OPET CHP/ DH Cluster:
Workpackage 2: Micro and Small Scale CHP

Cross National Report

European Commission (Directorate-General for Energy and Transport)
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Author(s)	Andrea Preiß
Organisation:	Berliner Energieagentur
Address:	Rudolfstraße 9, D-10243 Berlin
Tel.:	++ 49 30 29 33 30 - 29
Fax:	++ 49 30 29 33 30 - 99
E-mail:	preiss@berliner-e-agentur.de
Web:	www.berliner-e-agentur.de

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1 Introduction

In the latest EU policy, especially in the EU Directive 2004/8/EG on CHP which came into force on February 21, 2004, the promotion of combined heat and power generation is a declared target. Given the higher efficiency of CHP in comparison to separate heat and electricity generation, further exploitation of CHP potential in the EU can contribute remarkably to realizing the EU energy policy's objectives of increasing energy efficiency and improving the security of energy supply. Furthermore, the higher efficiency of cogeneration processes helps to reduce CO_2 emissions and thus contributes to complying with the targets set under the Kyoto Protocol.

Although these benefits of CHP are generally acknowledged, the CHP potential is not yet being exploited to a respectable degree in all the EU and candidate countries. Liberalization of the electricity markets in the EU and the accession countries has brought about restructuring of the electricity sector and setting up new national legislative frameworks. As a consequence of these uncertain and changing conditions, cogeneration expansion has stagnated in many countries. The aim of the OPET CHP/DH cluster is, to support the further use and market uptake of different CHP/DH technologies.

Within in the frame of the OPET CHP/DH, Workpackage 2 (WP 2) has focussed on micro and small-scale CHP (M/SSCHP). The partners of the WP 2 consortium have collected information on the political framework conditions, support schemes, and availability of technology, assessed the market potential and collected best practice descriptions of M/SSCHP use. This cross national report gives an overview on the information compiled by the partners. More detailed information for each country are available in form of country reports and best practice descriptions which can be downloaded at the website: http://www.opet-chp.net

Country	Partner	Short Form	OPET Partner No.
Austria	Energieverwertungsagentur Österreichischer Energiekonsumenten Verband	E.V.A. ÖEKV	14 26
Belgium	Vlaamse Thermie Coordinatie	VTC	22
Bulgaria	Sofia Energy Centre	SEC	12
Estonia	Estonian Energy Research Institute at Tallinn Technical University	EERI	4
Europe	The European Association for the Pomotion of Cogeneration - COGEN Europe	COGEN	19
Finland	Technical Research Centre of Finland	VTT	3
Germany	Berliner Energieagentur	BEA	2
Greece	LDK Consultants Engineers and Planners	LDK	21
Latvia	Ekodoma	Ekodoma	5
Lithuania	Lithuanian Energy Institute	LEI	6
Poland	Krajowa Agencja Poszanowania Energii Baltycka Agencja Poszanowania Energii	KAPE BAPE	7 23
Slovakia	Energy Centre Bratislava	ECB	10
Slovenia	Institut "Joszef Stefan"	IJS	20
Spain	Ente Vasco de la Energía	EVE	17

Policy Level

Cogeneration has been a subject to the represented countries' energy legislation and policy of the last years. In most countries, CHP is acknowledged as an important tool for achieving energy policy and climate protection goals as well as security of energy supply.

Table 1: CHP Targets in National Energy Policy

Country	Targets	Legal Basis *(national language)*	Legal Basis *(English)*	Year
Austria	no target			
Belgium	600 MWe additional cogeneration capacity between 1998 and 2005	Energiebeleidsbrief 2003 voor Vlaanderen	Energy Policy Letter 2003	2003
Bulgaria	no target			
Estonia	Estimation of the CHP additional potential: 200 MWe in DH sector; 25 MWe in industry.	Kütuse- ja energiamajanduse pikaajaline riiklik arengukava	Long-term Development Plan for the Estonian Fuel and Energy Sector	1998
	Estimation of the CHP share by 2020: 20% of total electricity production; 35-40% of the total heat production	Kütuse- ja energiamajanduse pikaajaline riiklik arengukava aastani 2015 (visiooniga 2030) (PROJEKT)	Long-term Development Plan for the Estonian Fuel and Energy Sector up to 2015 (with a vision to 2030) (DRAFT)	2003-2004
Germany	Climate protection target to reduce annual CO2 emissions between 1998 and 2005 by 10 million tons – and until 2010 by at least 20 million tons due to use of cogeneration	Gesetz für die Erhaltung, die Modernisierung und den Ausbau der Kraft-Wärme-Koppelung (KWKModG)	Law on the Conservation, Modernisation and Development of Combined Heat and Power	2002
Greece	no target			
Latvia	no target			
Lithuania	In the total electricity balance the electricity generated in CHP should increase up to 35-45% in 2015-2020 year	Nacionalinė energetikos strategija	National Energy Strategy	1999
Poland	General promotion of CHP, framework for future legislation	Założenia Polityki Energetycznej Państwa do 2020 r.	Assumption of Poland Energy Policy until the year 2020	2000
	Energy company which produces or trades electricity is obligated to purchase el-energy produced in CHP processes, this obligation is fulfilled if the share of electricity purchased or produced in own CHP plant(s) in whole amount of energy supplied by this company will be no less than: 12,4% in 2004, 15,0% in 2005, 15,2% in 2006, 15,4% in 2007, 15,6% in 2008, 15,8% in 2009, 16,0% in 2010	Rozporządzenie Ministra Gospodarki, Pracy i Polityki Społecznej z dnia 30 maja 2003 r. w sprawie szczegółowego zakresu obowiązku zakupu energii elektrycznej i ciepła z odnawialnych źródeł energii oraz energii elektrycznej wytwarzanej w skojarzeniu z wytwarzaniem ciepła - przepis wykonawczy do Prawa Energetycznego	Decree of the Minister of Economy, Labour and Social Policy of 30 May 2003 on scope of obligatory purchase of el-energy from renewable energy sources and el-energy produced in CHP processes - executory provision to Energy Law	2003
Slovakia	no target			
Slovenia	Increase of electricity share from CHP: 6,3% (2000) to 16% (2012)	Nacionalni energetski program	National Energy Programme	2004
Spain	Increase of 1.700 MWe of installed power in CHP between 2004 and 2012, reaching a primary energy saving of 512.000 toe/year	Estrategia de Ahorro y Eficiencia Energética en España 2004/2012	Saving and Energy Efficiency Strategy in Spain for 2004/2012	2003

