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COMMISSION STAFF WORKING PAPER

ANNEXES TO THE

IMPACT ASSESSMENT

Accompanying the document

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on energy efficiency and amending and subsequently repealing Directives 2004/8/EC and 2006/32/EC

{COM(2011) 370 final}
{SEC(2011) 780 final}

COMMISSION STAFF WORKING PAPER

Annexes to the impact assessment accompanying the document Directive of the European Parliament and of the Council on energy efficiency and amending and subsequently repealing Directives 2004/8/EC and 2006/32/EC

LIST OF ANNEXES:

Annex I: Public consultation report for the evaluation and revision of the Action Plan for Energy Efficiency

The report and related background information are available on Europa website:
http://ec.europa.eu/energy/efficiency/consultations/2009_08_03_eeap_en.htm

Annex II: Summary of the EU Sustainable Energy Week meeting on the Energy Efficiency Plan and the next steps

Summary of the EUSEW event on the Energy Efficiency Plan: Putting the Plan into Practice

Event name: **The new Energy Efficiency Plan – putting it into practice**
Event date: 12 April 2011 (14:30 – 18:30)
Event venue: Charlemagne Building (room Alcide de Gasperi), 170 Rue de la Loi, Brussels, Belgium
Registered participants: 400, room available for 220
Webstreaming of the event is available at:
http://scic.ec.europa.eu/str/index.php?sessionno=3837a451cd0abc5ce4069304c5442c87

In the context of the European Sustainable Energy Week, the Commission organised an event on how to best put the new Energy Efficiency Plan adopted in March 2011 into practice with particular view of the new legislative proposal on energy efficiency. The event gathered as speakers experts from the European Parliament and different stakeholders (regional ministry, local energy agency, energy company, energy services company and NGOs). More than 400 participants (e.g. from public administrations, industry and consumer associations, NGOs, utilities, energy service companies, ICT companies, European institutions, participants of ongoing EU projects and private citizens) followed the two panel debates discussing the following issues:

- **Energy saving obligations for utilities**: How they should be designed to ensure lasting energy efficiency improvements, e.g. in the buildings sector and how they could have a positive impact on improving energy efficiency in other sectors, e.g. energy generation, industry or buildings? How they can promote the uptake of energy efficient equipment in industry and appliances in households and what the best practices are?
- **Efficient generation of heat and electricity**: What are the most suitable instruments (legislative and others) to trigger higher efficiency levels? How to best enhance extensions and improvement of efficiency of district heating/cooling? How to ensure complementarity between these instruments with other energy policy instruments such as ETS and IED? What are the best practices?
- **Leading role of the public sector**: How can the public sector lead by example to trigger the demand for energy efficient products, buildings and services through public spending? What instruments can public authorities realistically rely on to improve the overall energy efficiency of the equipment their use (e.g. public procurement), the buildings their own (energy performance contracting, targets) or the energy services they contract (energy performance contracting). What are the main obstacles for public authorities to lead by example in this field? Examples of what has been achieved and lessons learnt (best practices)?
- **Energy services companies**: What role can they play in enabling public authorities to contract efficient energy services (e.g. building operation) or in improving the energy performance of their buildings? Are they already best practices? What have been the experiences of ESCOs so far in providing their services to improve the energy performance of the building stock (private and public)? What are the changes needed (legislative and others) to ensure the functioning of the ESCO business model in

providing energy services to public authorities, to the industry and buildings sector as well as to consumers (households/ SMEs)?

- **Empowering consumers**: What services (e.g. consumption data) should be provided to consumers (by energy suppliers, ESCOs) to enable them to better manage their own energy consumption (today and in the future)? How important is clarity and frequency of billing based on actual consumption of energy? What could be done to ensure that consumers (mainly households but also SMEs) benefit from energy efficiency policies, e.g. in the context of the roll out of smart meters, the development of smart grids, labelling of equipment? What measures (legislative and others) are needed?

