high fuel efficiency and if there is adequate heat load.[36]

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[34] COGEN Europe, 2001.
[35] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[36] COGEN Europe, 2001.

The National Equipment Program of 1995 for the electricity sector called for decentralized power generation of 1000 MW_e, to be provided mainly by industrial CHP plants by 2005. The target has almost been achieved. The Program introduced partnership agreements with price opportunities to promote CHP. The agreements were concluded between large co-generators and Electrabel or electricity distributors. In these standardized contracts, Electrabel or distributors agreed to buy electricity from high-quality CHP plants with attractive tariffs. Electrabel also agreed that if co-generators needed more power than they could produce, it would be supplied at competitive prices. The Equipment Program was replaced by the Indicative Program for Electricity Generation in 2002. The Indicative Program puts particular emphasis on production methods with low GHG emissions, such as CHP installations.

The actual promotion of CHP is a regional affair so the measures in the Programs mentioned above are to be taken at the regional level. The role of the federal government is limited to setting prices for electricity and heat generated by CHP.

The regions are promoting CHP to increase energy efficiency and reduce CO_2 emissions. The Flemish objective is to install an additional 1800 MW_e of CHP capacity by 2005. Wallonia and the Brussels area have not set numeric targets.

A wide range of regional measures exists for the promotion of high-quality CHP. Flanders and Wallonia have established organizations to promote CHP, and subsidies are available for CHP installation and research and development. Preferential treatment is given to CHP producers and their customers by awarding them eligibility in liberalized electricity and gas markets sooner than other generators and customers. CHP producers are also free to choose the supplier for any additional electricity they may need, including back-up power and, in the case of industrial CHP producers, power that they cannot cover by their own generation.

Unlike the Flemish green certificate scheme, where green certificates are given only to renewable energy installations, the Wallonia decree on electricity market liberalization makes it possible to use green certificates to promote CHP. This is done by issuing certificates based on CO_2 emissions that are avoided when using CHP compared to the emissions that would have resulted from heat and electricity produced separately by fossil fuel-fired plants. How this will change when the EU-wide Emission Allowance Trading Scheme will start in 2005 is not yet known.

In all regions, CHP installations can deduct as much as 13.5% of the cost of their initial CHP investment from their taxable income. The regions can use funds to subsidize feasibility studies and investment costs of CHP plants.[37]

The Flemish region has implemented the proposals by the EU Commission on qualifying CHP on the basis of the 'quality norm.' Only CHP processes that save at least 5% on top of the break-even consumption compared to separate power (50% efficiency) and heat (90% efficiency) are qualified and their output accepted as a basis for assigning certificates (Vlaamse Regering, 2001).

In the new propositions of the Flemish Region (Vlaamse Regering, 2002) on CHP certificates, there are strict numbers included in the quotas that should be attained in the years 2004-2013. The quotas are defined on the basis of 'energy savings by CHP,' and the savings are calculated

[37] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.

with the 5% enhanced 'quality norm.' For every MWh of energy saved through high-quality CHP, one certificate is attributed.

Every distribution grid company and every electricity supplier in Flanders should submit CHP certificates to the regulator. The number of certificates in year is a percent of the MWh power that was delivered for end-use in the preceding year.[38]

Denmark

CHP plants generate about 50% of electricity production, mainly in association with the DH sector. DH covers close to 50% of energy demand for space heating. Gas is the primary fuel in CHP plants, followed by waste fuel and biomass. Most of the CHP plants are equipped with condensing tails allowing long operation times of the plants. CHP and DH have a good public image in Denmark. Most cogeneration potential has already been developed, but some growth potential exists in the domestic sector and in larger-scale industrial plants.[39]

Danish energy policy aims at safeguarding an economically efficient energy sector with a high degree of security of supply. This is to be achieved in an environmentally sustainable manner. Policy is designed within a framework that can meet the global challenge of averting the risk of the climate change. National efforts with relation to CO_2 are at the center of energy policy.

The development of CHP plants has been the single most important policy objective in attaining stabilization and reduction of CO_2 emissions. CHP is a cornerstone of Danish energy planning. Most electricity in Denmark is produced by large, CHP plants, which also supply heat to large Danish cities. There are also small-scale CHP plants in medium and small size towns supplying heat to local networks and institutions, and industrial CHP plants supplying the owner with energy for both process and heating purposes. Great efficiency in the generation of electricity and heat is obtained by increased use of CHP and DH. The market for heat is guaranteed by municipality regulations, which can mandate connection to the heat grid for new and existing buildings in defined areas where gas networks are excluded. About one-third of the municipalities have used their power to mandate connection. For many years, there have been large subsidies for the construction and operation of small-scale CHP plants, and subsidies have been adjusted regularly.[40]

Finland

CHP supplies about 32% of national electricity demand. It is primarily used for DH and industrial applications. Gas, coal, industrial wood residues and peat are the main fuel sources. The existing capacity has been developed without specific support. There is a tax on fuel used for heat production, but not for electricity production. As penetration is already high, growth potential is relatively low.[41]

DH covers 48% of total space heating demand, and 75% of DH is produced by CHP plants. Most DH utilities are owned by municipalities. DH systems cover almost all regions of Finland where

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[38] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002.
[39] COGEN Europe, 2001.
[40] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[41] COGEN Europe, 2001.

the sale of DH is profitable. General practice for the construction of a DH system is that the sale of DH must be profitable even without CHP. On the other hand, the sales price of DH must be competitive with other forms of heating.

Finland's energy policy and its National Climate Strategy aim to meet the international emissions reduction commitments established in the Kyoto Protocol. In Finnish energy policy, CHP has been given priority over new power production capacity. However, no subsidies or other legislative support are granted or planned to enhance the profitability of large-scale cogeneration, except when using biofuels. The priority position has been ensured by removing the barriers to CHP. Electricity produced by using a wood-based fuel receives support that equals the electricity consumption tax per MWh. Small peat-fired CHP plants are granted a fuel tax refund to retain their competitiveness. There is also a possibility to apply for grants from the state for capital subsidies up to 25-30% of the investment costs, but normally the grants are lower.

France

CHP supplies 2% of electricity generation, and it is mainly used in large-scale industrial applications, where gas and heavy fuel oil are the main fuels. France currently suffers over-capacity in the electricity generation sector. There are no specific targets for CHP, and no significant growth is expected without significant market changes.[42]

The situation of CHP was facilitated by a regulatory provision that obliges Electricity de France (EdF) and local non-nationalized distributors to purchase electricity produced by cogeneration facilities and other types of generation in the public interest. At present, the scheme will concern only small and medium size CHP plants less than 12 MW. Beyond this limit, ministerial authorization is required, and the Ministry of Industry has agreed to approve these types of projects up to a cumulative power capacity of 1 GW in 2000. The electricity purchase price is determined by the government, and the electricity regulator assesses the additional costs incurred under this obligation which are compensated by a Public Service Electricity Generation Fund. Electricity tariffs for CHPs, renewables and waste heat are calculated to provide an incentive for private investors to invest in generating capacity, according to the present state of the art of each energy technology.[43]

In addition to measures adopted to encourage the use of wood, solar thermal energy and geothermal energy, the development of DH based on renewable energy produced in CHPs and other production plants will be supported by tax incentives.

Germany

Cogeneration contributes about 13% of electricity generation. The capacity is divided evenly between the industrial and DH sectors. Plants are quite modern, as many installations in the former East Germany have been refurbished. Gas and coal are the main fuels used in the plants. Electricity liberalization has caused prices to fall, leading to many plant closures.[44]

DH is used to great extent in the former East Germany. About 75% of heat supplied to the DH systems is produced by CHP plants and the rest by heat-only boilers. Natural gas has to some

[42] COGEN Europe, 2001.
[43] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002.
[44] COGEN Europe, 2001.

extent replaced coal in CHP and heat plants. Because electricity prices have decreased as a consequence of market liberalization and gas prices have increased to correspond to the oil price in the last few years, many municipal CHP plants initially lost their competitiveness.

The difficulties mentioned above faced by CHPs over the last few years triggered a broad debate to seek adequate policy instruments to make CHP sustainable. The government decided to include into its new Climate Protection Program (a) voluntary agreements with the industry to save energy, increase energy efficiency or to reduce CO_2 emissions and (b) the introduction of a new CHP Law which would support cogeneration by attractive feed-in electricity tariffs.

In August 2001, the government presented the new CHP Law. The Law aims to lower CO_2 emissions in 2005 by about 10 Mt and in 2010 by 20-23 Mt compared to the 1998 levels. The Law will be effective until the end of 2010. The 2002 Law allows CHP operators, feeding electricity into the public transmission network, to receive bonus payments on top of the revenue they would receive at market price. The legislation sets requirements for the power-to-heat ratio to qualify to receive the bonus. The bonus then varies according to the plant type of existing CHP plants, modernized CHP plants, existing and new small plants (up to 2 MW_e), and fuel cell plants. The rates will be progressively reduced from 2004 onwards, except for fuel cells and new small plants (up to 50 kW_e). Payments will end in 2010 for the small plants and for plants built before 1990 and modernized in 2002 or later. For non-modernized plants above 2 MW, payments end in 2006 if the plant went into operation before 1990; for other plants, the payments end in 2009. The cost of the bonuses granted within the feed-in tariffs can, in principle, be transferred to the electricity consumers through the electricity prices. The cost is transferred in proportion to consumption but for large consumers, meaning those consuming more than 100 MWh/year or those whose electricity bill is more than 4% of annual turnover, the resulting price increase has been limited for amounts exceeding 100 MWh/year.

In addition to the bonus payments, CHP is promoted by tax exemptions. CHP units with a maximum 2 MW of electricity generation capacity are exempt from the electricity tax for the auto-producer's own use, and units with a minimum 70% fuel efficiency are exempt from the mineral oil tax.[45]

Greece

CHP supplies 10% of electricity, predominantly in the industrial sector. However, the majority of the larger industrial applications have already been installed. There is a small market for DH in the north of the country. A gas network is currently being developed, and market barriers are being removed to allow several producers access to the network. Growth is expected to increase CHP capacity mainly in medium-scale industry and large-scale commercial applications.[46]

CHP has mainly been promoted through investment support. The mechanisms for this support are the Greek Development Laws, the Operational Program for Energy 1994-1999 and the Operational Program for Competitiveness (OPC) 2000-2006. The investor may choose the subsidy mechanism he prefers. The fuel efficiency requirements for eligibility for a subsidy are 60% for the industrial sector and 65% for the services sectors. The investment subsidy under OPC is 35%.

[45] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[46] COGEN Europe, 2001.

Under the Development Law of 1998, the investor can benefit from a 40% investment subsidy. Most investors have preferred the lower subsidy from the Operational Programs because it is available at the beginning of the investment project whereas the subsidies under the Development Laws are paid only upon completion of the project. Development Law 2773/99 introduces attractive buy-back tariffs for electricity produced by CHP. For environmental reasons, the prevailing legislation does not allow the installation of CHP or any other industrial plants in the region of Attika (surrounding Athens). There have been plans to revise the legislation to allow CHP installations using natural gas.[47]

Ireland

CHP supplies 2% of electricity mainly in the industrial sector. Drops in electricity prices and increases in gas prices have recently decreased the viability of CHP. The government set out definite CO_2 emission targets attributable to cogeneration in 2000. CHP is expected to grow through increasing demand expected in the large-scale industrial and commercial sectors.[48]

The Fourth Alternative Energy Requirement Scheme competition was launched in 1997 to support the competitive development of CHP. The objective of the competition was to secure 25 MW_e of newly installed electricity-generating capacity from existing similar systems. This period of incentives resulted in slow but continuous growth around the country.

The government has indicated its aspirations for CHP in response to the Kyoto Protocol. The strategy allocates 0.25 Mt CO_2 per year saving from the use of CHP by the year 2010. The national strategy also includes an initiative to fully liberalize CHP.[49]

Italy

CHP supplies about 23% of electricity. CHP is dominated by large-scale industrial plants. Liberalization is currently having a negative effect on the cogeneration potential, and cogeneration schemes have become uneconomic compared to grid-supplied electricity. There are no support measures currently used or planned. Some growth is expected in the domestic and industrial sectors.[50]

Based on past legislation, ENEL, the principal electric utility with the leading position in generation, transmission, distribution and supply, was to purchase the electricity produced by renewable sources, waste and cogeneration at avoided costs which ENEL would have had to pay to purchase electricity from other sources. Producers received an incentive premium paid by all consumers. Among proposals selected by ENEL within this regulation were included independent CHP plants.

Before 1992, CHP investments were supported by the State. In 1992 legislation was issued to support the construction of new renewable plants and assimilated plants utilizing wastes in a different way. The support was a guaranteed purchase of the electricity at a fixed price for the first 8 years of plant operation. New CHP plants were also given the guaranteed price if their equivalent electricity efficiency was greater than 51%. In the support scheme, the determination

[47] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[48] COGEN Europe, 2001.
[49] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[50] COGEN Europe, 2001.

of the electricity price for the different type of plants was based on avoided costs and on the extra costs of the specific plant type. The support produced a large growth of CHP plants with large profits for many generators. The decree was annulled in 1997 for new plants, but the already authorized plants with signed contracts of electricity purchase still have the benefits until the eighth year from their start-up.

The Italian Law for Electricity Market Liberalization in 1999 introduced green certificates with quotas for renewable plants for the kWh produced for the first 8 years of production. It did not introduce any quota or similar scheme for CHP plants. Instead the Law recognizes other benefits of operating CHP plants, defined as plants whose actual yearly operation leads to a significant reduction of primary energy compared to separate electricity and heat production.

From January 1, 2002, cogeneration plants are exempted from the obligation to either generate electricity from renewable sources or to purchase green certificates equal to 2% of the electricity generated by conventional sources. In early 2002, the Regulatory Authority for Electricity and Gas defined the conditions under which a CHP plant can be considered a cogeneration plant. The criteria take into account the efficiency of generation and the relevant savings as compared to a separate production of the same quantity of power and heat. Furthermore, a minimum value of 15% has been set for the ratio between heat and the total energy produced by the plant.[51]

Luxembourg

CHP generation amounts to 36% of electricity production, but this is against a background where 95% of electricity is imported. The capacity is predominantly in the industrial sector and mainly fuelled by gas. Growth in CHP is expected in all sectors, particularly in industry.[52]

Security of supply pays a major part in energy policy, and CHP is supported by the government. A ministerial regulation from 1994 allocated an investment grant to non-industrial co-generators. The benefits of the program were restricted to the first 5,000 kW installed, a limit which was reached in 1997.

The National Plan for Sustainable Development of 1998 sets the target to increase the share of cogeneration in electricity consumption from 7% in 1997 to 15% in 2010. There is an annual subsidy per kW installed capacity if electricity is supplied during peak load. Electricity plants using renewable sources receive the same subsidies as co-generators. The Grand Ducal Regulation of 1996 promotes CHP units in municipal buildings through grants per kW of installed capacity on the condition that the plants operate more than 2,500 hours per year with an annual efficiency of more than 80%. Currently there is in force a regulation from 2001 which establishes a system of financial grants for the promotion of rational use of energy and for the valuation of renewable energy sources.

The Grand Ducal Regulation of 1994 sets the buy-back tariff for electricity from non-industrial cogeneration and renewable sources. CEGEDEL (a distribution network operator) has a purchase obligation. There is an annual subsidy per kW of installed capacity if electricity is supplied

[51] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002.
[52] COGEN Europe, 2001.

during peak load. Co-generators receive the same subsidies as electricity plants using renewable sources.[53]

The Netherlands

The share of CHP in electricity generation is high at about 38% of total generation capacity. The capacity is mainly gas-fired. Liberalization is causing problems for CHP plants, as electricity prices fall and gas prices rise. State support for CHP has stopped with the exception of sophisticated schemes. The main opportunity for CHP increase in the future is in the domestic micro-cogeneration market.[54]

The Energy Policy of 1995/1996 set out an objective for CHP where 15,000 MW of capacity is to be installed by 2010. The objective was repeated in the 1998 Energy Conservation White Paper and is among the measures that would allow the Netherlands to reach the target under the Kyoto Protocol.