Almost all countries have ratified specific legislation for energy efficiency, cogeneration or decentralized energy. Legislation in some countries includes **quantitative targets for cogeneration**. The Belgian *Energy Policy Letter 2003*, the *Long-term Development Plan for the Estonian Fuel and Energy Sector* and *Saving and Energy Efficiency Strategy for Spain 2004/ 2012* present potential estimations in concrete terms of installed capacity. The draft of the new *Long-term Development Plant for the Estonian Fuel and Energy Sector up to 2015*, the Lithuanian *Energy Strategy* and the Slovenian *National Energy Programme* specify the potential share of co-generated electricity out of total electricity production. The target of the German *Law on the Conservation, Modernisation and Development of Combined Heat and Power* as well as *Saving and Energy Efficiency Strategy for Spain 2004/ 2012* define the potential of emission reduction due to CHP use.

Nevertheless, there are **no specific targets/ potentials defined for micro and small scale CHP** in the national energy policies. Most policies and legislation do not even mention small scale CHP and its promotion. An exception is Germany, where the extension of small CHP installations and the introduction of fuel cells is listed among the objectives of the *Law on the Conservation, Modernisation and Development of Combined Heat and Power*. However, in most countries there is no special acknowledgement of micro and small scale CHP and in all countries basically the same support mechanisms as for medium and big scale cogeneration apply. Legislative support measures comprise the obligation of the grid operator to purchase co-generated electricity, bonus payments for co-generated electricity as well as subsidies/ preferable tax treatment for fuels for CHP.

Most countries **oblige the grid operators to buy co-generated electricity.** Only in Belgium and Lithuania no such regulation applies. In the other countries, the **remuneration regulations** vary. Slovenia is a good example for a very flexible and differentiated tariff system. It allows the co-generator to choose between different tariff models – a fixed feed-in price or a bonus paid on the price the energy producer attains at the market. The energy producer may further choose between a uniform or a time-of delivery tariff system. In order to promote modern technology, the Slovenian remuneration is reduced for co-generated electricity from older plants. All tariffs are differentiated according to the field of application and the installed capacity. The latter allows producers with plants up to 1 MW installed capacity to receive higher remuneration per kWh. Likewise, the German and Latvian regulation provide higher bonus payments for electricity co-generated in smaller installations. Though the bonus payments are also differentiated in Bulgaria, this system cannot really be regarded as special promotion for small-scale CHP in particular since higher payments are granted for electricity co-generated in units up to 50 MW and there is no further differentiation beyond this threshold. In other countries, e.g. in Austria an uniform bonus per kWh of co-generated electricity is paid, regardless the installed capacity of the respective plant. Like this, the higher investment cost for small units cannot be compensated by the tariff. In some countries, such as Latvia and Austria, the definition of co-generated electricity even discriminates against M/SSCHP: In Austria, only the electricity which is produced as by-product of thermal energy for DH is considered co-generated and thus eligible for the CHP bonus system, and the Latvian bonus system for co-generated electricity only applies if at least 75 % of the thermal energy is fed into the DH system. Therefore, in these countries decentralised