The participants in the panels were the following:

Key notes speeches by Marie Donnelly (Director, DG Energy) and Bendt Bendtsen (MEP)

Round table 1: Chair Marie Donnelly, DG Energy

- **Topic 1**: Energy Saving obligation for utilities: how to get them right? Richard Cowart – Director, Regulatory Assistance Project
- **Topic 2**: Promoting energy efficient equipment and appliances through ecodesign and labelling: Anita Eide – Director, CLASP
- **Topic 3**: Tackling energy efficiency in the generation of heat and electricity: Giles Dickson – Vice President Government Relations Europe, Alstom Power

Round table 2: Chair Paul Hodson, DG Energy

- **Topic 1**: Leading role of the public sector (public procurement, energy performance contracting, refurbishment target): Lisa Ossman – Association of Swedish Energy and Climate Advisors
- **Topic 2**: Energy Service Companies as catalyst for renovation in the building sector: (i) The ESCO perspective - Adam McCarthy, EUROACE board member; (ii) The practice perspective - Michael Geißler, Managing Director, Berliner Energieagentur
- **Topic 3**: Empowering consumers with right information and technology applications: Heidi Ranscombe, Consumer Focus UK

The main findings resulting from the panel discussions and from the questions raised by the audience can be summarized as follows:

- **Energy saving obligations for utilities:** There is no miraculous scheme as such as the effectiveness will lay in the details of the implementation. Three main criteria should however be ensured:
    - Need for a mandate at top level;
    - Preserve the flexibility of the Member States in designing the obligation scheme;
    - The saving target of the scheme should be ambitious but realistic;
    - Integrated approach: all organisational levels (national, regional, local) should be involved to ensure ownership and commitment.

- **Efficient generation of heat and electricity:** New generation capacities installed throughout the EU do in average not reflect BAT levels. Much more could be done to promote higher efficiency levels in the generation of heat of electricity and in cost-effective manner.

- **Leading role of the public sector:** Public authorities have instruments at hand to improve energy efficiency, e.g. in public buildings. The representative of a regional governmental body presented the approach of his ministry to improve the energy performance in municipalities and hospitals through energy management scheme, but also the training initiative of energy managers as well as of energy facilitators. It showed how a relatively badly performing region in terms of the energy performance in buildings could effectively address the challenge through focused measures on the existing building stock. Further, the discussion showed that public procurement rules do not necessarily need to be a barrier for energy efficiency investments.

- **Energy services companies:**

The ESCO business model is suited to trigger the renovation process in buildings. It is however a more challenging task to ensure that this model triggers "deep renovation" when the demand is lacking.

- **Empowering consumers**: In order to change the behaviour of energy consumers, it is necessary to ensure
  - Clear, credible and comparable communication
  - Delivery of high quality services from day one l
  - Measures which encourage, enable, exemplify and engage consumers.

An important finding was further that no specific channel is largely trusted by consumers to provide advice on cutting their costs from energy bills. The most trusted channels in the UK were independent consumer groups and specialist green charity or non profit organisations. The lowest level of trust was attributed to suppliers, governmental agencies and companies selling green products. Regarding energy performance certificates for buildings, the majority of buyers and renters are not influenced by the information provided through them and almost 80% do not act on any of the recommendations put forward by them. Regarding the use of information on energy consumption to induce electricity savings, advanced meters (e.g. smart meters) must be used in conjunction with in-home (or online) displays and well designed programmes that successfully inform, engage, empower and motivate people have the largest impact (up to 12%).