The 1989 Electricity Act contained a variety of incentives for CHP such as an obligation on the centralized system to buy surplus electricity from CHP plants at avoided cost, subsidies of up to 17.5% of capital costs, favorable natural gas pricing for small-scale CHP, and exemption from paying for reserve capacity and ancillary services. The incentives expired along with the Act in 1998. The support measures caused vigorous investment in decentralized CHP facilities throughout the 1990s, often by energy distributors entering into joint-ventures with private companies. The number of new CHP plants was such that Sep (co-operating electricity production companies) had to limit output from existing, economic base load plants to accommodate overcapacity from the expensive new CHP plants. This led to underutilized capacity and higher unit costs. Prices, which would normally fall in a market with overcapacity, instead rose to recover Sep's higher unit costs. Higher Sep prices in turn encouraged decentralized suppliers to develop more CHP plants.

Severe competition with relatively low electricity prices, combined with high gas prices, has caused a slowdown in the development of CHPs, and therefore the Minister of Economic Affairs announced measures to support CHP. A temporary tax refund for co-generated power was introduced in the Regulatory Energy Tax. To be entitled to the refund, the plant must have a minimum efficiency of 60%. This has resulted in an almost unchanged operation of the cogeneration plants.[55] Instead of the criterion of 60%, a proposal can be prepared where the real fuel savings compared to separate production will be used as a basis.

The government intends to apply a number of public service obligations mainly related to energy efficiency, renewables and CHP. First, as in the new Natural Gas Act, electricity consumers are required to buy a number of green certificates corresponding to a fixed share of their electricity consumption. Second, captive customers who own small-scale CHP facilities under 2 MW of capacity are entitled to sell their surplus power to their licensed supplier who has to buy this power. Large-scale CHP is expected to be competitive in the liberalized market.[56]

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[53] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[54] COGEN Europe, 2001.
[55] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[56] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002.

Portugal

CHP supplies 11% of electricity demand, almost all in the industrial sector. Decreasing electricity prices are presently weakening the cogeneration market. However, CHP plants are financially supported by the government. The growth markets continue to be in the industrial sector, followed by the commercial and domestic sectors.[57]

The Decree Law of 1988 has provided for must-take obligations by the grid company REN (Rede Electrica Nacional), and favorable buy-back tariffs were set according to the price paid by end-use customers. The Decree of 1995 set minimum efficiency values and the minimum heat utilization necessary for CHP plants to qualify. The buy-back tariff for co-generators below 10 MW is calculated according to the price paid by end-use customers in the medium and high voltage tariff range where a minimum of 55% efficiency is required to qualify. For co-generators above 10 MW, the buy-back tariff is based on avoided costs calculated as the cost of building a new CCGT plant. Payments increase when the heat rate value and the availability of the plant increase. Co-generators pay for their connection to the grid. Decree 538 of 1999 allows sales to affiliate companies as well as to companies buying heat. The regulation will be valid for ten years.[58]

Spain

Electricity produced by CHP plants is about 11% of total electricity generation. Almost all cogeneration facilities are run by auto-producers, typically industries. The size of the installations is generally small: 86% of the plants have a capacity of under 10 MW_e. Natural gas is the most commonly used fuel, covering 72% of total CHP generation, followed by oil and other fuels. The typical industries to invest in CHP production are ceramics and tiles, food processing, textile, chemical, and pulp and paper industries. No large-scale public cogeneration plants have been built yet.[59]

Energy policy is the responsibility of the new Ministry for the Economy and implemented through the office of the Secretary of State for the Economy, Energy and Small Businesses, which in turn acts through the Directorate General for Energy Policy and Mines. The Institute for Diversification and Saving of Energy and the Directorate General for Energy Policy and Mines work in coordination on the implementation of policies and actions to promote the rational use of energy and diversification of energy sources.

The central government formulates the policies for mitigating climate change. However, the regional governments are allowed to adapt policies to their specific geographic area as long as they do not distort the intent of the national policies. The regional governments play an important role in the implementation of policies in their region, such as licensing installations for producing energy from renewables and CHP and promoting energy efficiency.

Cogeneration expanded rapidly in the 1990s, especially in the industrial sector, owing to a positive market framework. The Royal Decree of 1998 established the system to favor electricity generated from renewable sources and electricity generated by CHP plants. The Decree set up a guaranteed purchase scheme for electricity generators using renewable sources and for co-generators. The prices of CHP surpluses consist of the average price of the generation market

[57] COGEN Europe, 2001.
[58] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[59] COGEN Europe, 2001.

plus an economic premium. The premium depends on the size of the installation, being most favorable for installations of sizes less than or equal to 10 MW while installations of power between 25 and 50 MW do not receive any economic premium but the average price of the generation market.

The premiums have been updated annually in line with interest rates and the average price of electricity. In the case of cogeneration plants, the updating of the premiums has also taken into account the average price of natural gas. The premium system was revised during 2002 to be in line with the evolution of market prices for electricity, the contribution of renewable installations to overall electricity demand, and their impact on the technical management of the system.[60]

Sweden

CHP accounts for around 6% of electricity production, divided evenly between industrial plants and DH. Despite a strong DH sector, cogeneration is not well developed in Sweden. Competition from hydro and nuclear power remains high, but the potential phase-out of nuclear plant will boost the prospects for CHP in the long run. Growth markets are in the domestic and large-scale industrial sectors, with some scope in the DH sector.[61]

During more than 10 years, there has been no general support for CHP in Sweden, and only CHP plants using biomass as fuel have received support from the government. In an energy bill from 1997, support for CHP using biomass was introduced in a form of an investment contribution up to a maximum 25% of the total investment cost. There was also a possibility to receive a guaranteed price if the plant was smaller than 1,500 kW. Besides the direct support for CHP plants, there has been some indirect support, such as support for modifications in the heating systems of houses in order to connect these houses to DH networks.[62]

During March 2002, the Swedish government presented its Energy Policy Bill titled "Cooperation for a Secure, Efficient and Environment-Friendly Energy Supply."[63] The policy reaffirmed the country's established energy policy objectives, which were: (i) to create the conditions for efficient energy use and cost-efficient Swedish energy supply with low adverse impacts on health, the environment and the climate, (ii) to facilitate the transformation into an ecologically sustainable society, (iii) to contribute to the creation of stable conditions for a competitive business sector, and to the renewal and development of Swedish industry and (iv) to contribute to broadening co-operation within the Baltic region with regard to energy, the environment and the climate. The Energy Policy Bill also contained proposals to promote environmentally-friendly and renewable electricity production through a quota-based trading program for green electricity certificates and to strengthen the competitiveness of CHP by exempting such plants from certain taxes on energy products.

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[60] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002.
[61] COGEN Europe, 2001.
[62] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002.
[63] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.

United Kingdom

CHP accounts for about 6% of total electricity generation. Most of the installed capacity is in the industrial sector. Recent high gas prices and low electricity prices (fallen partially as a result of the implementation of the New Electricity Trading Arrangements) have created commercial difficulties for CHP.[64]

In 2000, the government set a target of 10,000 MW of CHP capacity by 2010 as an important part of the Climate Change Program. I t has introduced measures like the CHP Quality Assurance Program and the Community Energy Program to promote CHP plants.

The CHP Quality Assurance (CHPQA) Program certifies the energy efficiency and environmental performance of CHP schemes. Good quality CHP is exempt from the climate change levy, eligible for enhanced capital allowances on investment in energy saving technologies, and exempt from business rates of the electricity generating plant and machinery in CHP schemes.

The new United Kingdom-wide Community Energy Program aims to promote community heating (DH) through grants to install new schemes and refurbish obsolete infrastructure and equipment. The Revision of Planning Policy Guidance provides some leverage for local planning authorities to encourage developers to explore the feasibility of energy efficient options, including newly built CHP/DH. The power station developers must now demonstrate that they have explored the opportunity for CHP and sought to identify heat loads for the waste heat.[65]

[64] COGEN Europe, 2001.
[65] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.

Annex 2

Policies and Methods to Promote CHP in EU Candidate Countries

Bulgaria

CHP comprises 9% of electricity generation, and the capacity is located both in the industrial and DH sectors. The existing capacity is old, and a present electricity over-capacity exists. No new capacity has been constructed recently, partly owing to lack of funds and finance. Government policy to 2010 includes provisions for cogeneration, but significant growth is not expected in the short term. The main growth potential is in the industrial and DH sectors, representing a mix of renovated plants and new capacity.[66]

The Law for Energy and Energy Efficiency of 1999 deals with conditions for the development and security of national energy supplies, efficient use of energy and energy resources, development of a competitive energy market and energy sector privatization. The aims of the Law are to integrate Bulgaria with European energy systems and markets and create conditions for rational coverage of energy demand (electricity, heat, gas and other fuels).

Energy policy priorities are to increase energy efficiency and reduce energy consumption in energy-consuming industries, heat supply and the whole national economy. In the strategy for the DH sector, priority is given to promote cogeneration, transfer DH systems ownership from the State to communes, continue state control over DH companies by a regulatory body and to finance important measures of DH systems development. The main tasks are to arrest the declining share of industrial consumers, connect new clients (mainly to existing DH networks) and improve social support for poor families together with the reduction of direct subsidies for heat suppliers.

Bulgaria has a number of factors favorable for CHP development. Bulgaria is a country with scarce energy resources, high-energy intensity and is highly dependent on energy imports. Energy efficiency is a priority for ensuring a competitive economy, greater energy independence and environmentally acceptable development. Price increases of power and heat create conditions for competitive CHP. The Energy and Energy Efficiency Act requires obligatory access to the grid for CHP plants and the purchase of CHP power at fixed prices. The streamlined procedures for construction and licensing of CHPs with capacities below 5 MW combined with the opening of the low-pressure natural gas market is expected to lead to the development of small CHP plants in hotels, hospitals, schools and the dwelling sector, one of the most promising areas for CHP development in Bulgaria.[67]

Czech Republic

CHP plants supply around 20% of electricity demand and are located in the industrial and DH sectors. The plants are mainly coal-fired, with some gas and waste-fired. Gas prices are currently three times as high as those for coal, hindering the construction of new gas-fired CHP plants. Residential consumers still receive gas price subsidies, which has encouraged many of

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[66] COGEN Europe, 2001.

[67] ProCHP, Legal Aspects of CHP. SAVE II Promoting CHP in the Framework of East-West Energy Partnership. December 2002.

them to disconnect from DH and to install individual building gas boilers. The potential for growth of CHP plants is therefore mainly in the medium-scale industrial sector.[68]

Energy policy is concentrated on the efficient utilization of primary energy and environmental protection, including increased use of renewable fuels. The Government also takes into account the social aspects and impact of energy prices on citizens' economic situation. The Energy Management Act of 2000 specifies the rights and obligations of energy utilities in connection with energy production, transmission and consumption and deals with more efficient energy use, environment protection, reliable energy supply stimulation, promotion of competition and sustainable development. The main principle followed by the new legislation is an obligation to consider utilization of domestic fuels in new equipment.

The liberalization of the electricity market is likely to lower electricity prices and reduce the revenue of CHP operators. In order to mitigate the impact, the new Energy Act includes an obligation for transmission and distribution networks to purchase electricity generated from CHP plants whenever it is technologically feasible, so co-generators and buyers will have to negotiate prices. The new Act also contains an obligation for DH distributors to purchase heat generated from CHP, industrial processes, renewable energy and environmentally clean incineration.

While the liberalization process obliges suppliers to purchase electricity from co-generators, it does not protect co-generators against price competition. The Energy Act introduced an obligation to conduct energy audits of all existing CHP plants and organizations above a specified volume. For new CHP projects and rehabilitation of an existing plant producing heat or electricity alone, a cost-effectiveness audit is obligatory. The CHP scheme can be applied when the result of the audit is positive and the long-term purchase of power and heat is secured.[69]

DH is an important part of the energy system in the Czech Republic as 30% of the households are connected to a local DH network. Some 45% of DH production is from CHPs and 55% from heat-only boilers. Heat also accounts for 12% of energy consumption in the service sector and 14% in the industry sector. DH systems are organized locally and are operated by cities. Individual heating companies are also power producers. The sector was largely (about 80%) privatized during 1992-1994 through a voucher privatization scheme, and there have been significant foreign acquisitions of companies. DH in public services (army, police, schools, state hospitals etc.) remain under state ownership. The generation and network systems are generally 30 to 60 years old, which has a negative impact on efficiency, availability and maintenance.

Estonia

CHP plants supply around 13% of electricity generation. The plants are primarily fuelled by oil shale. Most of the plants, which are mainly in the DH and large-scale industrial sectors, are in need of modernization. Growth is expected in the DH and industrial sectors, partially through renovation.[70]

Estonia aims to bring its energy policy into line with EU requirements by emphasizing abundant and low priced energy sources on an environmentally sustainable basis, as well as securing domestic energy reserves. Energy policy will promote decentralized production, including CHP.

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[68] COGEN Europe, 2001.
[69] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[70] COGEN Europe, 2001.

The Government's energy strategy introduced in 1997 aims to meet prospective international environmental agreements. The main target of the Long-term National Development Plan for the Fuel and Energy Sector of 1998 is to provide stable and high quality energy supply to consumers with such a development of the fuel and energy sector that GDP could be increased to the level necessary for the accession to the EU. The Energy Act (EA) of 1997 regulates the tasks of network operators for power, heat, gas and liquid fuels. The EA distinguishes between fuel and energy traders dominating the market and others.[71]

There are no direct subsidies for fuel, electricity or heat. A program to ensure the optimal development of heat supply systems and to implement the potential of heat and power cogeneration has begun to be developed.

Hungary

CHP supplies about 10% of electricity. The plants are mainly fuelled by coal, although the role of gas is increasing as the gas network is becoming more widespread. A lot of DH capacity is old. Growth is expected in the industry and DH sectors.[72]

The Energy Policy Concept of 1993 stated strategic objectives such as securing energy supply through diversification of energy sources, modernizing energy supply systems, increasing efficiency and increasing the share of renewable energy sources. The Energy Policy Concept was reoriented in 1998 to be in line with the European legal system.

According to the Ministerial Decree of 1996, the electricity transmission company or electricity distribution companies are required to purchase electricity produced from renewable sources and from small-scale CHP (from 0.5 MW up to 20 MW) at guaranteed prices. Under the new Electricity Law of 2002, mandatory purchasing was enforced with guaranteed prices from 0.5 MW up to 50 MW (up to 5 MW for industrial CHP) and with market prices above the given limits. Since January 1, 2001, purchase prices are also applied to heat prices.

Energy policy in the DH sector is based on the District Heating Law of 1998. According to the Law, responsibility for municipal DH, including the setting and control of end-user prices, was transferred to municipalities. The Minister of Economic Affairs exercises the power to settle prices of heat supplied by power plants over 50 MW. The Hungarian Energy Office sets the prices and grants DH licenses when electricity production capacity is 50 MW or more. DH companies have to purchase heat at artificially high official prices while their tariffs for selling heat to their customers are kept low for social and political reasons and in the context of strong competition from natural gas suppliers in the residential sector. Official gas prices are set by the Minister and kept artificially low.[73]

DH companies were previously heavily subsidized by the central government (30-40% of end-user prices) but these subsidies were abolished in 1991. The production subsidy was replaced by a social fund for poor families, but the funds distributed amounted to only 1% of the DH sales revenue. Responsibility for the DH companies, including the setting and control of end-user prices, was transferred to the municipalities. Following this, some municipalities established commercial DH companies whose goal was to make a profit. The Ministry of Economic Affairs

[71] Organization for Economic Co-operation and Development. The Liberalization Process and Regulatory Developments in the Electricity Sector in the Baltic States, 2002.
[72] COGEN Europe, 2001.
[73] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.

retained the power to control heat prices set by the small number of private generators. DH prices increased considerably, but not uniformly across the country – and they still have not increased enough to fully cover costs.

At least until 1995, local DH companies were able to benefit from subsidized residential input fuel prices, especially natural gas, whereas Hungarian Power Company (MVM) had to pay the much higher industrial gas price for its CHP plants. This led to a situation in which the municipalities could maintain otherwise uneconomic capacity in DH. Although the DH companies no longer have access to subsidized input prices, the issue of strong regional price discrepancies and cross-subsidies led to adoption of a District Heating Law in 1998.

The Action Plan of October 1999 considers that the reconstruction of the DH systems is the highest priority, taking into account its present national status and the District Heating Law.