Table 2: Obligation to Purchase and Bonus for Co-generated Electricity

Country	Purchase obligation	Bonus	Legal basis *(national language)*	Legal basis *(English)*	Year
Austria	yes (1)	yes (1)	Elektrizitätswirtschafts- und organisationsgesetz (ElWOG)	Austrian Electricity Act	2002
			Ökostromgesetz	Green Electricity Act	2002 (6)
Belgium	no	no			
Bulgaria	yes (2)	yes (2)	Закон за енергетиката	Energy Act	2003
Estonia	yes (3)	(yes) (4)	Elektrituruseadus	Electricity Market Act	2003
Germany	yes	yes	Gesetz für die Erhaltung, die Modernisierung und den Ausbau der Kraft-Wärme-Koppelung (KWKModG)	Law on the Conservation, Modernisation and Development of Combined Heat and Power	2002
			Gesetz für den Vorrang Erneuerbarer Energien (EEG)	Act granting Priority to Renewable Energy Sources	2000
Greece	yes	yes	Απελευθέρωση της αγοράς ηλεκτρικής ενέργειας-Ρύθμιση θεμάτων ενεργειακής πολιτικής	Energy Law (Liberalisation of Electricity Market) 2773/99	1999
			Ν. 2244/94 Ρύθμιση θεμάτων Ηλεκτροπαραγωγής από Ανανεώσιμες Πηγές Ενέργειας και από συμβατικά καύσιμα	Law 2244/94 Regulation of issues regarding electricity production from RES and other conventional sources	1994
Latvia	yes (5)	yes (5)	Noteikumi nr. 9: Prasības koģenerācijas stacijām un kārtība, kādā nosakāma saražotās elektroenerģijas pārpalikuma iepirkšanas cena	Regulation No. 9: Requirements for CHP Plant and Procedures by which Purchase Price of Surplus Electricity Produced shall be Determined	2002
Lithuania	yes (4)	yes (4)	NUTARIMAS 2003 m. spalio 2 d. Nr. O3-63. DĖL viešuosius interesus atitinkančių paslaugų elektros energetikos sektoriuje kainų 2004 metams	Resolution Nr. O3-63 for prices in public service obligations in electric power sector for 2004	2003
Poland	yes	no	Prawo Energetyczne	Energy Law	1997
			Rozporządzenie Ministra Gospodarki, Pracy i Polityki Spolecznej z dnia 30 maja 2003 r. w sprawie szczegółowego zakresu obowiązku zakupu energii elektrycznej i ciepła z odnawialnych źródeł energii oraz energii elektrycznej wytwarzanej w skojarzeniu z wytwarzaniem ciepła	Decree of the Minister of Economy, Labour and Social Policy of 30 May 2003 on scope of obligatory purchase of el-energy from renewable energy sources and el-energy produced in CHP processes	2003
Slovakia	yes	no		Act Nr. 70/1998 on Energy	2000
Slovenia	yes	yes	Pravila za delovanje trga z električno energijo	Regulations about the electricity market	2001
			Uredba o pravilih za določitev odkupnih cen električne energije od kvalificiranih proizvajalcev	Decree about the rules of defining the purchase price for the electricity from qualified producers	2002
			Energetski zakon	Energy Act	1999
Spain	yes	yes	Real Decreto 436/04	Royal Decree 436/04	2004
			Real Decreto 2818/1998	Royal Decree 2818/1998	1998
			Real Decreto 2366/1994	Royal Decree 2366/1994	1994

(1) only for CHP plants delivering 100 % of thermal energy to the public DH system
(2) only until 2007 - after that tradeble green certificates schemes will be applied for CHP
(3) for all small producers of electricity (up to 10 MW installed capacity)
(4) only for CHP plants fired with RES
(5) only for CHP plants delivering 75 % of the thermal energy to the public DH system
(6) will be amended presumably by the end of 2004 and a specific CHP law is planned to be enacted

application of M/SSCHP where the heat is self-consumed are not supported by the feed-in systems for co-generated electricity. In Estonia and Lithuania, a bonus is granted only for co-generated electricity produced on the basis of renewable energy sources. In countries like Austria and Germany, co-generated electricity on the basis of renewable energy sources is not remunerated with the bonus for cogeneration which is granted in addition to market prices, but with an fixed feed-in payment per kWh for green electricity, which allows more predictable pay-back calculations.Some countries **promote cogeneration at the fuel side**. Like this, the German and Austrian exemption of tax on fuels used for CHP, the Spanish exemption of tax for fuels used for electricity production as well as the Greek price subsidies for fuels for cogeneration, improve the profitability of M/SSCHP remarkably.

Table 3: Fuel Side Support

Country	Fuel side support	Kind of support	Legal basis (national language)	Legal basis (English)	Year
Austria	yes	tax exemption in form of reimbursements	Erdgasabgabegesetz	Law on levy on natural gas	2004
Belgium	no				
Bulgaria	no				
Estonia	no				
Germany	yes	tax exemption for fuels for CHP	Mineralölsteuergesetz (MinöStG)	Mineral Oil Act	2004
Greece	yes	reduced prices for natural gas for CHP		Gas Supply Companies' tariffs	2003
Latvia	no				
Lithuania	no				
Poland	no				
Slovakia					
Slovenia	yes	exemption of excise tax	Zakon o trošarinah	Act about excise-taxes	1998
Spain	yes	reduced tax for fuels for electricity generation	Ley 38/92 sobre Impuestos Especiales	Act 38/92 on Special Taxes	1992

In addition to this support given by legislation, in many countries investment for M/SSCHP can be supported under **international, national or regional financial support schemes.** Objectives of these schemes are usually the promotion of climate and environmental protection or SME development. Support is offered in form of **soft loans**, for example under the German ERP/ KfW- Environment-Programme or under special credit lines by Bulgarian banks for investment in M/SSCHP by small and medium-sized enterprises. Often, investment costs for M/SSCHP units are subsidised by **grants**, for instance under the Greek operational Programme “Competitiveness”. In some countries, there are support schemes addressing M/SSCHP in particular, such as the Austrian *Kommunalkredit* under the environmental support scheme. With the *Kommunalkredit,* Austria subsidies 30 % of the costs for M/SSCHP equipment – turbines, engines, fuel cells and exhaust gas purification systems.

Only very few countries have introduced **mechanisms for the internalisation of external costs**. In Flanders, M/SSCHP owners profit by the Flemish trade with green and with cogeneration certificates. Similar systems will be introduced in Bulgaria in 2007 with the new energy regulation which is currently under preparation. In Slovenia, where in 1997 a CO_2 tax on fossil fuels was introduced, M/SSCHP owners benefit from the higher efficiency and thus less tax burden in comparison to separate production.