Annex III: Mid-term evaluation of Directive 2006/32/EC on energy end-use efficiency and energy services

The mid-term evaluation has been carried out in the framework of two background studies:

- Background study for horizontal issues concerning energy savings in the EU, prepared by:
  Piet Boonekamp, Paul Vethman, Joost Gerdes, Jeffrey Sipma and Ynke Feenstra (ECN)
  Hector Pollitt and Philip Summerton (CE)
  Joseph Ordoqui (AETS)

- Background study for Energy Supply Side Efficiency Framework, prepared by:
  Monique Voogt (SQ Consult)
  Jaap Jansen, Michiel Hekkenberg, Paul Vethman and Sytze Dijkstra (ECN)
  Hector Pollitt and Philip Summerton (CE)

The reports are available at:
http://ec.europa.eu/energy/efficiency/eed/eed_en.htm

Annex IV: Progress report on the implementation of Directive 2004/8/EC on the promotion of cogeneration

The report was prepared by European Commission, Joint Research Centre, Institute for Energy and is available at:
http://ec.europa.eu/energy/efficiency/eed/eed_en.htm

Annex V: Detailed explanation and analysis of options A1-A4 on national targets and objectives

1. BACKGROUND INFORMATION

Table 1. Targets adopted by Member States under the Energy Services Directive (Directive 2006/32/EC)

MS	2016 target in final energy savings as indicated in first NEEAP			Comment
	value	unit	%	
AT	80400	TJ	9%	
BE	27515	GWh	9%	From the synthesis Plan[1]
BE-BRU	2199	GWh		2929 GWh was reported in the separate EEAP
BE-Wa	8358	GWh		10478 GWh reported in the separate EEAP
BE-Fla	16959	GWh		Same target reported in the separate EEAP and the synthesis Plan
BG	7291	GWh	9%	
CY	185000	toe	10%	
CZ	19842	GWh	9%	
DK	ND			Annual 9.6 PJ saving of total final energy consumption (2008-2013)
EE	7.65	PJ	9%	
FI	17800	GWh	9%	
FR	12	Mtoe	9%	
DE	833	PJ	9%	This is with factor 1, with factor 2.5 it is 1080 PJ
GR	18659	GWh	9%	
HU	15955	GWh	9%	
IE	13117	GWh	9%	The sum of the measures listed is higher: 18274 GWh
IT	126327	GWh	9.6%	
LV	3483	GWh	9%	
LT	400	ktoe	11%	
LU	1582	GWh	9%	
MT	378	GWh	9%	
NL	51190	GWh	9%	
PL	192.4	PJ	9%	
PT	1.792	Mtoe	9.8%	This saving is for 2015 (final energy), no target indicated for 2016
RO	2800	ktoe	13.5%	
SK	37215	TJ	9%	
SI	4261	GWh	9%	
ES	ND			Goal of 11% final energy savings by 2012 (equals 24776 ktoe primary energy)
SE	32.3	TWh	Min 9%	This corresponds to 41.1 TWh primary energy
UK	136.5	TWh	9%	"Expected savings" are 272.7 TWh (18%), to which UK does not commit officially

Source: SEC(2009)889 Synthesis of the complete assessment of all 27 National Energy Efficiency Action Plans as required by Directive 2006/32/EC on energy end-use efficiency and energy services

[1] Belgium originally submitted 3 Plans for Wallonia, Flanders and Brussels Capital, which had separate targets expressed in different units. Therefore, Belgium had no national savings target. This has been revised and an umbrella Plan has been adopted, where the targets are standardized and recalculated. Therefore, the targets for each region have slightly changed – see comments.

2. DESCRIPTION OF THE POLICY OPTIONS

24 alternative target formulations have been analysed but not retained for the purpose of this impact assessment. However, to underline the present analysis, an overview of the target cases will be presented here. Further details on the precise impacts of these alternative target formulations can be found in the "Background study on horizontal energy efficiency issues in the EU" which is annexed to this document.