Latvia

CHP supplies some 30% of countrywide electricity generation. In Latvia most cogeneration applications are for district heating and they suffer from over-capacity. The existing plants are old, and recent investment has concentrated on system efficiency improvements. Electricity prices are low due to hydro capacity and cheap imports. New capacity growth will be dominated by plant renovations.[74]

Energy policy is based on the Government's Policy in Energy Sector, which sets out the basic principles for the regulation in the energy sector and supports privatization as a tool of efficiency and competitiveness improvement together with a reduction of state interference. High priority is given to CHP and restructuring of DH systems into joint stock firms with private participation. This is considered to be an important measure for improving management and quality of services. The policy also stresses the importance of environmental issues.

The general policy in the DH sector is governed by the law on State and Municipal Heating Policy, which states that efficient DH systems are considered to be the most environmentally friendly and convenient solution for the community in comparison to other options. Therefore, DH is a responsibility of the local government in each locality and is strongly supported officially. There are incentives for municipalities to give up direct economic activities related to heat generation, maintaining only control over management as well as long term planning functions in the DH sector.

The Law on Regulation of Business Activities in Energy Industries determines certain powers and duties of energy companies in order to secure a continuous and undisturbed supply of energy to consumers, encourage business in this field and ensure that the energy supply complies with the national energy policy. The Law stipulates procedures for energy sector regulation and for the energy companies of a specified size, which have to obtain a license.[75]

Lithuania

Cogeneration represents some 11% of generation with most of it (90%) in the district heating sector. Existing plants are old and in a need of refurbishment. Plants are mainly fired by heavy

[74] COGEN Europe, 2001.
[75] World Energy Council, 2002.

fuel oil and gas. The Ignalina nuclear plant dominates the capacity, and Lithuania is a net electricity exporter. Electricity prices are low due to over-capacity and low nuclear prices. Potential growth comes mainly expected from refurbishment in the district heating sector.[76]

Energy policy is based on the National Energy Strategy, whose main goal is reliable and safe energy supply at least possible cost. The priorities of the strategy are the increase of energy efficiency, improvement of management and implementation of market principles in the energy sector, reduction of the negative impact upon the environment, assurance of nuclear safety requirements, integration with energy systems of the EU, as well as regional cooperation and collaboration. The strategy does not contain any significant targets, but outlines broad policy objectives and there are no specific targets or legislation for CHP.[77]

Poland

CHP plants supply around 20% of electricity generation. The CHP capacity is in the industrial and district heating sectors. About half of district heating output is supplied by CHP plants. The majority of plants are coal-fired, while the move towards gas has started. Electricity liberalization is well advanced, but gas market opening has not started.[78]

Energy policy principles and objectives have been announced in the governmental document "Assumptions for Poland's Energy Policy until the Year 2020" prepared in accordance with the Energy Law of 1997. Its goals follow the EU principles of energy security through supply diversification and substitution, economic competitiveness of the energy sector associated with the development of competition as well as enhancement of efficiency and environmental protection.[79]

The Ministry of Economy has given an ordinance in 2003 on obligatory purchasing of electricity and heat from renewable energy sources as well as electricity generated in cogeneration with an annual total efficiency of not lower than 70%. The obligation of purchasing electricity from CHP must be fulfilled with defined percentages until 2010.

Romania

About 45% of electricity is generated in CHP plants, almost all in the district-heating sector. Existing plants are generally old. Gas resources are good and the network is being expanded. The growth in the markets comes through renovations of district heating plants and in the industrial sector.[80]

Accession to the EU represents a strategic option for Romania included in all governmental programs. Romania's energy policy is focused on the restructuring of electricity and heat sector, the liberalization of electricity market, and the restructuring of commercial arrangements to support market transactions. There are no specific government policies supporting CHP. However, credits are granted for projects which are expected to result in an increase of energy

[76] COGEN Europe, 2001.
[77] World Energy Council, 2002.
[78] COGEN Europe, 2001.
[79] ProCHP, 2002.
[80] COGEN Europe, 2001.

efficiency by 75%.[81] Energy price subsidies continue to penalize the market, which might lead to the replacement of CHP with heat-only boilers.

Slovak Republic

CHP plants supply about 11% of electricity generation. CHP is mainly located in the DH and industrial sectors. The market growth areas are in the commercial and DH sectors.[82]

Slovakia has set its policy objectives to promote energy efficiency and conservation, which include reduction of energy demand for space heating in the residential sector, promotion and reinforcement of use of renewable energy sources, adjustment of energy prices to reflect actual costs as well as modernization and application of modern technologies. The main issue for policymakers is the need to expedite energy market reforms and to restructure electricity supply.

The current Energy Policy of 2000 has the main goals of (a) preparation for integration into European Union internal market, (b) security of energy supply and (c) sustainable development. CHP contributes to all these major goals of the national energy policy.

An Energy Act of 1998 obliges the power traders and distribution companies to feed in the electricity produced in all environmentally justified sources, if this is technically viable and can be achieved with economically justified means, meaning there is no significant impact on the overall performance of the distribution network. Furthermore, the Energy Act obliges the heat generators, purchases and distributors to purchase heat from CHP plants in cases when this would not increase the price at the direct consumer level or when this would not reduce the energy efficiency of other heat sources within the system. The Energy Act also prescribes that the costs of connections have to be settled by the operators of CHP plants. The price for energy fed into the system is to be negotiated by the parties involved - the CHP operator and the utility.

Currently feed-in tariffs are not regulated. Electricity prices from current power sources in the grid are low and thus the feed-in tariffs offered for CHPs are low for sales of their surplus capacity. An exception exists in peak hours, during which the distribution company may prefer to buy electricity locally and is prepared to pay a higher price.

The Act from 1999 on Income Taxation of Legal and Physical Persons on Tax Exemptions is providing to both private and legal entities an exemption of taxes on the income from operation of CHPs with an installed capacity of maximum 10 MWe.

Some grant support and soft loan schemes are also available for CHP projects. However, the number of supported installations is small, and the funds have only a very limited impact on the market penetration of CHPs for a number of reasons, including (a) the limited availability of funds, (b) the difficult and time-consuming application procedures, and (c) the lack of experience and capacity in project development.

In a Draft Energy Efficiency Act, it is proposed to adopt further measures to promote development of CHP production.[83]

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[81] ProCHP, 2002.
[82] COGEN Europe, 2001.
[83] ProCHP, 2002.

Slovenia

Cogeneration supplies about 30% of power production. The installed capacity is both in industrial and DH sectors. Most of the CHP plants are old, leaving significant opportunities for upgrading and renovation. The natural gas network is expanding rapidly. The growth potential in the commercial and domestic sectors is estimated to be small.[84]

The National Energy Program spells out the long-term development objectives of energy policy. A National Energy Program shall be drawn up every five years by the Government and submitted for adoption to the National Assembly of the Republic of Slovenia.

The main principles on which the Slovenian energy policy is based are: (a) a reliable and high-quality energy supply, (b) long-term balanced development of the energy sector, (c) the diversification of various primary energy resources, (d) promotion of the use of renewables, (e) priority to the efficient use of energy and the utilization of renewable resources over non-renewable resources, (f) environmental acceptability in generation, transport and use of all types of energy, (g) encouragement of competition in the energy market, (h) consumer protection and the encouragement of adaptable energy users as well as (i) a transparent and non-discriminatory approach for all participants in the energy sector.

Favorable clauses for qualified production (QP), i.e. production of electricity with high efficiency, such as CHP, or from renewables, have been introduced. The market operator will have the responsibility to secure the purchase of electricity from QP at conditions that are at least equal to the conditions on the organized market. Other clauses to favor small CHP and renewable production also exist. Firstly, qualified producers up to 1 MW will be allowed to sell the electricity produced to all consumers, including the captive market. Second, a provision will limit the network access costs for small QPs up to 1 MW.[85]

[84] COGEN Europe, 2001.

[85] Mihael G. Tomšic and Andeja Ubancic. National Energy Programme of Slovenia in View of Opening of the Energy Market and the Kyoto Protocol, July 2001.

Policies and Methods to Support CHP in FSU Countries

Belarus

CHP covers almost 50% of electricity generation in Belarus. Natural gas is the main fuel used in CHP plants while oil has a minor share. Approximately 25% of the electricity demand is met through the import of electricity from Lithuania and Russia.

In Belarus, energy policy consists of a number of energy saving programs, which are coordinated and promoted by the Committee for Energy Conservation. The main purpose of energy policy is to determine and form the conditions for an efficient utilization of power resources and reliable power supply of the country, which could raise the living standards and meet environmental safety concerns. There is a regulation coordinating the relationship between producers, suppliers and consumers of DH. However, specific legislation or regulations concerning CHP and DH are yet to develop. All investments aiming at modernization and all energy saving programs are financed from different sources including: (a) the Innovation Funds of Belenergo and other enterprises, (b) the Energy Savings Fund of the Committee for Energy Conservation, and (c) national and local budgets. The activities of the Committee for Energy Conservation and the Ministry of Housing and Communal Services are concentrated mainly on technical improvement of DH systems and implementation of the energy conservation and modernization programs.[86]

Moldova

CHP supplies one fourth of the electricity generation. CHP plants supply mainly the DH sector. Three CHP plants operated by the state-owned utility are planned for privatization. It is expected that after CHP plants are privatized, they will continue to be regulated, possibly having the option of selling power at market prices in wintertime only.

The generation assets are in serious need of rehabilitation and modernization as they have deteriorated over the past decade. The problem has been exacerbated from unpaid consumer electric bills for electricity and DH. Electricity supply has not been able to meet the demand causing Moldova to be a net importer of power, with mounting significant debt from unpaid bills for imported power. In April 2001, the Moldovan government passed laws to permit utilities to cut service to non-paying customers.

Moldova's energy policy is in the responsibility of the Ministry of Economy and Reforms, the State Department of Power and Fuel and Energy Resources, the Ministry for Territorial Development, Construction and Communal Government, and the National Energy Council. The economic, commercial and tariff regulations are applied to the energy sector in Moldova in order to ensure proper incentives are in place to encourage the energy and gas enterprises, which are natural monopolies, to become more efficient and to promote the efficient utilization of heat and energy sources such as CHP plants and the hydro power system. Regulation of energy enterprises activities was carried out through issuing licenses and monitoring the fulfillment of their conditions, refinement and approval of tariffs, technical losses and technological consumption calculation methodologies, establishing distribution tariffs for electricity consumers, assuring

[86] World Energy Council, 2002.

protection of customers rights and expansion of the wholesale energy market and retail gas market.[87]

Russia

CHP comprises 66% of total electricity generation. Most of the heat generation of CHP plants is used for DH. Also some industrial CHP plants are owned and operated by different factories, but their share in heat and power generation is rather small (3-5% of electricity and 7-9% of DH). Energy policy is based on "the Energy Strategy of Russia" and "the Main Directions of the Energy Policy of the Period till 2010", which state that energy is an important factor of both economic development and improved quality of life. The main goals of energy policy are to determine the optimal conditions for efficient energy production and consumption together with significant reduction of their negative impact upon the environment, as well as to preserve and strengthen energy independence.

The Ministry of Fuel and Energy is responsible for elaboration of an energy policy draft and simultaneously for implementation of this policy in the oil, gas, coal and non-nuclear power sector as well as energy efficiency and renewables. Nuclear power generation remains the responsibility of the Ministry of Atomic Energy, which also covers military aspects of nuclear energy. The Ministry of Construction, Ministry of Science and Technology and Russian Energy Efficiency Union, Center for Energy Efficiency and other institutions linked to the Ministry of Fuel and Energy are active in the areas of DH and energy efficiency. Responsibility for heat supply was transferred from the central government to the regional and local authorities. The Federal Authorities have withdrawn from direct responsibilities, especially investments, and are now preoccupied with establishing a legal framework for the energy sector.

The role of CHP in improving energy efficiency in the power sector is very high. Essentially, the potential for energy conservation is concentrated in the field of technical improvements of existing CHP plants and in using combined-cycle power plants instead of traditional steam turbine power plants.[88]

Ukraine

CHP supplies about 7% of total electricity generation. The average age of thermal power stations in Ukraine is 26 years and a few have already reached the end of their useful lifetime. Many stations suffer from boiler problems, old turbines and deficiencies in control and instrumentation systems.

Natural gas accounts for over 40% of the primary fuel consumption of Ukrainian thermal power plants. Non-payment by consumers is another obstacle hindering the further development of Ukraine's power sector. Although Ukraine's regional energy distributors (oblenergos) legally are allowed to cut off non-paying customers to reduce losses and enforce payment discipline, in practice this often cannot be done without government permission.

Ukrainian legislation provides that thermal power generation companies and regional power distribution companies must be privatized. According to the National Electricity Regulatory

[87] United States Department of Energy. An Energy Overview of the Republic of Moldova. Office of Fossil Energy. May 2003.
[88] World Energy Council, 2002.

Commission and Ukraine's antimonopoly legislation, a single company cannot own more than 15% of Ukrainian power supply companies. However, state-owned properties like nuclear power plants, operating hydro power stations, and CHP plants will not be privatized. Concurrently, Ukrainian legislation does not prohibit construction of hydro power plants or CHP plants by independent developers.[89]

[89] United States Department of Commerce. Ukraine – Energy Guide. Market Briefs. Energy & Power Generation.

Regulatory Framework for CHP in EU Member Countries

Austria

Austria implemented the Electricity Directive through a federal electricity law, the Elektrizitätswirtschafts- und -organisationsgesetz (ElWOG), which entered into force in February 1999. In addition to the general framework of the law, several details are included in complementary laws of the 9 Länder (provinces) as well as in two Ministerial regulations (Verordnungen). The Länder laws focus primarily on authorization criteria for new power plants and on details on public service obligations and promotion of renewables.

The main authority carrying out regulatory functions is the Ministry of Economic Affairs. The Ministry is responsible for developing legislation and general energy policy, making decisions on energy and energy supply networks, and determining all regulated access and electricity tariffs. The Ministry acts as the arbitrator for refusals of access cases.

Energie-Control Ltd. was set up by the legislator on the basis of the new Law and took up work on March 1, 2001. Energie-Control is responsible for monitoring, supporting and regulating the Austrian electricity and natural gas market. The major objective of Energie-Control is to guarantee some benefit for all market participants in the course of the liberalization. Regulation will be implemented in a transparent way and on a non-discriminatory basis. Furthermore, Energie-Control is to handle matters concerning the treatment of power generated in plants using renewables and CHP plants.

Energie-Control is an organization under private law, which also has to perform judicial duties by act of law. These duties are in full awareness of the resulting responsibility performed by Energie-Control itself as well as by the Energie-Control Commission (authority with judicial power). The Commission proposes tariff structures and calculation principles and serves as a consultative body to the Ministry on all new electricity regulation, determination of grid use tariffs and other tariffs as well as on the determination of tariffs and billing principles for deliveries of electric energy across regulatory zones.

The authorities of the Länder are responsible for the authorization of new generation capacity. They are also in charge of legal instruments for energy conservation, such as building codes, and provide subsidies for energy conservation measures and for renewables. Cases concerning abuse of dominant position and other aspects of competition law have to be referred to the Competition Authority (Kartellgericht).[90]

Austria relies on a combination of market forces and government action to achieve a well-balanced energy market for CHP and DH by removing market imperfections. The driving force has been the opportunity to produce heat with or without power which has been shown to be cost-effective as compared with alternative means of producing heat and power.

CHP has long been supported by the regulatory structure in Austria. In order to survive financially, the majority of Austrian CHP plants require additional tariffs above the market prices of electricity in order to compete on the market with other generation capacity.

[90] International Energy Agency. Regulatory Institutions in Liberalized Electricity Markets, 2001.

The Green Electricity Act of 2002 governs the aid provided for green energy and CHP generation throughout the country. The Green Electricity Act specifies a budget limit on aid based on calculations of the expenditure required for cost-effective implementation. The expenditure is financed as two components: firstly, the electricity generators and traders must reduce their proportion of cost to the market price and secondly, the end consumers must pay a supplement to the distribution tariff. This means that all end-consumers and electricity generators/traders in Austria are contributing to the finance of the aid required.[91]

Tariffs of DH are bound to an index linked to the development of other factors like prices of heating oil, gas as well as wages. The introduction of the liberalized electricity market means that CHP plants will be delivering services to a competitive electricity market and a non-competitive heating market. Earlier, CHP heat was cross-subsidized by CHP electricity since the assured minimum price for electricity was sufficient to allow the setting of heat prices below full costs.[92] However, the situation might change with competition in the electricity market.