Table 4: Support Schemes for M/SSCHP Investment Costs

Country	**Programme** ***(national language)***	**Programme** ***(English)***	**Kind of support**	**Conditions**
Austria	Umweltförderung	Environmental support scheme	grant	Supporting scheme for investment costs, up to 30 % of capitel costs can be subsidised
Belgium	Ecologiesteun	Subsidies on surplus investment cost (2003)	grant	All cogeneration systems; only surplus investment with respect to separated production is eligible
	Fiscale reductiemaatregelen	Supplement on fiscal reduction on investment costs (2003)	fiscal reduction on investment costs	All cogeneration systems; only surplus investment with respect to seperated production is eligible
Bulgaria	Фонд за енергийна ефективност	Energy Efficiency Fund (currenty under establishment) supported by EBRD and WB	soft loan	Still under preparation, but generally the credit terms of the Bulgarian Banking Act will apply with some softer terms
	Кредитни линии от местни банки за малък и среден бизнес	Credit lines from local banks for SMEs (supported by different international donors such as Phare, Deutsche Bank, Dutch Government, etc.)	soft loan	Only SMEs can apply, financing is up to 70-75 % of the total costs, grace period 1-2 years, in some cases operation costs can also be covered
Estonia	-			
Germany	Kreditanstalt für Wiederaufbau (KfW) - CO2 - Gebäudesanierungsprogramm	Kreditanstalt für Wiederaufbau (KfW) - CO2 Building Reconstruction Programm	soft loan	For extensive investments for CO2 reduction in old residental buildings with saving effects of 40 kg CO2/ m2,a
	ERP/ Kreditanstalt für Wiederaufbau (KfW) - Umweltprogramm	ERP/ Kreditanstalt für Wiederaufbau (KfW) -Environment Programme	soft loan	Energy saving and energy efficiency measures in industry and trade sector
Greece	Επιχειρησιακό Πρόγραμμα "Ανταγωνιστικότητα"	´Operational Programme "Competitiveness"	grant	For private investment: Public co-financing: 35%; minimum investment cost: 44,000 EURO; Minimum efficiency of 60% for industrial sector, 65% for tertiary
	Αναπτυξιακός Νόμος 2601/98;	Development Law 2601/98	grant interest fund tax reduction	Investment funding 40% or tax reduction 100%-Interest funding 40%; Minimum efficiency of 60% for industrial sector, 65% for tertiary
Latvia	-			
Lithuania	EU Structural Funds		grant	Grant up 50% for private sector for activities with the aim of reducing energy cost and environmental protection

Poland	Ekofundusz	Ecofund	grant	Grant up to 30% of total investment costs Support goals: investments of big importance for protection of Polish environment fulfilling international priorities, transfer of good environmental technologies, support for development of Polish industry of environment protection sector
	Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej	The National Fund for Environmental Protection and Water Management	loans	Loan up to 50% of total investment costs with possibility of 10 - 15% loan amortisation Goal of support: environment protection investments of country importance
	Wojewódzkie Fundusze Ochrony Środowiska i Gospodarki Wodnej	The Regional Funds for Environmental Protection and Water Management	loans	Loan up to 50% of total investment costs with possibility of 15 - 40% loan amortisation Goal of support: environment protection investments on regional level
	Fundusz Termomodernizacyjny	Thermomodernisation Fund	grant	Commercial loan up to 80% of the total investment costs and than 25% loan amortisation as "Thermomodernisation award" from Fund Support goal: energy efficient investment
	Fundusze Structuralne, Fundusze Spójności - różne programy	Structural Funds, Cohesion Fund - different kind of programmes	grant	Support goals: investments supporting regional develoment
Slovakia	Schéma podpory nákupu inovatívnych technológií a budovania systémov manažérstva kvality	Support scheme for purchase of innovative technology and building-up quality system management	grant	Beneficiares: personal entities, legal enttities, Total support: 60% of eligible costs for purchase of innovative tehcnology (max. 3.5 mil SK), 50% of total eligible costs for building of quiality system management, Costs: Investment cost
	Grantová schéma pre rozvoj inovácií a technológií – INTEG	Grant scheme for development of inovations and technologies - INNTEG	grant	Beneficiares: non-governmantal organisation (municipalities, universities, research centres, industrial parks, and associations of mentioned groups), Max. support: 75% of eligible costs (min. 900,000 EUR, max. 1,450,000 EUR), 50% of total eligible costs
	Program „de minimis“ na podporu energetickej efektívnosti a využívania alternatívnych zdrojov energie	De minimis program on support of energy efficiency and RES utilisation	grant	Beneficiares: SMEs, associations of personal and legal entities, Max support: 100,000 EUR, Min support: 100,000 Sk
Slovenia		Public tender	grant	Investment subsisdies for RES CHP
		Public tender	grant	Financial support up to 50% for feasibilities studies
Spain		ICO-IDAE Financing Programme	soft loan	Interest rate subsidy up to 5% for energy efficiency and renewable energy projects
		Basque Government Energy Efficiency Subsidies	grant	Subsidies up to 15% of the investment; only applicable in the Basque Country area

2 Sector Level

Apart from an promotional energy policy, the **availability of the technology** is an important condition for the dissemination of M/SSCHP. The biggest market is definitely Germany with almost 50 companies offering M/SSCHP services such as operation, maintenance, financing, installation, planning, consultancy and turn key installations. In most national markets, there are representatives of foreign companies such as Viessmann, Jenbacher or Wärtsillä and sometimes also domestic equipment suppliers e.g. WOLA in Poland. Gas engines are the most common drive mode. Innovative technology such as stirling, fuel cells or micro-turbines are available only in very few countries such as Germany, Belgium and Austria. Estonia has a research centre on fuel cells.