The target options retained for a closer analysis were:

A0	Baseline (energy efficiency)
A1	ESD extension to 13% in 2020
A2A	MS primary 2007 level
A2B	MS primary PRIMES 2007
A2C	MS primary PRIMES 2009
A2D	EU primary 2007 level
A2E	EU primary PRIMES 2007
A2F	EU primary PRIMES 2009
A2G	Voluntary (60% of MS primary PRIMES 2009)
A2H	Voluntary (80% of MS primary PRIMES 2009)
A2I	Voluntary (60% of MS primary PRIMES 2007)
A2J	Voluntary (80% of MS primary PRIMES 2007)
A3A	MS final 2007 level
A3B	MS final PRIMES 2007
A3C	MS final PRIMES 2009
A3D	EU final 2007 level
A3E	EU final PRIMES 2007
A3F	EU final PRIMES 2009
A3G	Voluntary (60% of MS final PRIMES 2009)
A3H	Voluntary (80% of MS final PRIMES 2009)
A3I	MS Franhofer final total
A4A	MS Fraunhofer final Household
A4B	MS Fraunhofer final Industry
A5A	MS energy efficiency final at 2%pa
A5B	MS Energy additional final energy efficiency improvement of 0.5 pc pa to baseline

3. EVALUATION OF THE IMPACT

Table 2. Overview of the main modelling results of the different target formulations

	A0	Additional impacts										
		A1	A2A	A2B	A2C	A2D	A2E	A2F	A2G	A2H	A2I	A2J
GDP (2000 m euro)	12537127	0	44492	33745	75453	39954	31826	42411	41260	54616	30058	32422
Consumption (2000 m euro)	7155944	0	-26771	-14750	9643	-37933	-14809	-41514	-9384	-5409	1448	-5854
Investment (2000 m euro)	3177669	0	77130	46528	66120	68846	40489	75011	47960	58035	26605	35556
Exports (2000 m euro)	6147093	0	-55420	-16229	-28696	-27898	-13658	-31274	-15549	-21616	-6607	-10870
Imports (2000 m euro)	5744389	0	-49553	-18196	-28386	-36939	-19803	-40189	-18233	-23606	-8612	-13592
Consumer prices (2000 = 1.0)	1,62	0	0,09	0,04	0,08	0,09	0,05	0,10	0,05	0,06	0,02	0,03
Employment (000s)	226942	0	931	398	1011	542	339	593	413	581	216	327
Real household incomes (2000 m euro)	8672403	0	-46927	-18908	20859	-49986	-20831	-54729	-9748	-16197	-2018	-8693
Energy demand (m toe)	1910	0	-328	-198	-338	-325	-197	-348	-201	-266	-116	-155
CO2 emissions (m tonnes carbon)	1064	0	-196	-123	-209	-202	-125	-216	-124	-164	-80	-98
GHG emissions (m tonnes carbon)	1250	0	-225	-142	-237	-229	-143	-245	-143	-187	-92	-113
ETS Price (08 euro/tCO2)	28,7	28,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0	0