In order to give incentives for heat production from cogeneration, CHP plants have benefited since 1996 from tax rebates on the mineral oils and natural gas tax. Plants with a minimum electricity efficiency of 44% are exempted from taxes on the heat share of energy output.

Belgium

The Ministry of Economic Affairs has ultimate responsibility for most regulatory activities concerning the electricity industry with the exception that substantial portion of the legislation on distribution falls within the jurisdiction of the regional governments. In addition to taxation and development of general legislation, the Ministry sets maximum national tariffs for captive consumers who are not eligible to choose their electricity supplier freely, approves tariffs and access conditions for transmission as well as national requirements for generating and transmission capacity. The Ministry is also responsible for nuclear issues.[93]

An Electricity and Gas Regulatory Commission (CREG) with legal status has been established. It has a general advisory role in the drafting of laws and regulations concerning the electricity market and is responsible for supervising and monitoring their application. It is assisted by a General Advisory Council composed of Federal and regional government representatives as well as representatives of the sector's socio-economic interests. CREG Belgium has two energy regulators since the opening of the electricity market: the Control Committee for Electricity and Gas (CCEG), for non-liberalized segments and CREG, for liberalized segments.

Competition law applies to the electricity industry. The competition authority is the Conseil de la Concurrence, an administrative judicial body linked to the Ministry of Economic Affairs. It works in collaboration with the Electricity and Gas Regulatory Commission, which has conciliation and arbitration powers.

The CCEG defines high-quality CHP as being able to save primary energy and significantly decrease CO_2 emissions compared to separate heat and electricity production. In order to promote CHP, CCEG has made recommendations on prices and tariffs. It has recommended that natural gas prices be reduced for operators of high-quality CHP installations. The regions are

[91] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.
[92] ProCHP, 2002.
[93] International Energy Agency, 2001.

using their own criteria of what constitutes high-quality CHP in their decrees for market liberalization.[94]

Since the promotion of CHP is an issue of regional competence, many of the measures envisaged in the programs mentioned above should be implemented at the regional level.
A Flemish regulator, VREG (Vlaamse Reguleringsinstantie voor de Elektriciteit- en Gasmarkt), regulates the electricity and gas markets in the Flemish region. In Wallonia, the regulator is CWAPE (Commission Wallonne de Régulation pour l'Energie).

The regional decrees on electricity market liberalization include rules to promote high-quality CHP. CHP producers will be free to choose the supplier for any additional electricity they may need, including back-up power and, in the case of industrial CHP producers, power that they cannot cover by their own generation. The consumers of electricity and/or heat produced by CHP plants will be eligible to choose their supplier regardless of their annual consumption.

Unlike the Flemish green certificate scheme in which green certificates are given only to renewable energy installations, the Wallonia system makes it possible to use green certificates to promote CHP. This is done by issuing certificates based on CO_2 emissions that are avoided when using CHP compared to the emissions that would have resulted from heat and electricity produced separately by fossil fuel-fired plants.[95]

To derive separate running costs for the CHP heat and electricity outputs, the manufacturers' performance figures are used to proportionally allocate fuel consumption and hence fuel costs, and similarly to allocate other costs.

Denmark

The basis for regulation of the Danish energy sector is provided in: (a) the Electricity Supply Act, which governs the development and structure of the electricity sector, (b) the Natural Gas Supply Act which provides the guidelines for the construction of the Danish natural gas network, (c) the Heat Supply Act which provides the framework for planning of the heating sector and (d) their amendments.

The objectives of the Electricity Supply Act are to ensure that the Danish electricity supply will be planned and operated respecting the security of supply, the national economy, the environment and the consumers. The Act shall especially promote sustainable use of energy, energy savings, utilization of CHP, utilization of renewable energy and efficient use of economic resources and shall create competition in the markets for production and trade of electricity. The Act regulates production, transport, trade and delivery of electricity. In order to ensure environmentally benign energy production, grid companies and transmission system operators are obliged to buy electricity from decentralized industrial and non-industrial CHP production and from electricity production based on renewable energy and on waste. Consumers are also obliged to use this prioritized electricity or to pay an additional fee in order to adequately compensate companies. The price of this environmentally benign electricity is regulated.

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[94] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002
[95] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002.

The Heat Supply Act allows municipalities to delineate areas where consumers are obliged to connect to DH supply systems. Furthermore, the legislation spells out rules for the price setting of heat products, the general rule being that production should be without a profit. However, private producers of heat based on renewables and industrial surplus heat producers are allowed to earn a profit.

Regulatory functions are shared between a ministerial agency and an independent body that administers regulated electricity prices. The Danish Energy Agency (DEA), an agency within the Ministry of Environment and Energy, is responsible for energy policy formulation and implementation. The Energy Supervisory Board was created in 1999 to replace the Electricity Price Committee and the Gas and Heat Price Committee. The main roles of the Board are to supervise end user prices and delivery conditions and amend them whenever they are found to be unreasonable or to result in an environmentally or economically inappropriate use of energy. In addition, the Board is responsible for setting tariffs for transmission under a general framework established by the Ministry.

The Danish Competition Act applies to the electricity sector provided that it is not in conflict with the Energy Supply Act. The secretariat of the Competition Council is the competition authority (Konkurrencestyrelsen). The Authority also performs secretariat services for the Energy Supervisory Board.

CHP plants are committed to deliver heat at reasonable regulated prices. The intention is to protect heat consumers from costs of electricity production in the liberalized market to be passed on to them. Price regulation is intended to ensure that the benefits of CHP production are shared according to current principles and only appropriate costs are included in the price of heat supplied by CHP plants.

The Heat Supply Act establishes the basic parameters for heat pricing, stipulating that heat supplies must be priced according to actual costs, based on total economic self-sufficiency. In calculating its heating prices, a company must adhere to two major policies: (a) it should include all the necessary costs of heat supply which should allow the company not to go bankrupt; and (b) it should include a reasonable level of interest on capital invested. The local authority which owns a DH company must not transfer profits from the DH company to other uses in the local authority. Profits should be used to benefit the consumers via a corresponding reduction in heating prices.

Thus, all DH companies act as non-profit cooperatives aiming to minimize costs to the consumer by reducing heating prices and thereby eliminating taxable profits.

The Heat Supply Act also establishes that all terms for prices and supply which are made public are regarded as valid after submission to the Gas and Heat Price Committee. Consumers and companies can complain to the Committee about unacceptable tariffs and contracts. The Committee's decisions are made public and, like legal rulings, become guidelines for future terms of agreements and tariffs.

For supplying heat from a major CHP plant owned by the power company, the DH company pays the extra costs associated with the heat production under a comparison with the price of power production alone (the marginal price). In the contracts, the DH companies are foreseen to share the economic benefit derived from the combined production with the power companies after a period of 12-15 years.

For CHP plants owned by the DH company, the heat price is determined as the total cost incurred by the plant including fuel minus the income derived from the sale of power. The power companies have agreed to buy the total power production at a price, which corresponds to 85% of a large consumer's purchasing price. The value of the power depends on the time of day or night and corresponds to the marginal cost in the power system.[96]

As a consequence of the requirement that prices must cover costs, prices vary from one DH company to another. The price charged to the consumer depends on factors such as the price of heat production, the age of the DH network (whether it is a new company with a large debt burden or an old company without debts), and operating and maintenance costs. Normally, a DH company sets the same tariffs in the whole supply area (irrespective of distance from the heating station).

Finland

In Finland, liberalization of the electricity sector began in 1995 through the adoption of the Electricity Market Act. The Act has since been amended to include provisions on balance settlement and includes the load curve profiling method for small consumers and provisions concerning the protection of small customers.

Regulatory activities are split between the Ministry of Trade and Industry and the Energy Market Authority. The Ministry of Trade and Industry is responsible for developing new legislation. The goal of the Energy Market Authority is to promote healthy and efficient competition in the electricity and natural gas markets and to secure reasonable and equitable service principles in electricity and gas network operations. The Energy Market Authority monitors the pricing of network services provided by distribution and regional network operators and the national grid to ensure that it is reasonable and non-discriminatory. Cases can be brought up for supervision either through complaints or on the initiative of the Energy Market Authority. The Energy Market Authority also promotes efficient competition in electricity and natural gas trade, by intervening in the terms and prices of the network services that are considered to restrict competition. The Energy Market Authority produces and publishes real-time information on the pricing of both electric energy and its distribution.

The Finnish Competition Authority (FCA) was founded in 1988. The goal for the FCA is to foster competitive markets. The FCA has determined the DH markets to be a local natural monopoly. The DH networks limit the distribution area to the size of a municipality.

A Finnish CHP production company acts as a seller in two different market environments. The produced electricity is sold in a competitive market and the DH is sold in a market where the company usually is in a dominant position. Competition within the electricity market has been characterized by low average price levels due to the availability of inexpensive hydro and nuclear capacity in Nordic market. Recently, when consumption has increased, the trend of the electricity price has been increasing.

As a result of the market environments, the Act on electricity markets legislates the CHP company to differentiate the bookkeeping of electricity production, electricity sales, power distribution network and other operations. The differentiated business activities are treated as independent economic objects, with profit and loss accounts and balance sheets calculated separately for each. In practice, these business activities are often separated internally into

[96] P. Randløv and A. Dyrelund. Economy and Organisation.

independent activities. The separation diminishes the possibilities for cross-subsidization between different business activities.

The typical CHP company's actions in these two different markets have raised a question of abusing dominant position from a Competition Law point of view. Some claims of abuse of dominance have been brought against CHP companies in the FCA. DH companies typically consider having market dominance in DH markets.

In Finland, as in most other Western countries, the DH companies have a strong and relatively independent role in tariff setting. Tariffs usually are linked to some generally available indexes. Adjustments are implemented automatically if the cost parameters (indexes) have changed. The Office for Free Competition and the Consumer Protection Office may intervene only on request, for example, on a complaint by a consumer. Political pressures and local elections have very little if any impact on heat prices.

The Electricity Market Law defines that electricity pricing should cover operation costs. In a decision of Ministry of Trade and Industry, it has been defined that the benefits from CHP have to be allocated evenly to both operations taking the technical and local conditions into account. The applied cost allocation method also has to be reported in the company's annual report.

France

In France, the Electricity Directive was implemented through the Law of Modernization of 2000 which concerns the modernization and development of the public electricity service.

The Ministry of Economics, Finance and Industry is responsible for most aspects of regulation and energy policy with the exception of the regulation of the network. The Ministry's responsibilities include public service obligations, general technical regulations for the electricity sector and safeguarding the security and smooth operation of the electricity system. It also supervises the industry to ensure that these objectives are met.

Responsibility for network access issues lies with an independent Commission de Régulation de l'Electricité (CRE). The CRE is responsible for ensuring fair and transparent transmission tariffs and access to the electricity network. The CRE also arbitrates disputes concerning network access and advises the Ministry in other areas of regulation, including tariffs for end users. The Commission has the power to impose penalties for non-compliance by the industry with their obligations. The CRE also checks the due and proper nature of offers and criteria adopted by the transmission grid operator, RTE, and has competence to check the proper application of the rules on unbundling. The CRE has widespread powers of investigation and its President is empowered to submit to the French antitrust authority (the "Conseil de la Concurrence") any case of abuse of a market position and anti-competitive practices in the electricity sector.[97]

The regulator reviews the accounts of unbundled operations to ensure that cross-subsidies do not exist. However, the regulator does not have any power to establish tariffs for the captive market, i.e., for those customers who cannot change their supplier. Its role in this respect is limited to reviewing the public utility's demand for tariff increases and giving simple advice.

[97] International Energy Agency, 2001.

A price mechanism of power purchase obligation and feed-in tariff for small CHP plants (< 12 MW_e) has been established and published covering also small hydropower generation.[98]

Under the Decree of 1999 on district heating and cooling networks, new buildings must be connected to existing heating networks and buy the heat if the heat is produced predominantly from renewables or waste. In order to protect the DH consumers, the price for DH provided by the concession holder is regulated.

The tariff of electricity from CHP plants normally provides the basis for determining the heat price. The situation in the DH market is difficult in light of the competing heating sources from natural gas and electric heating. Tax policies discriminate against DH, since a reduced rate of VAT applies to electricity and gas, whereas DH is subject to normal VAT.[99] DH companies have responded to the competition by developing new tariffs and global services and in general by providing a more consumer-oriented approach. In order to create better conditions for CHP, a price reduction of DH is needed. This could be facilitated by new technical regulations, by ensuring that gas prices for large and small consumers reflect their actual costs of supply, and higher prices for CHP electricity sold to the grid and to consumers.

Germany

The new Energy Law ("Gesetz zur Neuregelung des Energiewirtschaftsrechts") entered into force in 1998. The Energy Law amended the Competition Law "Gesetz gegen Wettbewerbsbeschränkungen - GWB" by abolishing existing exceptions for the electricity industry. A further amendment of the GWB introduces a clause whereby refusal of network access without justification is qualified as an abuse of dominant position, which applies not only to electricity but also to other networks (such as gas).

The Ministry of Economy is the general authority in the context of the German Energy Law. The cartel authorities, Landeskartellbehörden or the Budeskartellamt at the federal level are responsible for dispute settlement concerning network access and for issues of competition law, in particular abuse of dominant position. The authorities of the Länder are responsible for authorizations concerning new generation capacities.

The Ministry of Economy is responsible for energy policy and has the general authority over the electricity market. The Ministry is responsible for international activities, analysis of the energy market, rational energy use, renewables, energy research, phase-out of nuclear energy, environmental and climate protection statutes, and overseeing the electricity and DH sectors.

In Germany, there is no ongoing price or access regulation for the electricity market. In this context, no specific electricity regulator exists, although currently there are plans to establish a specific regulator for the energy sector.

The Länder governments are responsible for implementing Federal law. They are responsible for granting licenses in their jurisdiction and the approval of new generating capacity and for applying general standards on land use, security and environmental protection. The Länder may

[98] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002.
[99] Euroheat and Power. Country by Country / 2003 Survey. May 2003.

take their own measures in the field of energy policy, including the promotion of renewables and energy efficiency.

The competition authorities, Landeskartellbehörden in the Länders and the Bundeskartellamt at the federal level are responsible for the application of the Competition Law, notably regarding cases of abuse of dominant position and disputes settlement concerning network access. The Federal Cartel Office has jurisdiction in all cases which have impacts beyond the territory of a county or state, while the Länder Cartel Offices have jurisdiction on cases within their areas.[100]

The Cogeneration Act (Gesetz zum Schutz der Stromerzeugung aus Kraft-Wärme-Kopplung; KWK-Gesetz) was enacted in 2002 and developed a framework for the stranded investment arrangements for cogeneration systems threatened by competition. The Cogeneration Act also aims to contribute to climate protection by reducing Germany's CO_2 emissions. Under the Act, the network operators are required to buy all power produced by energy suppliers in approved CHP facilities inside their territories. The Cogeneration Act determines a fixed surcharge for electricity produced from CHP and fed into the public grid. This surcharge is added to the market price of electricity. These surcharges are reduced annually and completely phased out in ten years. The CHP support under this program is scheduled to end in 2010.[101]

Heat prices are not regulated. Prices are negotiated between the supplier, usually the municipal supplier, and the consumer. Increases in prices are handled through changes allowed for in price clauses in the heat supply contract.

The Competition Law is not applicable to the DH sector, since the DH market is not seen as a monopoly. Because there are no obligations for customers to be connected to the network, the DH sector is not seen to be in a dominant position. Neither is there any obligation to publish DH tariffs.[102]

There are no general regulations in regard to the allocation of costs in CHP plants. The methods utilized may vary widely among the plants and operators.

Greece

Greece adopted a law for liberalization of the electricity sector in 1999. Implementation of the EU Directive has been effective from February 2001.

All regulatory responsibilities are with the Ministry of Development. Control of the monopoly utility Public Power Corporation (PPC) is exercised through power of appointment to the Board of Directors and top management of the utility. The Ministry of Development is responsible for coordinating the development plans of the company with state energy policy and for approving electricity tariffs. The Ministry of National Economy approves the PPC's financing programs.

An independent Energy Regulatory Authority serves as a consultative body on electricity, natural gas and other energy sector matters. Its specific tasks are to advise the Ministry on the granting of licenses, monitor the electricity market, collect information, impose fines for non-compliance and make proposals for the adoption of new measures and regulations.

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[100] International Energy Agency, 2001.