Although the M/SSCHP technology is available, there are **only few cogeneration units with an capacity of 1 MW and less** in most of the countries. The spectrum ranges from countries like Bulgaria, Greece and Estonia on the one hand, where SSCHP as a decentralised solution for heat and electricity production is just starting to be implemented to Austria, Belgium, Germany and Spain on the other, where M/SSCHP technology is widely applied.

Table 5:Total Installed M/SSCHP Capacity

Country	Total installed electrical capacity of units of < 1 MWe [MWe]	Number of units with an capacity of < 1 MWe [unit]	Source of information	Year of information
Austria*	20,00	400	Estimation	2004
Belgium (Flanders)	76,00	180	Annual survey	2003
Bulgaria*	1,50	4	Contacts and visits to CHP installers and sites	2003
Estonia	2,70	4	Contacts	2003
Germany	n.s.	n.s.	no up-to-date statistical data are available	
Greece*	2,00	5	Centre of Renewable Energy Sources (CRES)	2002
Latvia	6,80	13	OPET Survey	2003
Lithuania	< 3,00	< 25	Data collected, data available at LEI	2004
Poland	> 7,50	* 23	Contacts with produceres, own investigation	2004
Slovakia	10,00	100	Intech Slovakia ltd	2004
Slovenia	10,60	17	JSI	2004
Spain	178,75	265	Industry Government Department	2004

* approx./ estimation

Table 6*: Availability of M/SSCHP Equipment on the National Markets*

Capacity, Fuel \ Country, Drive Mode	Austria				Belgium				Bulgaria				Estonia				Germany				Greece					Latvia				Lithuania					Poland				Slovakia				Slovenia				Spain			
	engine	fuel cell	microturbine	stirling	engine	fuel cell	microturbine	stirling	engine	fuel cell	microturbine	stirling	engine	fuel cell	microturbine	stirling	engine	fuel cell	microturbine	stirling	engine	fuel cell	microturbine	stirling	others	engine	fuel cell	microturbine	stirling	engine	fuel cell	microturbine	stirling	others	engine	fuel cell	microturbine	stirling	engine	fuel cell	microturbine	stirling	engine	fuel cell	microturbine	stirling	engine	fuel cell	microturbine	stirling
< 50 kWe																																																		
natural gas	x*	x	x	x	x		x	x	x								x*			x*	x									x					x				x*				x	x	x	x	x		x	
landfill gas	x*				x		x	x									x*													x					x				x*		x	x	x	x	x	x	x			
fuel oil	x*				x												x*			x*										x					x								x	x	x	x				
diesel	x*				x												x*				x									x					x				x*				x	x	x	x	x			
biogas	x*	x	x		x		x	x									x*			x*										x					x				x*				x	x	x	x	x			
biodiesel	x*				x												x*													x					x								x	x	x	x				
propane gas																	x*				x														x															
50 kWe - 1 MW																																																		
natural gas	x*		x		x		x	x	x				x				x*	x*	x		x				x	x		x		x		x		x	x*				x*				x	x	x	x	x*			
landfill gas	x*				x		x	x					x				x*				x					x				x				x	x*			x	x*				x	x	x	x	x*			
fuel oil	x*				x*												x*													x				x	x				x				x	x	x	x	x*			
diesel	x*				x*								x				x*				x					x				x				x	x				x*				x	x	x	x	x*			
biogas	x*				x		x	x									x*				x					x				x				x	x				x*				x	x	x	x	x*			
biodiesel	x				x												x*													x*				x	x								x	x	x	x	x*			
sewage gas																	x*																		x*															

* (also) domestic manufacturers

Barriers to further development of the M/SSCHP market depend of course on the situation in the respective country. Nevertheless, some **legislative-administrative, economic and technical barriers** have been reported by some of the countries represented in the WP-consortium.

As explained above, there are promotional legislation and respective support schemes in most countries. Nevertheless, none of the national energy policies sets targets for M/SSCHP, and only few support measures consider M/SSCHP and the higher investment costs per kW installed capacity, in particular. Some legislation even discriminates against smaller appliances by requesting a great part of the thermal energy to be delivered to the DH system and thus discouraging decentralised appliances of M/SSCHP. In some countries, there is no coherent promotion strategy for cogeneration or the targets are not efficiently supported by respective legislation. Mostly, the promotion of M/SSCHP is not supported by mechanisms for the internalisation of external costs like CO_2 tax or CHP certificate trade. In countries with no preferable treatment for smaller cogeneration, long and costly administrative processes for obtaining authorisation to run the M/SSCHP unit hinder respective investments. Another barrier is, that the promotional legislation and financial support schemes are often not known to the target groups.

As to the economic barriers, overcapacity of conventional power plants hinder further development of M/SSCHP. The big power plants have often been amortized and can thus produce electricity at very low prices M/SSCHP cannot compete with. In addition, traditionally vertically integrated energy markets are not supportive to broader appliance of M/SSCHP. Permanently decreasing heat demand due to better insulation of buildings further reduce M/SSCHP market chances. On the other hand, the need for replacement of obsolete and oversized capacities in DH can also mean an opportunity for small scale cogeneration as the example of the Latvian municipality of Adazi shows (see below).

Apart from these structural changes, liberalisation of the gas and energy markets has brought along increasing gas prices and decreasing electricity prices. The unfavourable fuel/ electricity price ratio with further price development remaining uncertain has led to a stagnation of investment in M/SSCHP. Furthermore, interconnection fees and back-up electricity tariffs are considered discriminative by M/SSCHP operators in some countries.

Since gas driven engines are the most common M/SSCHP technology, the fact that in some countries such as Greece and Estonia gas supply is not available in all parts of the country and that connection fees to new gas consumers are relatively high means a technical barrier to the use of M/SSCHP. Furthermore, a lack of experience and know-how in both practical and financial aspects by potential small heat and power producers impedes an exploitation of the M/SSCHP potential.

There are hardly any studies on the **potential for M/SSCHP** in the represented countries. Estimations by the partners show that potential for conventional M/SSCHP plants will be exploited rather on the mid- and long-term run, and that there will be only very few plants with innovative technology such as microturbines, fuel cell and stirling even in the long run.

Table 7: Estimated Potential for Conventional M/SSCHP Technologies

Country	Conventional technology: Potential installed capacity [MWe]			Source or Estimation	Comments
	short term (1 year)	mid term (5 years)	long term (> 5 years)		
Austria	5	25	65	Estimation	Basis of this estimation is the increasing positive environment for SSCHP in the last years. This includes both project-specific drivers (available product portfolios covering many different power sizes, state-of-the-art of technologies, economics, subsidies, simple authorisation procedures) and increasing public awareness about SSCHP concerning their contributions to environmental and energy policies. In case of innovative technologies contributions to RTD policies can be achieved. Existing barriers for high tariffs for back-up and top-up power could be eliminated by the implementation of CHP directive into national law. Grid-access was not mentioned by supplier and distribution companies as major barrier.
Belgium	n.s.	n.s.	n.s.	n.s.	New potential to be determined
Bulgaria	n.s.	n.s.	n.s.	n.s.	Big-scale CHP is currently well developed (supplying about 17 % of generated electricity) but SSCHP is considered still too expensive to apply widely in 2007, Bulgaria is expected to join the EU and then overall economic and investment framework could make SSCHP more attractive; after the accession of Bulgaria to the EU the pace of its introduction is expected to speed-up
Estonia	1 unit	7 units	20 units (2015)	Estimation	M/SSCHP has been completely out of interest of market, ministry, etc. in Estonia. This is not due to any principles or lack of information, but to the situation in the Estonian electricity sector - lot of spare generation capacity on (still) cheap oil shale, unbundled structure of electricity sector, etc. As result, there has been no need to estimate the potential for larger scale CHP plants, not to mention small and micro scale.
Germany	470,00	1.400,00	2.800,00	Estimation	
Greece	2	20	50		
Latvia	2	10	50		
Lithuania	3	10	35		In the National Energy Strategy it was planned that the modernisation of existing CHP plants and the constuction of new ones (of about 400 MW capacity) will facilitate the solution of the problem relating to the growing demand. Capacity about~35 MW by 2022 will be installed SSCHP.
Poland	16 units, 6,7 MW	174 units		EC BREC/IMBER	CHP is in the scope of a government interest but there are still not strong measures to support these investments thus potential for M/SSCHP is almost equal 0 because of high investment and maintenance costs, high fuel prices and low electricity prices. There is potential for M/SSCHP in landfill sites and sewage treatment plants where is surplus of cheap fuel. The important information for potential is that a company for CHP plant constructing and operating was established by Polish state gas company. It could increase potential for gas CHP. It is very difficult to estimate a potential for long terms - it could be considerable if policies and measures will be implemented.
Slovakia	2	12,21	20		Assumptions: short term: no significant changes in enegry policy, utilisation of SSCHP in order to cover own consumption of power energy, marginal comercial el. production, no changes in feed-in tariffs; mid term: adoption of EU directive on cogeneration, support only for efficient CHP units, marginal commercial production of elec. from CHP, market liberalisation, expected wider utilisation of micro CHP in residential sector; long term: progressive utilisation of innovative SSCHP technology, continuos replacement of convetional outdated SSCHP technology
Slovenia	1	20 (2008)	50 (2012)		
Spain			147 (2012)	Industry Government Department	

Table 8: Estimated Potential for Innovative M/SSCHP Technologies

Country	Innovative Technology Potential installed capacity [MWe]			Source or Estimation	Comments
	short term (1 year)	mid term (5 years)	long term (> 5 years)		
Austria	0,25	1,25	3,75	Estimation	The estimated numbers mainly include stirling engines. Due to the high technological status of this development several projects are expected by this technology offering similiar economics for potential investors than state-of-the-art technologies. Concerning micro-gas turbines cost reductions have to take place in order to multiply installations in the next years. This applies even more to possible projects involving fuel cells.
Belgium	n.s.	n.s.	n.s.		Microturbines offer possibilities for niche markets with biogas on short term; the potential is limited to some hundred installations (this potential was determined in a study finalized end 2003 for the Flemish region of Belgium); If stirling engines of 200-500 kW could prove good results, a potential similar to the microturbines is possible; Small stirling engines are not likely to enter the market on a large scale since the residential heating market is quite conservative; the step towards large introduction of condensing boilers still has to be made. Fuel cells are not expected to have a major impact in the first 10 years, since efforts on the level of reliability, cost and safety are not expected to be solved immediately.
Bulgaria	n.s.	n.s.	n.s.		These technologies are too novel and therefore they bear significant economic and financial risk that cannot be met under the current and near future economic conditions in Bulgaria.
Estonia	0	0	2 units (2015)	Estimation	
Germany	n.s.	n.s.	n.s.		Currently, these technologies are in a test phase with the leading plant construction companies involved in. Still investment cost are too high to compete with conventional technologies. Therefore, at this stage no potential estimation can be made since, the potential very much depends on promotional measures.
Greece	0	2	5		
Latvia	0	1	5		
Lithuania	0	2	5		
Poland	0	0		estimation	These technologies are too novel and therefore they bear significant economic and financial risk that cannot be met under the current and near future economic conditions in Poland.
Slovakia	0,05	1	n.s.		short term: only pilot projects, no special support; mid term: expected improvement on the market condition of innovative SSCHP, commercial availability and wider application of the technology; long term: long term potential of innovative SSCHP hardly depends on development of this technology, therefore not possible to determine it at the moment
Slovenia	0,25	1 (2008)	5 (2012)		
Spain		2 (2008)	10 (2012)	Estimation	