[101] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002

[102] Arbeitsgemeinschaft Ferwärme e. V. Rechtliche Grundlagen der Fernvärmeversorgung, 2003.

The Greek Competition Act applies to the energy sector. The competition authority is the Competition Council. However, the government can exempt public undertakings such as the electricity state-owned company from competition law.[103]

The law of 1999 provided new provisions on the buy-back tariffs for electricity produced by CHPs. In the interconnected system, the generator receives compensation for energy, which is 90% of the energy component in the medium-voltage end-use tariff and 50% of the capacity component in the same tariff. Prices in the non-interconnected system are determined as percentages of the current PPC low-voltage residential tariffs, ranging from 60% for CHPs using fossil fuels to 90% for CHPs using renewable energy.[104]

According to a ministerial degree, in order for a system to be considered as a CHP system, it must satisfy requirements with respect to its efficiency. First, the nominal total efficiency of the system must be equal to at least 65% and secondly, total operating efficiency referred to a period of one month must be equal to at least 60%.

The heat market is not as regulated as the electricity market, and CHP generators may sell the heat they produce at a non-regulated price. However, a Presidential Decree regulates billing of central heating systems in multi-apartment buildings. It prescribes directions and calculation methods for allocation of the heating bills between the apartments according to surface and thermal losses of each apartment.

The Code for Supply to Eligible Customers specifies that as long as PPC holds more than 70% of the eligible customers market, prices offered shall be regulated and public. All suppliers are required to make public their tariff structure.

The Energy Regulatory Authority has submitted for public consultation proposed electricity tariff guidelines, which are based on the separation of use of the transmission system, use of the medium voltage network, use of the low-voltage network and payment for public service obligations. These guidelines also require energy supply tariffs to reflect long run marginal costs of power generation. All regulated tariffs, i.e. use of system and network, correspond to total allowable revenue for the monopoly provider. Regarding the capital costs, the calculation is made on the basis of a regulated asset base and a regulated rate of return on capital. Following the conclusion of the public consultation, the Energy Regulatory Authority is preparing its recommendation to the Minister of Development.

Ireland

An Electricity Regulation Act was implemented in 1999 laying down the framework for the introduction of competition in electricity generation and supply in Ireland. The Act also established an independent Commission for Electricity Regulation.

The Department of Communications, Marine and Natural Resources is in charge of implementing energy policy. The regulation of the electricity market is undertaken by the Commission for Electricity Regulation. The Commission has a duty to examine charges and the costs underlying such charges for electricity supplied by the Electricity Supply Board, the publicly-owned electricity supplier.

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[103] International Energy Agency, 2001.
[104] International Energy Agency. Energy Efficiency Policies 2000, 2001, 2002 and 2003.

The main tasks of the Commission for Electricity Regulation are to grant and supervise operating licenses, authorize the construction of generating stations, approve charges for access to the transmission and distribution systems, and approve arrangements for access to the transmission and distribution systems. The Commission also determines disputes relating to access. The Commission's decisions are subject to an independent mechanism for appeals.

The Competition Act applies to the electricity sector. Breaches of competition law can be investigated by the Irish Competition Authority and, where necessary, it can bring civil and criminal court actions in order to stop anti-competitive arrangements or abuses of dominant position.[105]

The Electricity Regulation Act allowed that electricity produced from CHP plants could be supplied to their main heat customer, which was defined as the person who has entered into a contract with a CHP plant to purchase, in a calendar year, an amount of heat produced by that producer which is greater than that contracted to be purchased in that year from that producer by any other person. CHP generators were also allowed to sell their electricity into the eligible customer market, i.e. the part of the market which was liberalized. However, CHP plants were not allowed to sell their electricity to premises occupied by multi-owners such as commercial offices and business parks. This barrier was removed with the introduction of the Electricity Act of 2001 which provided for 100% access to the electricity market for CHP.[106]

Presently, 40% of the electricity market is open to competition, and electricity generated in a CHP plant can be sold to any final customer but the price paid for any surplus power sold to the grid (i.e., the spill price) remains very low. The major utility companies are currently under no obligation to pay a fair spill price, which, in this context, could be considered as the marginal cost of generation. A CHP Supplier License allows the sale of spill power by that supplier to any consumer via an unregulated bilateral contract. Reclassification also permits unlimited top-up power to be purchased at a lower rate than traditionally generated power, provided the maximum power generated from traditional methods does not exceed 5% in the year. In practice, the spill price would be lower than the top-up price.

In common with other EU states, the heat market is not as regulated as the electricity sector. The heat prices are judged to allow sufficient income for the energy supply company, whether this is owned by a Local Authority or a third party organization. The CHP plant operator pays less for gas than the domestic consumer, because it is a large consumer. This margin, plus the revenue from electricity sales, are judged adequate to provide the operator with sufficient profit.[107] At the same time, the consumer should be provided with heating that is priced attractively compared with the available heating alternatives. A competitive heat price is not the DH company's only selling point, although it is probably an overriding one for domestic consumers. The quality of service, reliability and life cycle costs are important factors, particularly in a DH scheme, which also includes business and commercial users.

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[105] International Energy Agency, 2001.

[106] Irish Energy Center. An Examination of the Future Potential of CHP in Ireland. A Report for Public Consultation, December 2001.

[107] WS Atkins Consultants Ltd. Assessment of the Barriers and Opportunities Facing the Deployment of District Heating in Ireland. Final Report, September 2, 2002.

Italy

The implementation of the Directive has been realized through the adoption of a Legislative Decree in 1999. The Decree establishes the general framework for electricity market opening.

At the national level, the Ministry of Industry, the Ministry of the Treasury and the independent regulatory agency regulate the energy industry. The Ministry of Industry conducts general energy policy and is specifically responsible for licensing electricity companies, issuing building permits and for setting technical standards for generation and distribution. Some policy tasks related to energy efficiency and the promotion of renewables are being progressively transferred to the regional authorities. The Ministry of the Treasury, as owner of a majority stake in ENEL, has an influence on the restructuring and gradual privatization of the industry. It will also remain owner of the new System Operator.

The independent regulatory agency for electricity and gas is the Autorità per l'Energia Elettrica e il Gas (AEEG). It was established in 1995 and has substantial regulatory powers. AEEG is entrusted with an array of functions including the regulation of the network, consumer protection, end-user tariffs, implementing unbundling obligations and some consultative and support activities. In particular, it is responsible for setting tariffs and conditions for third-party access to the network and for system operation, setting maximum tariffs for electricity according to a price cap formula, setting directives for accounting methodology and unbundling, establishing and enforcing quality standards for services and penalties for non-compliance. It also makes proposals to the Ministry of Industry on renewals, modifications and cancellations of concessions, advises the government and the parliament on issues related to electricity and deals with customers' complaints. To carry out these tasks, AEEG has powers to request information from the regulated parties, to inspect them and to fine them for non-compliance. Its decisions are subject to appeal to an administrative court and then to the Council of State. The government can issue general guidelines that the authority is not obliged to follow.

The Competition Act fully applies to all economic sectors and the competition authority (Autorità garante della concorrenza e del mercato) is responsible for enforcing the Act on an exclusive basis. However, AEEG monitors the energy sector and reports any suspected violations of competition law to the competition authority.[108]

The heat market is not as regulated as the electricity market. However, a few favorable measures exist such as tax advantages related to heat supplied by DH systems fuelled by biomass to buildings located in very severe climatic conditions.[109] There has been also a reduced VAT rate for the connection costs to DH up to the end 1996.

Luxembourg

A Law of 2000 regulates the organization of the electricity market in Luxembourg. The framework of the electricity sector provides obligations related to public service for energy enterprises. These obligations are related to information and measures of energy savings, rational use of energy and of the application of new and renewable energy sources.

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[108] International Energy Agency, 2001.

[109] National Agency for New Technology, Energy and the Environment, ENEA. Report on Renewable Energy Policy in Italy.

In 1999, the Ministry of Energy was changed to a Department of Energy in the Ministry of Economic Affairs. The Ministry of Environment is in charge of the policy to curb air pollution and CO_2 emissions. Both ministries have authority for energy efficiency and renewable energy issues.

The regulation from 1996 established the Conseil National de l'Énergie as an advisory body to the government on energy issues. It provides advice to the minister in charge of energy and can, on its own initiative, give advice on energy policy matters which it considers useful.

A regulator is set up to deal with abuses of dominant position. The regulator looks into, inter alia, complaints from eligible consumers about supply contracts and negotiations and access to the grid. Decisions are subject to appeal to the administrative court. The regulatory body is the Institut Luxembourgeois de Régulation. The regulator needs to ensure that there are no cross-subsidies in favor of consumers who are eligible to freely choose their electricity supplier.[110]

The Netherlands

The Dutch Electricity Act relating to the generation, transport and supply of electricity entered into force in 1998. Provisions related to imports and exports, tariffs, technical requirements for connection to the network and supply conditions entered into force with a supplementary law in 1999.

Regulatory responsibilities of the energy sector fall under the jurisdiction of the Ministry of Economic Affairs. Dienst Toezicht en Uitvoering Energie (DTE) is the regulator for both the electricity and the gas sectors. DTE operates as a chamber of the Dutch Competition Authority (NMA), under the authority of the Director of NMA and of the Minister of Economic Affairs.

The Ministry's most important direct roles are to regulate prices for captive customers which are not allowed to change their electricity supplier freely and to specify the terms and conditions of supply to these customers through a licensing process. The Minister also has significant indirect influence over the sector.

DTE regulates the transmission and distribution networks. Its powers under the Electricity Act are, among others, to notify the Minister if a network manager is inefficient in or incapable of providing transport of electricity over the network it manages and to establish the rate structures for connection to the network, for transport of electricity and for the provision of directly related services in agreement with the NMA. DTE notifies the Minister if a license holder (supplier of captive customers) is inefficient in or incapable of providing electricity to its customers it is obliged to supply, advises the Minister on the appointment of network managers, the tariffs for captive customers who cannot change their electricity supplier freely and the import capacity allocation mechanism.

Supply to captive customers can only be carried out by licensed suppliers for a certain supply area under regulated tariffs and conditions. The powers of DTE are restricted to the part of the market of the eligible customers. The Minister sets the rules regarding captive customers and is being advised by DTE on these responsibilities.

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[110] Institut Luxembourgeois de Régulation. National Agency for New Technology, Energy and the Environment.

The NMA settles disputes related to contracts, refusal of access, refusal to purchase and third party access disputes in general. The NMA is under the authority of the Ministry of Economic Affairs. NMA's general responsibilities are to police anti-competitive behavior by electricity market participants, mergers, and horizontal and vertical agreements. In addition, it has specific responsibilities to review and reach agreement with DTE on network tariffs and access rules and to settle disputes relating to contracts and refusal of access or refusal to purchase.[111]

The price of heat is indexed to gas prices. If gas prices increase due to an increase of energy taxes, the indexed heat price will also increase. However, CHP heat consumers do not have to pay energy taxes, so CHP plants receive additional income as a result of the increased taxes on gas.[112]

In the long term agreements between CHP plants and industrial consumers and in the system of benchmarking, prices are calculated for electricity assuming 40% efficiency and for heat assuming 90% efficiency when determining the value of fuel used for electricity generation and heat production from CHP plants.

Portugal

The Portuguese legislation concerning the electricity sector 'Framework law and laws relating to production, distribution and transport' dates from 1995. Amendments to the legislation were made in 1997. Further implementation of the legislation is carried out through secondary regulations.

Responsibility for regulation of the electricity sector is split between the Ministry of Economic Affairs and an independent regulatory agency, the Entidade Reguladora do Sector Electrico (ERSE). The Ministry is responsible for the formulation of general energy policy and regulatory framework, as well as for licensing electric activities. ERSE is responsible for issuing codes concerning tariffs, commercial relations, network and interconnection access, dispatch, as well as for defining consumer eligibility thresholds. ERSE is responsible for setting the regulated prices of electricity and network services. ERSE also serves as a consultative body to the Minister on topics such as licensing and monitoring of the electricity market. Quality standards are set jointly by ERSE and the Directorate General of Energy. To conduct these functions, ERSE has powers to require information and to audit and fine the regulated parties. ERSE's decisions can be appealed before an administrative court only, so that the Minister of Economic Affairs cannot repeal its decisions. ERSE decisions are made after listening to both the regulated parties and a consultative body, representing various social interests.

The Competition Act is applies to the electricity industry, and a Competition Council is responsible for its application. However, the Public Service System including all consumers not opting for the Independent System, which comprises most of the industry, is primarily subject to the specific electricity regulation.[113]

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[111] International Energy Agency, 2001.

[112] SRC International CS, March Consulting, the Institute for Ecology and Environmental Protection IEEP, National Energy Conservation Agency NECA and the Netherlands Energy Research Foundation ECN. Regional Action Plan for Promotion of Combined Heat and Power Production in the Neisse-Nisa-Nysa Euroregion. Analysis of Legal, Administrative and Regulatory Barriers to the Expansion of CHP and District Heating, and Assessment of Possible Impact of the New Liberalized Energy Markets, July 2001.

[113] International Energy Agency, 2001.

A law to regulate CHP production came into force in 1999. This law introduces new prices for the electricity sold to the grid which take into account the environmental benefits resulting from the better energy efficiency of the cogeneration systems. In addition, this legislation defines the amount of heat and electricity that have to be consumed by the producer or its associated companies. It is also compulsory for the grid to purchase electricity generated in a CHP plant.

Spain

The Electricity Directive has been implemented into Spanish law by means of the Electricity Act, which entered into force on January 1, 1998. The Act represents a fundamental reorganization of the Spanish electricity market. Also, several pieces of secondary legislation have been adopted for establishing the regulated electricity tariffs, including the organization and regulation of the procedure for the settlement of transmission, distribution and tariff related costs, the permanent costs of the electricity system, diversification and security of supply costs, the electricity generation market including production on the basis of renewables, waste and cogeneration.

The regulatory responsibilities are split between the Ministry of Economy and the National Energy Commission (Comisión Nacional de Energia, CNE). The Ministry of Economy is the main regulator of the energy sector. Besides having an overall policy responsibility for reforms, the Ministry sets tariffs and charges such as network access tariffs and regulated retail tariffs, allocates revenues among utilities for different cost components such as payments for use of domestic coal, regulates the operation of the power market, issues licenses and authorizations to participants, approves transmission projects, and establishes minimum quality and safety standards.

Autonomous communities have powers in several areas, including the approval of distribution facilities and other electric facilities when their use does not affect other regions and the issuance of authorizations for electricity distribution. The communities also have legislative powers in the framework of national legislation, including the development of regulations with respect to connection of supply and inspection and disciplinary functions including the enforcement of regulations with respect to quality of service.

The CNE is the regulatory body for Spain's energy systems. The goals of the Commission are to ensure the existence of effective competition in Spain's energy systems and their objective and transparent functioning for the benefit of all agents operating in those systems and that of consumers. The energy systems are deemed to be the electricity market and the liquid and gaseous hydrocarbons markets.

The CNE is attached to the Ministry of Economy, which monitors the efficiency of the Commission's activity and is governed by the provisions of the Hydrocarbons Act and its own By-Laws, by any of the provisions in the Budget Act that may apply to it, and by the Act on the Organisation and Functioning of the Central State Administration.

The Spanish Competition Tribunal has the power to apply antitrust rules to the electricity sector, particularly in cases of abuse of dominant position and anti-competitive behavior. In the case of mergers, the Ministry has complete discretion regarding referral to the Tribunal on competition grounds.[114]

[114] International Energy Agency, 2001.

Self-generators and generators operating under the special system of arrangements shall keep separate accounts in their internal accounting procedures for electricity activities and non-electric activities. In the report attached to their annual statement of accounts, the companies must explain the criteria applied for the allocation of costs in relation to other companies in the group that carry out different electricity activities.

Co-generators have two possibilities to sell their surplus electricity, either through the pool, or directly to retailing or distribution companies.

CHP schemes less than 50 MW_e remain under the special regime, which means that distribution companies must purchase the surplus electricity generated by then. For schemes under 25 MW_e, there is an incentive tariff.[115]

The heat market is not as regulated as the electricity sector.

Sweden

The electricity market in Sweden has been liberalized since 1996, and there was only a small need to adapt existing legislation in order to implement the Electricity Directive. A new Electricity Act, consolidating and adapting existing legislation in this area, entered into force on January 1, 1998. The Act was amended to include a provision on publication of transmission tariffs and an order to abolish the requirement for small consumers to invest in special metering equipment in order to get access to the electricity market.

The lead regulatory responsibility belongs to the Ministry of Industry, Employment and Communications. The Swedish National Energy Administration (NEA) was established in 1998 as a ministerial agency responsible for the main part of the implementation and co-ordination of energy policy. Within NEA, the network authority regulates the network. The Administration's main task is to promote a safe, efficient and environmentally sustainable supply and use of energy. It supports research on renewable energy, technology procurement of energy-efficient products and provides investment support for the development of renewable energy. The Administration also has a supervising function as a monitoring authority of the electricity market and provides analyses of the linkages between energy, the environment and economic growth.

The Network Authority, which is part of the NEA, is the specific regulator of the electricity market. It has the task of monitoring network tariffs and other conditions within the monopoly part of the industry. Complaints regarding tariffs from companies or private households are handled by the regulatory authority, which thereby applies the Electricity Act. Its decisions can be appealed to the public administrative court.[116]

The overall regulatory approach is based on limited regulatory intervention. Thus, network tariffs are regulated only indirectly while the network companies manage tariff setting. The network authority monitors tariffs and has the power to accept or reject proposed modifications.

The Competition Authority is responsible for ensuring the application of the competition rules. It also monitors the competitive conditions of production and trading in electricity. It had the

[115] Eurelectric. European Combined Heat & Power: A Technical Analysis of Possible Definition of the Concept of "Quality CHP", 2002.
[116] International Energy Agency, 2001.

special task of following the electricity market in the first six months after deregulation in 1996. In addition, the Competition Authority has given the Network Authority assistance in its work of following the development of market conditions. The Government and the Network Authority regularly invite the Competition Authority to submit its views on reports from the Network Authority.[117]

The electricity market is liberalized in Sweden, and electricity is bought from the market with competitive prices without regulation.

The DH market in Sweden is a monopoly market but it is not regulated since it competes with other heating forms (electric heating, oil etc.), and therefore the DH companies are to establish heating tariffs at competitive prices. However, once a customer has selected DH and invested in DH equipment, the customer is not likely to invest again in equipment of another heating option. In DH areas, since there is only one network supplier who may cross-subsidize his electricity operations through higher DH tariffs, a study is underway in Sweden to determine the need to regulate the pricing of DH and how to allocate the costs to heat and electricity sectors.[118]

In Sweden, separate bookkeeping is required for separate operations such as electricity and heat.

United Kingdom

The United Kingdom consists of three separate and differently organized electricity markets of which the area of England and Wales as well as Scotland have fully opened their electricity markets. Northern Ireland, with currently no physical connection to other areas, has adopted a slower timetable in its market opening. The electricity market system of England, Wales and Scotland was created by the Electricity Act in 1989, and 100% market opening was achieved in 1999.

The Department of Trade and Industry (DTI) is the responsible Ministry with overall supervisory and executive functions on energy policy. DTI has a leading role in the ongoing review of energy regulation and in moving forward with legislative reform of energy regulation. The consent or agreement of DTI's Secretary of State is required for key regulatory decisions such as the licensing of generators, transmission and electricity supply companies. Alternatively, DTI may issue licenses with the consent of the Director General of Electricity Supply.

The Office of Gas and Electricity Markets (OFGEM) is the main regulatory authority acting in England, Wales and Scotland. Other specific roles exist for the Competition Commission and the Office of Fair Trading (OFT). The Director General of Gas and Electricity is the competent authority for the issuing and monitoring of licenses under the general authority of the Secretary of State. There is a separate regulatory office for Northern Ireland.

OFGEM was formed early in 1999 by combining the functions of the former Office of Gas Supply (OFGAS) and the Office of Electricity Regulation (OFFER). OFGEM is responsible for all price regulation and issuing and monitoring of licenses, in collaboration with DTI. The Board of OFGEM comprises one person, the Director General of Electricity Supply. Its duties are to ensure that all reasonable demands for electricity are met and that license holders are able to finance their licensed activities, to promote competition in the generation and supply of

[117] International Energy Agency, 2001.
[118] Kommittédirektiv. Fjärrvärme på värmemarknaden. Decision at the Session of the Government at December 12, 2002.

electricity, to protect the interests of electricity customers in respect of prices charged, to ensure continuity of supply and the quality of services provided, and to promote efficiency and economy on the part of licensees in supplying and transmitting electricity.

The specific functions of the Director General of Electricity Supply are to grant licenses to persons who wish to supply, transmit or generate electricity under a general authority from the Secretary of State, fix and publish maximum charges for reselling electricity and publish information and advice for the benefit of customers with regulated tariffs.

Competition law is applicable to the energy sector. The Director General of Electricity Supply has powers with the Director General of Fair Trading in respect of cases concerning anti-competitive behavior. Merger cases are under the exclusive jurisdiction of the Director General of Fair Trading, who advises DTI's Secretary of State on whether to clear the transaction, refer the transaction to the Competition Commission or accept undertakings in lieu of a reference to the Commission.[119]

After the liberalization of the electricity market in the United Kingdom, CHP plants have had a non-discriminatory access to the network and nowadays they receive market prices for their output. There is no longer any scope to charge excessive prices for standby generation. In addition, CHP schemes benefit from a favorable regulatory environment, as in most cases they are exempted from holding a generation license, do not bear certain system costs and can determine their own operating schedule.

If the CHP plant is supplying more than a few customers, a tariff structure will be devised, based on a unit charge and some kind of standing charge. Heat charges should be competitive with all other forms of heating energy such as electricity, oil or gas. Where there are only one or two customers, for example, an industrial or agricultural unit or hospital, the tariff may be negotiated individually.

There are plans to improve the popularity of housing estates by facilitating the introduction of CHP. The new systems would provide heating to tenants at prices well below the price of electricity for heating.

The United Kingdom quality assurance program involves a Quality Assessment based on a Quality Index (QI) for allocating costs to co-generated power and heat. The QI methodology is built on the rationale that electricity supplied is more valuable than heat supplied. It compares CHP to separate electricity-only and heat-only alternatives.[120]

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[119] International Energy Agency, 2001.

[120] Department of the Environment, Transport and the Regions, United Kingdom. The CHPQA Standard. Quality Assurance for Combined Heat and Power, November 2000.

Regulatory Framework for CHP in EU Candidate Countries

Bulgaria

The adoption of the Energy and Energy Efficiency Act in 1999 marked the beginning of reform of the energy sector and harmonization of the country's regulations with the EU Electricity and Gas Directives. In December 2001, the State Agency for Energy and Energy Resources was transformed into the Ministry of Energy. An independent State Energy Regulatory Commission has been set up and given authority for issuing licenses and setting prices for electricity, natural gas and DH.[121]

Actually there is hardly any competition in the heat market, since the heat production is a local monopoly. However, an element of competition exists with regard to electric heating, since heat from the CHP plant can be replaced by electric heating, which is currently less expensive. Usage of gas is also beginning in residential heating. Some manufacturers build their own heat sources decreasing the heat demand from CHP plants.

Beginning from 2002, the price of heat is determined using the method of residual costs. In this method, power plants are divided into two groups: plants, whose main product is electric power and heat is a subsidiary (secondary) product, and plants whose main product is heat and electric power is a subsidiary product.

In plants whose main product is electric power and heat is a subsidiary (secondary) product, expenses for production of electric power are taken as equal to expenses for an ideal condensing production with a turbine that generates the same quantity and quality of steam as the cogeneration cycle turbine. The price for electricity is generally set in accordance with the Decree on setting and utilization of rates charged for electricity by determining the consumption of ideal fuel for each unit of the ideal condensation operating regime and the corresponding turbines with steam collection or resistance.

In power plants for which the main product is heat and electric power is a subsidiary product, the price of electric power for all producers is set equal to the market price, regardless of the individual expenditures of the power plant. At present, the price is defined as the price for power at the most expensive operating condensing plant with an electric power system plus a surcharge set by the regulatory agency.

The use of surcharges was dictated by the requirements of the Energy Law to the effect that the price of co-generated electric power must be preferential in order to stimulate its production.[122]

Czech Republic

The new Energy Act was passed in December 2000 and came into force on January 1, 2001. The legislation brings the electricity and gas sectors closely in line with the EU Directives. The law

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[121] Eurelectric. Towards a Pan-European Energy Market: Electricity Sector Reform in the Candidate Countries, Balkan Countries and the Russian Federation, June 2002.

[122] Energy Regulators Regional Association, Cost Allocation Between Heat and Electric Power in Combined Energy Production at Cogeneration Plants, 2001.

defines electricity generation, transmission, distribution and trading as business activities in the energy sector, each requiring a license issued by the Energy Regulatory Office.[123]

The Ministry of Industry and Trade (MIT) has overall responsibility for energy policy, including general policy objectives, development of the energy sector, industry supervision and climate change. The Ministry of Finance is responsible for tariffs, ownership and competition. The Ministry of Environment has a portfolio which includes emissions regulation and control, climate change and certain issues related to nuclear and energy policies.

Since January 2001, the Energy Regulatory Office (ERO) has performed the main regulatory functions. The activity of the ERO in price regulation arises consequently from the deregulation framework, which is defined by law and the implementing decrees.

The Office for the Protection of Economic Competition within the Ministry of Finance is the anti-monopoly body and has jurisdiction over the energy market.[124]

The construction of new heating plants above 30 MW_t of capacity must be approved by the MIT, and smaller units are approved by regional authorities. Criteria for approval in both cases include the use of domestic and local energy sources, energy efficiency and solvency of the investing company. There is no compulsory buy-back tariff between heat generators and heat distributors, and prices are fixed by contract. Electricity sales must comprise up to 80% of DH revenues. The liberalization of the electricity market is likely to lower electricity prices and reduce the revenue of CHP operators. In order to mitigate the impact, the new Energy Act includes an obligation for transmission and distribution networks to purchase electricity generated from CHP plants, so co-generators and buyers will have to negotiate prices. The new Act also contains an obligation to purchase heat generated from CHP, industrial processes, renewable energy and environmentally clean incineration.

Fixed prices for heat for industry were eliminated in 1994, but pricing rules with cost formulas remain. Since January 2001, the ERO has regulated household tariffs using a cost-plus-fees method for each network. Tariffs for 50% of households not having individual meters and flow regulation are calculated based on size of space and/or number of persons per apartment. This complicated tariff structure does not accurately reflect heat consumption and does not encourage energy saving. Heat subsidies were abolished in 1996, but the VAT rate remains at 5%.

A new regulation is being prepared concerning the distribution of costs between electricity and heat prices in CHP plants.

The decrees on price regulation are closely interconnected with the rules applicable to keeping separate evidence of revenues, expenses and profits of individual regulated activities. This part of the regulation framework respects the directives on transparent setting of prices and tariffs and the transparency and stability of regulating procedures. Regulated and non-regulated activities are strictly separated. The regulatory framework respects the opening-up of the market and unifies the regulation stages for all sectors.

The decree on the content of economic information and procedures for price regulation in the energy sector sets out the principles and procedures of price regulation in the electricity, gas and

[123] Eurelectric. Towards a Pan-European Energy Market, 2002.
[124] International Energy Agency, 2001.

heating sectors, including the time schedules for the preparation of proposed price submissions. This decree also defines the terms that may be used and the necessary economic information to be submitted to the ERO by license holders. The decree contains the procedures for setting prices, together with requirements for transparency of these prices, the elimination of cross-subsidies among respective categories of end customers, and the principles for their protection in locations where competition is not possible. The basic terms are defined, the activities subject to regulation are set out and the methods used for price regulation for the respective activities of the electricity sector are explained.

Accounting for the production and distribution of heating energy is carried out separately. A system of price increases is set, which is different for production without distribution pipelines and for production including distribution pipelines. The regulated price contains all costs for ensuring particular activities a reasonable profit.

For the first regulatory period, the regulation and capping is applicable to prices of heating energy for households. From the second regulatory period, it is assumed that the position on regulation will be similar to that of electricity and gas. The limit on the year-on-year growth in heat prices for households is expressed by an escalation factor. This escalation factor for a particular year is set by the ERO by a pricing decision.[125]

Estonia

The Energy Act (EA) of 1997 regulates tasks of network operators for power, heat, gas and liquid fuels. The EA distinguishes between fuel and energy traders dominating the market and others. According to the EA, energy companies must keep separate accounts for the production, transmission, distribution and trade of fuel and energy.

In 1998, the Energy Market Inspectorate (EMI) was created as a government agency within the framework of the Ministry of Economy. Its main aims are the promotion of competition in the energy market and the monitoring of its development. The tasks of EMI include licensing and evaluation of tariffs. Depending on the extent of the obligation to purchase energy from renewable sources, a distribution network operator may apply to EMI for a reduction in the transmission rate applied by a transmission network operator. EMI can also examine the financial solidity of market actors and intervene against predatory behavior, especially in the monopolistic parts of the sector.[126]

The decline in DH and cogeneration output is due to the decline of industry in the first half of last decade, competition from alternative heating sources (small gas-fired units) and a relatively high price level of centrally provided heat (due to large losses). In the last years, DH consumption has further reduced as a result of energy conservation measures and energy efficiency investments undertaken by consumers and energy utilities.

The cost of heat has increased in recent years, and the cost increase varies in different production plants. The main reasons for the increase of costs is the higher fuel cost and lower consumption. The range of heat prices is very wide. Some DH companies have introduced price formulas for adjusting the heat prices in accordance to rapidly changing fuel prices.

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[125] Jihlava. Report on the Activities and Financial Management of the Energy Regulatory Office for 2001, May 2002.
[126] Organization for Economic Co-operation and Development, 2002.

Heat providers are usually monopolies in the service area. Competition exists with the alternative energy providers (mainly individual gas boilers).

There is no approved methodology for allocating costs in CHP plants. The energy (physical) method is used in practice and this method allocates most of the benefits to electricity.

Hungary

The new EU-conforming Electricity Act was passed by the Parliament In December 2001. It is to prepare Hungary for the introduction of market opening in the electricity industry. The new legislation simplifies the licensing activity and allows for the implementation of power plant projects on a market basis. An important change is that the Act will partly eliminate the regulated price of electricity sold between producers and traders and between traders and eligible consumers. Regulated prices will remain in the fields of transmission, distribution, system operation and in the field of public utilities.[127]

The Ministry of Economic Affairs is responsible for the regulation of the industry. The Ministry is assisted by the Hungarian Energy Office (Magyar Energia Hivatal, MEH), which is a form of a ministerial agency. The Ministry determines end-user prices and has authority on issues related to the construction of new power plants. However, these decisions are made by Parliament for some large plants. The Minister can also influence the structure of the industry and major capital transactions.

The Hungarian regulator (MEH) was established in 1994 responsible for both electricity and natural gas. MEH conducts a number of advisory and support activities and also has some operational responsibilities. MEH is responsible for licensing and issuing construction permits for generation and transmission, applying individual charges based on average pricing decisions and providing data for pricing decisions by the Ministry, supervising the operations of license holders, monitoring of the markets, as well as monitoring and enforcing the network code, the dispatch code and the distribution code. It is also in charge of customer protection and dealings with customer complaints, approving of the terms of contracts involving regulated parties and mediating disputes between market participants. Decisions made by the MEH can be appealed before the Courts.

Competition law does not apply to actions based on orders by the Hungarian energy authorities. Thus, the Office of Economic Competition does not proceed in cases of abuse of dominant position when the complaint relates to electricity pricing policy in electricity cases, but forwards these cases to the MEH. Both the MEH and the Office of Economic Competition must approve major mergers and acquisitions.[128]

Large heating power plant utilities have a heat supply monopoly because there is only one DH network and no other heat suppliers are allowed to feed heat into that network. However, gas utilities may develop gas networks parallel with DH systems. The District Heating Law of 1998 provides the basis for the general regulation of DH in the household and communal DH areas. The Law divides the responsibility for licensing and administrative control of heat generators and suppliers between the Hungarian Energy Office and the municipalities. The heat producers who generate heat in public power plants fall within the competence of the Energy Office, and the supervision of their electricity generating activities is also exercised by the Office. Promotion

[127] Eurelectric. Towards a Pan-European Energy Market, 2002.
[128] International Energy Agency, 2001.

rules under the District Heating Law present a possibility of designation of city areas for DH and sharing of benefits of CHP between heat and power.