3 Project Level

In the context of the OPET CHP/ DH project, the partners have reviewed existing M/SSCHP units in their countries and compiled some of the information in best practice descriptions. These case studies are available on the OPET CHP website http://www.opet-chp.net/. Since M/SSCHP pays back, where heat and electricity are needed during the whole year the following examples collected by the partners illustrate possible application fields.

The examples of Hotel Almesberger (A), Hotel Bankya Palace (BG) and Hotel Európa (SK) show that **hotels** are a profitable application field for M/SSCHP units. Apart from heat demand for hot water and space heating, particular needs such as spa treatments, swimming pools, laundry, sauna landscapes and hot water for catering services lead to an increased heat demand also in summer season, the electricity in these buildings being self-consumed. Similarly, **sanatoriums** such as the hospital rehabilitation centre in Palanga (LT), the district hospital Kartuzy (PL) and the San Eloy hospital (E) as well as **sport centres** as the one in Zumaia (E) with a high demand for heat and hot water throughout the year are good examples of profitable application fields for M/SSCHP.

The examples of small co-/ trigeneration use in shopping centres in Bratislava (SK), Berlin (D) and Celje (SLO) and) demonstrate the application in **commercial and office building centres.** The two latter ones are also examples of third-party financing models: Not the owner of the centres, but an energy service company has planned and financed the small cogeneration units at its own risk. The energy service company is operating the units, supplies heating/cooling and electricity to the commercial centre and gets remunerated per kWh.

The M/SSCHP use in the **residential sector** is not yet developed in most countries. One of the few examples is the micro-CHP in social housing building blocks with 19 dwellings in Herenthout (B). In order to reduce energy consumption for room heating and hot water, thermal collectors, condensing boilers and the MSCHP plant were set-up in the frame of an energy efficiency project . The MSCHP plant is used for pre-heating for space heating and for after-heating the hot water. The co-generated electricity is fed in to a power grid of the two building blocks. Another example is the CHP in Hel (PL), where a small-scale CHP plant produces the electricity for heat pumps for central heating for a complex of 16 residential buildings and provides heat for another 25 residential buildings.

Due to the constant heat demand for space heating and production processes, **industry** offers another interesting field of application. An example of this application field is a furniture factory in Azpeitia (E), where heat is used for drying wood and co-generated electricity covers part of the factory’s consumption. Other examples are M/SSCHP use in industry are the small scale CHP use in a Bulgarian textile factory as well as in Slovenian poultry processing and sport equipment plants.

With the advantage of turning waste into usable energy and decreasing greenhouse gas emission, **landfill sites** are an application field for M/SSCHP with an added ecological benefit. The examples of the SSCHP installation in in Pääsküla (EW), Tagarades (GR) and Liosa (GR) landfill sites show, how nearby municipalities can be supplied with heat whereas the co-generated electricity is fed into the grid. The latter can be particularly profitable if electricity produced by landfill gas fired cogeneration plants is remunerated according to special tariffs for green electricity as it is in Estonia, where there is no feed-in tariff for cogeneration in general but only for electricity produced on the basis of renewable energy sources.

Similarily, the ecological problems of waste disposal can be solved by the application of M/SSCHP in **agriculture**, when animal, agricultural and food wastes are used for the anaerobic production of biogas to fire M/SSCHP. A good example of this application is the plant in the farm Letŭs (SLO) where heat is used for the digestion process, drying straw, heating greenhouses and fed into a small district heating system whilst electricity is sold to the grid at the Slovenian feed-in tariff. In the Rokai pigfarm demonstration project in Kaunas (LT), animal waste is converted into ready to use fertiliser. A SSCHP unit is fired with biogas produced of the pig manure in anaerobic reactors. The heat is used to heat the converters and the co-generated electricity is sold to the grid. Another example of this application field is a purifying plant in Nemšcak (SLO). The pig slurry from two pig-breeding farms is used for the production of biogas to fire a small scale cogeneration plant and the cogenerated heat is used for heating the digester.

M/SSCHP use in **greenhouses** is another field of application, an example of which are the units in the greenhouses of the Belgian company Scheers and the Latvian company Canikava Darznieks. The generated heat is used to maintain the required temperature in the greenhouse and for water heating for the plants. The electricity is self-consumed for artificial lightening, pumps, ventilation etc. or supplied to the grid. Furthermore, the CO_2 produced is used as fertilizer for the plants.