Special promotion rules for DH and CHP are also provided for in the Electricity Act and include a mandatory purchase of all co-generated electricity on DH-basis and guaranteed prices for all co-generated electricity on DH-basis up to 50 MW.

Direct price subsidies of network-connected energy ended in 1992 in Hungary. The Minister of Economic Affairs sets the official prices of steam and hot water generated in public power plants and sold to DH companies. Municipalities set the official DH prices for residential and other consumers and usually try to minimize profits because of social needs. This has had the result of a permanent lack of capital at DH utilities thereby not allowing large investments but only the maintenance of the existing system. The Law on Prices of 2000 prescribes official prices according to the pass-through principle, i.e. cost-determined official prices, and DH operate in the official price environment.

The Minister for Economic Affairs establishes official prices for natural gas, and a cross-financing of gas prices exists for the benefit of small gas consumers. The Ministry establishes also the official prices for heat from power plants resulting in cross-financing of electricity from heat.

Proportional (economic) and social methods for allocating costs to electricity and heat in CHP plants are used. However, a market-based approach is proposed which would be a combination of the proportional and the social method, that is, a more business-oriented approach.[129]

Latvia

The Latvian power market opening formally started in 2000 in accordance with the provisions of the Electricity Law. At present, Latvian electricity sales are principally based on bilateral agreements concluded between Latvenergo and consumers.

The Energy Department in the Ministry of Economy is responsible for energy sector development concepts and manages and analyzes the energy resource balance, prepares draft internal agreements on energy issues, coordinates efficient use of energy resources, analyzes investment projects in energy and participates in the regulatory activities concerning energy enterprises.

The Public Utilities Regulation Commission is an independent state institution responsible for regulation of energy, telecommunications, post and railway sectors in accordance with the law "On Regulators of Public Utilities" and the corresponding normative acts in the regulated sectors. The electricity, gas and heat supply sectors are provided by historically established monopolies. Regulation of public utilities is intended to prevent abuse of monopoly power and provide consumers with services of adequate quality for reasonable price. Electricity and gas are regulated by the Public Utilities Regulation Commission while heating industries are regulated at the local government level by institutions established by the respective municipalities.

The goals of Latvian regulation are to provide users with high quality, continuous and safe public utilities for economically reasonable prices (tariffs), to stimulate efficiency and sustainable development of public utilities ensuring profitability levels consistent with the prevailing

[129] Energy Regulators Regional Association, 2001

economic conditions, and to promote economically justified competition in the regulated sectors. In order to reach the preceding goals, the regulator establishes the tariff calculation methodology, approves tariffs for utilities, issues licenses, supervises implementation of the established conditions, supervises compliance of utilities with requirements for quality and environmental protection, technical regulations, standards, and performs out-of-court settlement for disputes.[130]

Latvia has also introduced a regulation on the requirements for CHP plants and procedures by which the purchase price of surplus electricity produced shall be determined. The methodology for allocating costs for power and heat in CHP plants is based on the alternative energy supply method, which allocates all the benefits of CHP production to electricity. Nowadays gas purchase by small gas consumers is subsidized, so the competitiveness of heat from CHP is poor compared to individual gas heaters when this method is used. However, the subsidies to small gas consumers will decrease according to the future gas tariff modifications.

Lithuania

The Energy Law of 1995 was renewed and accepted by the Parliament in 2000. The Law aims at achieving conformity with EU legislation and the requirements for EU Accession. There is an established framework, which is made more explicit in the respective laws on electricity, gas and heat. The Law is very general and provides broad guidelines. The laws on heat and gas date from 2001.

The Ministry of Economy is responsible for the energy sector. However, the responsibility for restructuring of the DH sector has almost totally devolved to other entities. The Ministry is relying on the Lithuanian Energy Agency, which was brought into existence to help prepare new legislation and to gather information on the energy sector in general. Until the end of 1996, any rulings on tariff policy have been subject to direct approval by the central government, but since the State Control Commission of Prices for Energy Resources and Energy Activities was established, this body has regulated tariff policy. The Commission's duties include establishing electricity and gas pricing principles, approving tariffs calculated by the utilities and protecting consumers.

There is no specific legislation relating to CHP. When it comes to the power sector, at present the Lithuanian Energy Company should remain in majority state ownership, but it is envisaged that a separation of sale and distribution operations established as independent companies will be carried out.

In 1999, Parliament passed a law on compensation for low-income customers. In cases where the DH and hot water bills exceed one quarter of the households income, the balance will be compensated by the state budget.

The main competitors to DH companies are natural gas distribution companies, who are more competitive and are easily picking up the best customers. There is no general state policy to either allow or restrict competition, but municipalities of larger cities have already issued regulations restricting the changes in heat supplier.

Until 1997 when DH was separated from the state monopoly Lietuvos Energija and transferred to municipalities, this sub-sector was fully regulated by the Government. From July 1997,

[130] Organization for Economic Co-operation and Development, 2002.

municipal DH companies are regulated by municipalities and regional DH companies by the national Control Commission for Energy Prices and Activities. From the beginning of 1999, the Commission started to regulate DH tariffs for all municipal companies. Thus, the Commission may take the necessary decisions for tariff increases despite political, social or other pressures. On the other hand, Commission closely cooperates with the Association of Municipalities, and separate municipalities are helping to develop their DH policy, improving quality of supply and energy efficiency. Tariffs are revised twice a year, following a cost plus formula ensuring that tariffs cover costs.[131]

Three of the country's CHP plants use the energy (physical) method for allocating the costs for heat and electricity and one uses the proportional method.[132]

Poland

The main legal basis for the energy sector regulation is the Energy Law of 1997, and the secondary legislation, including the ordinance about the schedule of third party access implementation, three ordinances about principles of tariffs setting for heat, electricity and gas, and an ordinance about obligatory purchase of electricity and heat from the non-conventional and renewable sources as well as obligatory purchase of electricity produced in cogeneration with heat.

The Energy Law defines the principles for developing a national energy policy, the principles and terms for the supply and use of fuels and energy, including heat and the operation of energy enterprises. The Law defines the conditions for conducting economic activities in the energy sector, imposes certain obligations on economic entities and guarantees them certain rights. The major task of the law is to introduce a competitive market in the electric energy and gas industries. Under the law, energy enterprises must sign contracts for delivery of electric energy, gas and heat and must follow the third party access rule allowing all domestic energy entities equal access to the electricity and gas networks. The third party access rule is limited only to electricity and gas produced domestically.

The Ministry of Economy is responsible for overall national energy policy, while the Energy Regulatory Agency (ERA) has regulatory rights. A new mechanism for setting energy prices has been established. The government has gradually moved away from central price setting in favor of prices resulting from competition and determined by energy producers under the supervision of the ERA.

The ERA was established to issue licenses for electricity, gas and heat production, transmission, distribution and domestic trade. The ERA also verifies and controls tariffs, supervises the contracts for power supply and intervenes with natural monopolies such as the power grid. Foreign trade in gas and electricity requires a license from the Ministry of Economy, and the necessary intermediary of the Polish Oil and Gas Company (gas) and Polish Power Grid (electricity) is required in local distribution.

The Energy Law defines the scope of regulation concerning tariffs established by the ERA. Regulation includes the analysis of costs and verification as well as definition of the coefficient of the planned improvement of the energy enterprise, taking into account expected changes in

[131] World Energy Council, 2002.
[132] Energy Regulators Regional Association, 2001.

conditions of economic activity. The basic principle of tariff setting is minimization of supplier and consumer costs. According to the Energy Law, tariffs for heat, electricity and gas should ensure covering justified costs of the supplier and simultaneously protecting the consumers against an unjustified level of prices.

The tariff setting procedure mainly takes place between each enterprise and the ERA. The regulator's role is very strong; an increase in price has to be reasonable and well justified. The Polish tariff setting system is complicated and aims to follow the cost structure in detail. The price setting formulas lead to complicated tariff systems, with basically every boiler and distribution area even within the same city might have different tariffs.

The price of electricity generated by cogeneration is regulated by the Ordinance on Tariffs of Electricity of 2000. The electricity price is calculated based on the average price of energy from condensing units (alternative electricity supply method). Costs can only include justified costs. Justified costs are shared between heat and electricity, while ERA controls both heat and electricity tariffs.

Romania

A governmental decree, an Emergency Ordinance, on electricity and heat was issued in 1998 to regulate the activities of production, transmission, distribution and supply in the power and heat sectors. It also set the rules for import and export of electricity and foresees competition in electricity generation and supply. This ordinance also set up an Electricity and Heat Regulatory Authority (ANRE), which started operating in March 1999. Since then, it has issued the first licenses for the different activities of the unbundled Romanian market.

The Committee for Dispute Reconciliation on the Electricity Market (CADPEE) was also set up beside ANRE, as disputes are generally caused by the non-compliance or misunderstanding of the operating rules. This Committee represents a highly important and efficient factor to ensure a dissension-free operation of the market mechanisms. It is charged with competently solving all misunderstandings and through its decisions, it supplements the system of regulations and contracts.

The Romanian wholesale electricity market is operating according to ANRE's regulations and to the procedures issued by OPCOM, corresponding to the regulations in force. In the Romanian system, an electricity purchase contract from an independent power producer is signed between a seller (an independent power producer) and a supplier/producer. The contract is regulated where quantities are established and prices are negotiated between parties.[133]

The method used by the National Electricity and Heat Regulatory Agency for allocating costs between co-generated electricity and heat is based on a comparison of the total costs of combined production and the calculated costs for separate production (proportional method). The costs are subdivided into the following categories: fuel, investment and others. For each category, costs are allocated between electricity and heat so as to support profitability of cogeneration of both types of energy. The methodology was adopted in 2000.[134]

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[133] Jean Constantinescu, Gheorhe Indre, Vasile Rugina and Niculae Liciu. Building the Competitive Electricity Market in Romania. A Challenging Experience. World Energy Council, October 2001.
[134] Energy Regulators Regional Association, 2001.

Slovakia

The Energy Management Act (EMA) defines the rights and duties of various actors as well as terms and conditions for economic activity in the power, gas and heat supply sectors including efficiency. The aim of the EMA is to guide the energy sector into a market-oriented system in line with EU standards. The EMA sets measures for preventing critical situations in the energy industries, including the terms for state intervention as well as the terms for supervision of the energy market. For the heat supply sector, the EMA defines the fundamental terms and conditions for regulation of heat supply, heat purchase and measurement as well as the principles of dealing with illegal heat use.

The Ministry of Economy, and especially its Energy Policy Department and Department of Power and Heat Supply, are responsible for enforcement of energy conservation measures. However, operative responsibilities are under the specialized agencies. The Slovak Energy Inspectorate (SEI) acts as a regulatory body on technical matters, while the Slovak Energy Agency (SEA) acts as a research, consulting and commercial auditing agency.[135]

The rules for price regulation, intended to be a simulation of price competition, are covered under the Act of the Slovak National Council of1996. Until 2003, regulation in the area of prices and tariffs in the energy sectors have been carried out by the Ministry of Finance. Regulation in the area of economic competition is carried out by the Antimonopoly Office and in the area of business conditions by the Ministry of Economy. The independent Regulatory Office of Network Industries will establish and regulate prices of all natural monopolies, including electric energy and heat supply, from 2003 onwards.[136]

No single and final method exists for the precise distribution of costs between heat and electricity in CHP plants. The prices of heat from CHP sources are the result of the calculations carried out by the producers, depending on their allocation of costs between heat and power production.[137]

Slovenia

The Energy Act in 2001 introduced the energy market in order to modernize the energy regime in light of contemporary developmental trends. At the same time, the Act represents an important step in harmonizing national legislation with that of the EU in this sector. It allows for competition in the energy market and prescribes effective regulation of the energy supply. Thus, the foundation stones were laid for the establishment and opening of the energy market.

The Energy Agency was established by the Energy Act to regulate the operation of the electricity and gas markets, and it began work in January 2001. During the year, it was actively involved in the process of opening the electricity market at all levels and secured certain key conditions for it to unfold smoothly.[138]

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[135] World Energy Council, 2002.

[136] Ondrej Studenec. Changes Within the Energy Sector in Slovakia. Ministry of Economy of the Slovak Republic, August 2003.

[137] Netherlands Energy Research Foundation ECN, Policy Action Plan for Promotion of Combined Heat and Power Production in the Slovak Republic to 2010, November 2000.

[138] Energy Agency of the Republic of Slovenia. Report on the Work of the Energy Agency of the Republic of Slovenia and the Situation in the Energy Sector in 2001, September 2002.

Fixed feed-in tariffs for electricity exist for small generators, and the distribution network operator is obliged to buy all the electricity from qualified producers up to 1 MW of connected power. The Minister of Energy establishes the price in accordance with the Energy Agency. For larger generators, the electricity price is fixed in the open market.[139] State support to CHP is under consideration. It will most probably be based on fixed feed-in tariffs or a green certificates system.

All producers and/or distributors of heat now use a uniform methodology for tariff calculation. The methodology was prepared on the basis of similar methodologies in certain European cities, taking account also of the specific situation in Slovenia.

[139] Tomšic et al., 2001.

Regulatory Framework for CHP in FSU Countries

Belarus

The State still controls most of the energy complex in Belarus. The gas transportation system, electricity transmission and centralized heat supply systems are all monopolies owned by state. The transition to a market economy is starting to take place in Belarus and is beginning to impact the fuel and energy complex. For example, energy payments now need to be made on time whereas previously payment deadlines were not very strict.

After Belarus became an independent nation in the early 1990s, the Ministry of Fuel and Energy was divided into two agencies. The state energy concern Belenergo is responsible for exploitation of all energy sites and planning energy development. The State Committee On Energy Saving and Energy Control is responsible for reducing energy consumption and energy costs. In Belarus, there is a regulation coordinating the relationship between producers, suppliers and consumers of district heating.

The Government regulates fuel prices and energy tariffs in Belarus. Tariffs for electrical energy are standard throughout the country and are declared by a subcommittee of the Ministry of Economics. Thermal energy tariffs are regionally based.

Heat tariffs for residents are regulated by the Government while companies calculate heat prices for industry. Recent heat prices of households reflect only about 10% of actual production costs. To compensate the unprofitable heat supply to the residential sector, heat prices for industry are cost-reflective and include some profit. Thus, DH is not attractive for industrial consumers who in some cases build their own heat-only boiler plants to reduce the costs of heat supply. DH companies are operating with very low profits or even losses. An additional problem is connected with the methodology of cost distribution in CHP plants between heat and power production. At present, all benefits of cogeneration are allocated to the electricity side, so electricity is very inexpensive while heat is as expensive as heat produced in heat-only boiler plants.[140]

Moldova

In 1997 the government embarked on a major restructuring of the energy sector by preparing the state monopoly Moldenergo for privatization. The Energy Law of 1998 covers the organization and regulation of the sector. The government also created the National Energy Regulatory Agency (ANRE), an independent agency in charge of regulating and supervising the sector, setting tariffs and enforcing license conditions.

The main functions of ANRE include regulation of power and natural gas sectors, issuing licenses, promoting competition in energy markets, development of tariff methodologies, supervision of accuracy of calculation and approval of tariffs for generation, transmission, distribution and supply of energy. ANRE also controls service quality, determines economic and technical information to be published by electric and gas utilities, and supervises participants in the power and gas markets. In order to support the local electricity generators, ANRE has obliged

[140] World Energy Council, 2002.

the electricity distribution companies to purchase electricity from local power plants on a priority basis. ANRE also regulates the tariffs for gas, electricity and heat generated by local CHPs.

ANRE has conformed its tariff policy to principles of correctness and fairness in assurance of stability of tariffs, coverage of actual and minimal necessary power costs, coverage of production, transmission, distribution and fixed assets maintenance costs, efficient use of energy, material and human resources, and provision of reasonable profit margin for electric utilities.[141]

The proportional (economic) method for allocating costs between electricity and heat in CHP plants is used. The regulator views this as the optimal solution allowing CHP plants to be competitive in the electricity market. Cogeneration plants produce 30% of all power generated, and the prices of electricity generated by CHPs have reached the level of imported electricity prices.[142]

The accepted methodology describes in detail the list of costs for electric and thermal energy production by CHP plants. The methodology provides definitions for material expenses, works and services in energy production, auxiliary energy consumption, payroll expenses, depreciation of fixed assets, indirect production costs, commercial expenses, administrative and general expenses, etc. In order to define the tariffs for thermal and electric energy properly, the methodology reflects the specific features of the power industry, including the particularities of CHP production. Generally, most expenses are allocated between thermal and electric energy on a pro rata basis, taking into account the fuel cost to produce the specific type of energy in the total fuel cost. Given that the fuel cost is the major component of the total cost of the CHP plants, the methodology determines the fuel cost under the optimal dispatch conditions of the power plant's operation, which implies the lowest possible heat rate.[143]

Russia

The government approved a pro-competitive restructuring plan developed by the Ministry of Economic Development in 2001, thus initiating the restructuring of the Russian electric power industry. The key principles of the Russian restructuring program are in line with international trends of deregulating power sectors. The program envisages the break-up of vertically integrated structures into competitive generation and supply sectors and regulated transmission and distribution businesses. Deregulation of generation and supply is expected to create a competitive market environment, to boost efficient production of electricity and reveal fair economic costs of production.

Two major recent documents highlighting the present status and chosen directions for pricing policies were approved by the Government in 2002: Basics of electricity and DH pricing in the Russian Federation and Rules of state regulation and application of electricity and heat tariffs in the Russian Federation. The pricing policies were developed by RAO EES Rossii and the Ministry of Economic Development. Many mechanisms are specified under conditions that do not contradict legislation in force but do contradict the Russian Constitution, the Law "On the government regulation of electricity and heat tariffs in the Russian Federation" and several other

[141] ANRE Administration Council. Report on the National Energy Regulatory Agency Activity for Year 2001, 2002.
[142] Energy Regulators Regional Association, 2001.
[143] Energy Regulators Regional Association. Designing Tariffs for Efficient, Reliable & Least Cost Energy Supply, 2000.

pieces of legislation. Thus, many of these mechanisms are not legitimate. The federal government already approved a package of laws including one "On the tariffs regulation", and passed this package to the State Duma for approval.

Tariffs and prices, which are regulated by the Federal Energy Commission (FEC) include the following: (a) capacity charge and energy charge for suppliers to the regulated wholesale market sector; (b) capacity and energy charges for buyers at the regulated wholesale market sector; (c) price cap for the free sector of the wholesale market; (d) price for transmission by national and regional grids; (e) grid access charge; (f) charge for the system reliability; (g) charge for guaranteeing the safety of nuclear power stations; (h) charge for balancing services; (i) charge for system operator services; (j) price for heat generated by companies supplying electricity from CHP plants to the wholesale market; (k) price for electricity not supplied to the wholesale market; and (l) subscription fee for the development of EES Rossii transmission grid.

Regional Energy Commissions (RECs) regulate the prices for heat and electricity for final users; the equilibrium price at the wholesale market sector is established by market forces.

Jurisdiction for establishing prices for electricity generated at all sources, as well as for heat generated by CHPs, supplying to the wholesale market is moving from RECs to the FEC. In addition, the basic pricing period is one year with a number of conditions for adjusting tariffs earlier. Production costs depend substantially on the capacity load. A producer could therefore apply for an adjustment of his prices when the gap between the actual and regulated production is over 5%. Thus, generators will apply for adjustment only when real production is 5% lower than the planned levels and new tariffs when production is 5% higher and corresponding production costs are lower. The incentives under this system are to have lower planned volumes and high costs but to sell more and benefit from the cost reduction.

Like the former Soviet State Pricing Committee, FEC will exercise full price control. FEC will directly establish all prices for electricity generation and therefore indirectly all prices for heat generation from CHP plants. Prices for heat for those CHP plants working on the wholesale market will be set up by FEC. If heat prices are established at high levels in order to better allow electricity to be competitive, CHP plants will continue losing local heat markets. If heat prices are established at low levels, CHP plants will lose competition in the power market. RECs will essentially have little authority over heat tariffs other than to deduct required electricity revenues from CHP plant collections and share the balance with co-generated heat.

Electricity prices for all independent power producers (IPPs) also falls under centralized FEC control. The ability of industrial IPPs to provide power to the grid to a large degree depends on the overall market situation and capacity loads which are difficult to maintain within the 5% precision limit. Thus, in many instances, it is difficult to identify how much electricity can be sold to the grid for a year ahead.

It is not clear how much room the new pricing system leaves for competition. Only 5-15% of electricity is to be traded initially in the open market. In the market framework where excess capacities exist, as in Russia, and with substantial differences in production costs and large possibilities for costs reductions, free market prices should be lower than regulated ones.

For a long time, discussions on how to set proper prices for heat and electricity generated at CHP plants have been taking place. It has been recognized that unwise heat pricing policies can result in making CHP less competitive both in heat and electricity markets. Many Russian experts have proposed approaches which allow flexibility in allocating the costs between heat and electricity to

maximize overall economic and energy efficiency of CHP plants. Flexibility is necessary for seasons, climate conditions and many other factors, taking into consideration the market situation of power and local heat markets.[144]

In the majority of regions, the energy (physical) method for allocating costs between electricity and heat in CHP plants is used. In some regions where competition in heat supply has led to a decrease in heat produced by cogeneration plants, CHP plants have begun to use another (so called "economic") method for cost allocation to decrease the costs allocated to heat. In addition, profit levels have been decreased to zero.[145]

The main pricing principle utilized is that utilities should be compensated for all economically justified costs, and competition in the market defines what costs are economically justified. Government is to safeguard that sufficient investments will take place through pricing policy, with the investment component included in the profit margin. So profits are to be guaranteed and set sufficiently high. The transition to the new regulatory system where FEC is responsible for setting prices with a guaranteed investment component provides more hope to the energy sector that adequate investments will be undertaken, since FEC is setting prices for new power plants with profitability sufficient to cover the costs and pay back the invested capital.

Retail electricity and heat prices will be set up by RECs based on the average cost of electricity acquired from the wholesale market, local producers and other suppliers. So if FEC establishes prices for all generating and network companies, the role of RECs is just to develop three tariff menus, i.e., single tariff, capacity charge and energy tariff, and time-of-day tariff for the end-user to choose from.

For new investments, each regulated market agent is to submit its investment plan to be approved by the regulating body. For new power stations, FEC is setting prices at a level that will ensure a given profitability sufficient to pay back invested capital. Those sources are not entering the competitive segment of the market but rather supply exclusively to a regulated market.

If an investment project generates cost reductions, the level of specific consumption used in the planning process is to remain as long as the payback period plus 2 years. No limits on the duration of the payback period are specified, and no procedures for recalculation of these specific variables later are specified. This provision is only applicable to the regulated segment of power market.

The heat tariff setting process is managed by a number of agencies. Gas prices are established by FEC, coal and oil prices are established by market forces, CHP heat tariffs are established by FEC while tariffs of heat-only boilers are established by municipalities and heat prices for final consumers are established by REC and the municipalities. The amount of heat subsidies for residential consumers is established at the federal, regional and municipal levels. This fragmented regulation scheme creates problems related not only to establishment of heat tariffs but also for budget planning, allocation of CHP costs for electricity and heat, and CHP economics and creates uncertainty for the stability of tariffs on a seasonal basis.[146]

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[144] Igor Bashmakov. Electricity Sector Restructuring in Russia: Mismatching Goals and Strategies. Center for Energy Efficiency, 2002.
[145] Energy Regulators Regional Association, 2001.
[146] Igor Bashmakov. District Heating Burden on the Federal, Regional and Municipal Budgets: Planning for Financial Stability. Center for Energy Efficiency, 2003.

Ukraine

The reforms and restructuring of the electricity sector were initiated in Ukraine in 1994. The legal framework of the Ukrainian energy regulatory system is based on laws "On the Electricity Sector" (1997) and its amendments and "On Natural Monopolies" (2000). The rest of the energy legislation is formed by Presidential Decrees and various resolutions.

Before 1994 the Energy Ministry performed all regulatory and control functions in the electricity sector, and the Ministry of the Economy dealt with energy price and tariff policy. The Energy Ministry was the main state body responsible for implementation of state policy in the electricity sector and represented the state as the owner of energy companies. According to the more recent legislation, the activity of natural monopoly industries is regulated by state regulatory commissions. According to the 2000 Law, electricity and gas transportation and distribution undertakings are the subject of natural monopolies and electricity generation and electricity and gas supply are adjacent markets subject to state regulation. Targets of regulation are prices of goods and services, conditions of access to goods and services, and other conditions of carrying out entrepreneurial activity provided by legislation.

The National Electricity Regulatory Commission of Ukraine (NERC) was founded in accordance with a Decree as a standing, independent, non-departmental public agency. The Electricity Law of Ukraine defines NERC as the power sector state regulatory body. Regulation of activity in the power sector is implemented by means of granting licenses for carrying out particular activities in the power sector, developing tariff policy and monitoring the quality of provided services. Responsibility for regulation of the gas sector was also transferred to NERC.

The most recent reform initiative in the sector is the Concept for the Wholesale Electricity Market (WEM) Reform, approved by the Cabinet of Ministers in 2002. The reform aims to liberalize the electricity market and to promote competition by allowing electricity generators and suppliers to enter into direct contracts.

The pricing mechanism in Ukraine remains regulated. Despite the officially declared market-based determination of wholesale prices, the base for price calculation is established by NERC which limits the upper level of the wholesale tariffs for gencos. Retail tariffs are calculated based on a pass through of the wholesale tariff considering the costs of transmission and distribution. The retail tariff structure includes cross-subsidies from industrial consumers to lower the tariffs of residential consumers. The state also provides subsidies in the form of privileges for certain customer groups. Regarding CHPs, NERC regulates the tariff at which the WEM would buy electricity from CHP plants.

Electricity is supplied to consumers mainly by suppliers with regulated tariffs, known as oblenergos and to a very small extent by suppliers with unregulated tariffs (independent suppliers).

In allocating CHP costs, the energy (physical) method is used based on relative amounts of fuel consumed.[147] NERC uses this fuel-based methodology regardless of whether a CHP plant feeds its electricity to the grid or not.

[147] Energy Regulators Regional Association, 2001.

Calculations of the Comparison of Different Cost Allocation Methodologies (VC) as Applied to Two Typical CHP Plants

Basic Data of CHP Plants

Symbol	Basic data is for modern power plants in typical operation environment		Natural gas-fired combined-cycle CHP Plant	Coal-fired CHP plant
	Electricity output, MW		120	60
	Thermal output, MW		120	120
	Efficiency		90%	88%
	Power to heat ratio		1.0	0.5
	Fuel input, MW		267	205
	Peak load hours, h/a		5,000	5,000
E	Electricity generation, GWh		600	300
H	Heat generation, GWh		600	600
F	Fuel consumption, GWh		1,333	1,023
	Fuel costs, EUR/MWh	Variable costs are typical values in Europe (Finland)	13.50	5.40
	Other variable costs, EUR/MWh		1.05	1.40
VC	Total variable cost of CHP plant, MEUR/a		19.40	6.95

Basic Data of Alternative Heat-Only-Plants

Symbol	Basic data is for modern power plants in typical operation environment		Natural gas-fired Heat-only-plant	Coal-fired Heat-only-plant
	Thermal output, MW		120	120
η_h	Efficiency of separate heat production		92%	90%
	Fuel input, MW		130	133
	Peak load hours, h/a		5,000	5,000
	Heat generation, GWh		600	600
$F_h^{'}$	Fuel consumption, GWh		652	667
	Fuel costs, EUR/MWh	Variable costs are typical values in Europe (Finland)	13.50	5.40
	Other variable costs, EUR/MWh		0.36	1.44
$VC_{a,th}$	Total Variable cost of alternative heat, MEUR/a		9.04	4.56

Basic Data of Alternative Electricity Condensing Plants

Symbol	Basic data is for modern power plants in typical operation environment		Natural gas fired combined cycle condensing plant	Coal-fired Condensing plant
	Electricity output, MW		120	60
η_e	Efficiency of condensing power production		56%	39%
	Fuel input, MW		214	154
	Peak load hours, h/a		5,000	5,000
	Electricity generation, GWh		600	300
$F_e^{'}$	Fuel consumption, GWh		1,071	769
	Fuel costs, EUR/MWh	Variable costs are typical values in Europe (Finland)	13.50	5.40
	Other variable costs, EUR/MWh		1.05	1.40
$VC_{a,e}$	Total variable cost of alternative electricity, MEUR/a		15.59	5.23

Allocation of Variable Costs by Applying Different Methods

	Energy Method	**Formula**	**Natural gas fired combined cycle CHP plant**	**Coal-fired CHP Plant**
VC_e	Electricity, MEUR/a (% of total costs)	$VC_e = \frac{E}{E+H} * VC$	9.7 (50%)	2.32 (33%)
VC_{th}	Heat, MEUR/a (% of total costs)	$VC_{th} = \frac{H}{E+H} * VC$	9.7 (50%)	4.64 (67%)

	Work Method	**Formula**	**Natural gas-fired combined-cycle CHP Plant**	**Coal-fired CHP Plant**
VC_e	Electricity, MEUR/a (% of total costs)	Based on theoretical process calculations as described in paras 5.10...5.12.	16.63 (86%)	5.22 (75%)
VC_{th}	Heat, MEUR/a (% of total costs)	Based on theoretical process calculations as described in paras 5.10...5.12.	2.77 (14%)	1.74 (25%)

	Exergy Method	**Formula**	**Natural gas-fired combined-cycle CHP Plant**	**Coal-fired CHP Plant**
VC_e	Electricity, MEUR/a (% of total costs)	Based on theoretical process calculations as described in paras 5.13...5.14.	11.03 (57%)	4.13 (59%)
VC_{th}	Heat, MEUR/a (% of total costs)	Based on theoretical process calculations as described in paras 5.13...5.14.	8.37 (43%)	2.83 (41%)

	Alternative Heat Method	**Formula**	**Natural gas-fired combined-cycle CHP Plant**	**Coal-fired CHP Plant**
VC_e	Electricity, MEUR/a (% of total costs)	$VC_e = VC - VC_{th}$	10.36 (53%)	2.39 (34%)
VC_{th}	Heat, MEUR/a (% of total costs)	$VC_{th} = VC_{a,th}$	9.04 (47%)	4.56 (66%)

	Alternative Electricity Method	**Formula**	**Natural gas-fired combined-cycle CHP plant**	**Coal-fired CHP Plant**
VC_e	Electricity, MEUR/a (% of total costs)	$VC_e = VC_{a,e}$	15.59 (80%)	5.23 (75%)
VC_{th}	Heat, MEUR/a (% of total costs)	$VC_{th} = VC - VC_e$	3.81 (20%)	1.72 (25%)

	Proportional Method	Formula	Natural gas-fired combined-cycle CHP plant	Coal-fired CHP Plant
k_e	Fuel consumption ratio for electricity	$k_e = \frac{E + H - \eta * k_h * H}{\eta * E} = \frac{F}{E} - k_h * \frac{H}{E}$	1.14	1.19
k_h	Fuel consumption ratio for heat	$k_h = \frac{1}{\eta_h}$	1.09	1.11
VC_e	Electricity, MEUR/a (% of total costs)	$VC_e = VC * k_e * \frac{E}{F}$	9.91 (51%)	2.42 (35%)
VC_{th}	Heat, MEUR/a (% of total costs)	$VC_{th} = VC * k_h * \frac{H}{F}$	9.49 (49%)	4.53 (65%)

	Benefit Distribution Method	Formula	Natural gas-fired Combined-cycle CHP plant	Coal-fired CHP Plant
$F_e^{'}$	Fuel consumption of alternative electricity, GWh	$F_e^{'} = \frac{E}{\eta_e}$	1071	769
$F_h^{'}$	Fuel consumption of alternative heat, GWh	$F_h^{'} = \frac{H}{\eta_h}$	652	667
F_e	Fuel consumption of electricity in CHP, GWh	$F_e = \frac{F_e^{'}}{F_e^{'} + F_h^{'}} * F$	829	548
F_h	Fuel consumption of heat in CHP, GWh	$F_h = \frac{F_h^{'}}{F_e^{'} + F_h^{'}} * F$	505	475
VC_e	Electricity, MEUR/a (% of total costs)	$VC_e = \frac{F_e}{F_e + F_h} * VC$	12.06 (62%)	3.73 (54%)
VC_{th}	Heat, MEUR/a (% of total costs)	$VC_{th} = \frac{F_h}{F_e + F_h} * VC$	7.34 (38%)	3.23 (46%)

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