Apart from all these decentralised applications, M/SSCHP is also used for district heating. With the increasing energy efficiency, structural changes and more efficient use of energy in particular in the new EU member states, many **district heating** generation and transmission capacities are oversized. In addition, the technology often is obsolete. M/SSCHP units provide a solution to these problems. During the transition period in the early nineties, the Municipality of Adazi (LV), experienced a decline of the industrial and agricultural sector in the region. Given the outdated technology and oversized capacities, the municipality decided to outsource the heat production. Essent Balitic started to run a SSCHP system for heat supply, the co-generated electricity is delivered to the grid. The better performance of the technology, the reduced consumer’s cost for hot water and heating and the relief of the municipal budget due to the third party financing of the installation are only some of the variety of advantages of this M/SSCHP project.

The wood-fired CHP plant in the town Ilawa (PL) ran by the local district heating company fires wood-chip from waste wood of the surrounding forests, sawmills and furniture industry. Like this it is a good example of how distribution companies can comply with the targets to generate “green energy”.

Other examples of small-scale CHP use for DH are the SSCHP units for the DH company of Pravets (BG) installed as a Joint Venture between Dutch and Bulgarian partners, the unit installed by Edon in Lielvarde (LV), the plant set-up by Gdansk District Heating (PL) for the far off district Gdansk-Matarnia and the one installed by TEHOS in Dolný Kubín (SK).

Gas-fired engines are the common drive mode in the application fields presented. **Innovative technologies** such as microturbines, stirling and fuel cells are not yet used in most countries.

In Germany, there as some examples of appliance of innovative technologies in test stage. For example, a **stirling** motor is applied in a test stage by the district heat and electricity provider of the city of Kiel, in order to prove that long maintenance intervals and less emissions make this technology an attractive alternative to conventional technology.

Another example of the use of innovative technology is the use of two **fuel cells** developed for multi-family houses in the German cities of Brake and Oldenburg which cover the mayor part of the electricity, hot water and space heating required by the residents of two building complexes. The fuel cells were installed in the frame of the project of a virtual power plant, which is co-financed by the EC in the Fifth R&D Framework Programme. In the frame of this project, 31 decentralised residential fuel cells installed in houses, public facilities and small enterprises in Germany, the Netherlands, Spain and Portugal will be centrally controlled.

Table 9: Fields of Application of M/SSCHP Projects:

Country	**Administration Buildings**	**Agriculture**	**Commercial buildings**	**District Heating**	**Educational buildings**	**Food industry**	**Greenhouses**	**Hospitals**	**Hotels**	**Industry**	**Landfill sites**	**Military buildings**	**Residential Buildings**	**Sewage tanks**	**Swimming Pools**
Austria	x	x	x	x		x	x	x *	x*	x*				x	x
Belgium						x	x	x		x	x		x		x
Bulgaria				x					x	x					
Estonia				x			x			x	x				
Germany	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Greece										x	x		x	x	
Latvia		x		x		x				x				x	
Lithuania		x		x	x	x		x		x	x			x	
Poland								x		x	x			x	x
Slovakia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Slovenia		x		x		x		x	x	x	x				x
Spain	x	x		x		x		x	x	x	x				x

* Major field of application

Table 10: Promising Fields of Application for M/SSCHP

Country	Administration Buildings	Agriculture	Commercial buildings	District Heating	Educational buildings	Food industry	Greenhouses	Hospitals	Hotels	Industry	Landfill sites	Military buildings	Residential Buildings	Sewage tanks	Swimming Pools
Austria	x	x	x*	x		x	x	x	x	x					
Belgium		x				x		x						x	x
Bulgaria	x			x		x		x	x	x					x
Estonia	x		x	x	x	x		x	x	x	x				
Germany	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Greece	x	x		x	x	x		x	x						
Latvia		x	x	x		x		x		x	x	x		x	x
Lithuania	x	x	x	x	x	x	x	x	x	x	x			x	
Poland	x			x	x	x		x	x	x	x	x	x	x	x
Slovakia															
Slovenia		x		x		x		x	x	x	x		x	x	x
Spain	x	x	x	x	x	x		x	x		x		x		x

* especially in combination with cooling applications

4 Conclusion

Micro and small scale cogeneration offers solutions for a wide range of applications. Nevertheless, in most of the countries only very few units have been installed so far. This is due to a variety of legislative, economic and technical barriers:

Most countries support cogeneration with obliging the grid operator to purchase co-generated electricity and some kind of remuneration model. Furthermore, there are investment cost support schemes in most countries. Nevertheless, there are hardly any targets and only few support mechanisms especially for M/SSCHP. Sometimes regulations even exclude M/SSCHP by encouraging centralised CHP solutions. Only some countries promote fuels for cogeneration which increases the profitability of M/SSCHP units remarkably. Given the higher investment costs per kW installed capacity, in many countries M/SSCHP is thus not considered profitable under these legislative frame conditions.

Furthermore, the structure of the energy sector in most countries with vertically integrated energy companies, declining heat demand and low prices for electricity produced in amortised big power plants, is far from beneficial for M/SSCHP. At last, potential users of

M/SSCHP often a lack of know-how concerning promotion schemes and M/SSCHP technology.

Therefore, in most countries, M/SSCHP needs further promotion on the legislative level with special regulations and schemes for small appliances. Measures like CO2 tax and green and cogeneration certificates could increase M/SSCHP profitability additionally. M/SSCHP should also be considered as a cost-effective solution for replacing of obsolete and often oversized big-scale heat and power plants. Last but not least, existing promotion measures and technical know-how need to be communicated to potential users. In this context, the seminars and events organised in the frame of OPET CHP/DH have been a valuable contribution.