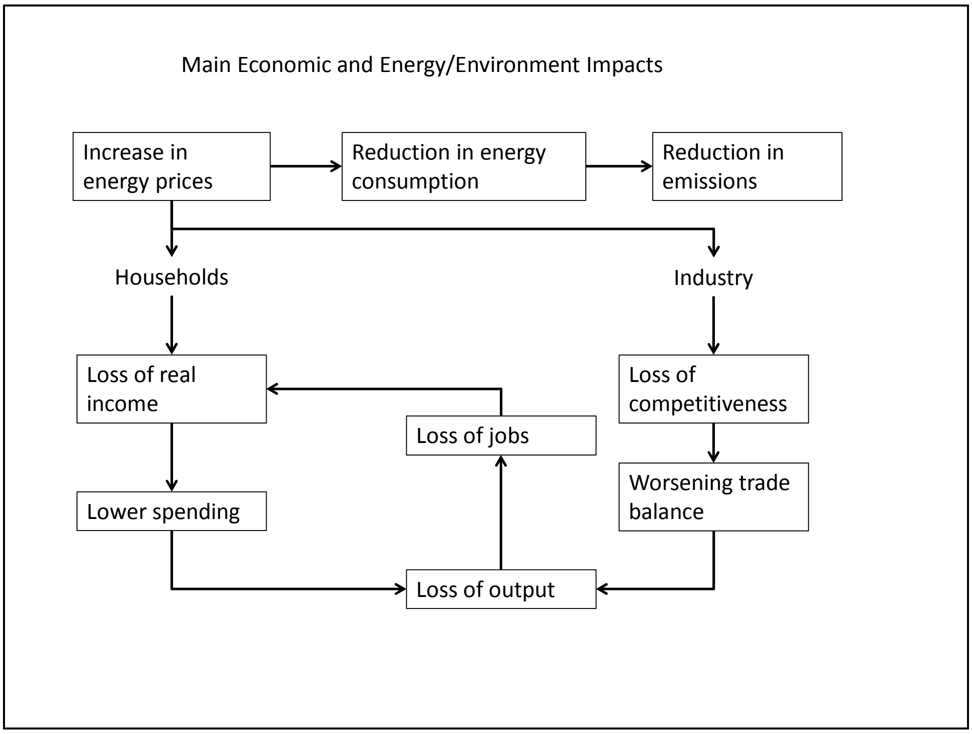
	A0	Additional impacts								
		A3A	**A3B**	**A3C**	**A3D**	**A3E**	**A3F**	**A3G**	**A3H**	**A3I**
GDP (2000 m euro)	12537127	70895	24746	39602	39373	29821	35804	33064	29895	14123
Consumption (2000 m euro)	7155944	-25335	-2793	-11456	-36386	-5999	-26200	-3659	-6155	1073
Investment (2000 m euro)	3177669	93138	26011	49271	67609	30830	54455	33384	35110	10568
Exports (2000 m euro)	6147093	-29918	-9140	-21478	-25555	-7073	-19015	-9007	-16483	-1314
Imports (2000 m euro)	5744389	-33011	-10668	-23265	-33705	-12063	-26564	-12346	-17423	-3796
Consumer prices (2000 = 1.0)	1,62	0,07	0,03	0,06	0,08	0,03	0,06	0,03	0,04	0,01
Employment (000s)	226942	729	242	410	498	281	394	238	273	136
Real household incomes (2000 m euro)	8672403	-56668	481	-18538	-48504	-10807	-35991	-5146	-7746	2793
Energy demand (m toe)	1910	-301	-135	-252	-307	-138	-249	-153	-194	-39
CO2 emissions (m tonnes carbon)	1064	-183	-88	-159	-191	-92	-158	-102	-122	-29
GHG emissions (m tonnes carbon)	1250	-210	-102	-181	-217	-105	-179	-117	-140	-36
ETS Price (08 euro/tCO2)	28,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,9

	A0	Additional impacts			
		A4A	A4B	A5A	A5B
GDP (2000 m euro)	12537127	-19189	2756	3374	184
Consumption (2000 m euro)	7155944	-16872	9134	4290	-1637
Investment (2000 m euro)	3177669	871	-6534	-1716	3546
Exports (2000 m euro)	6147093	-5946	514	-1985	-7386
Imports (2000 m euro)	5744389	-2757	358	-2785	-5662
Consumer prices (2000 = 1.0)	1,62	0,02	0,00	0,01	0,01
Employment (000s)	226942	-171	63	21	0
Real household incomes (2000 m euro)	8672403	-12895	13485	4142	5418
Energy demand (m toe)	1910	-32	9	-21	-55
CO2 emissions (m tonnes carbon)	1064	-20	1	-18	-37
GHG emissions (m tonnes carbon)	1250	-15	1	-22	-44
ETS Price (08 euro/tCO2)	28,7	25,9	16,3	15,6	7,3

Table 3. 2020 EU27 Real income (% diff from base)

	A2 Extension of ESD	**A3 Pessimistic scenario**	**A3 Optimistic scenario**	**A4 Binding targets**
1 All households	0	0,0	-0,1	-0,2
2 Exp groups: first quintile	0	-0,1	-0,2	-0,3
3 Second quintile	0	-0,1	-0,2	-0,3
4 Third quintile	0	-0,1	-0,2	-0,3
5 Fourth quintile	0	0,0	-0,1	-0,2
6 Fifth quintile	0	0,0	-0,1	-0,2
7 Socio-econ:manual workers	0	0,0	-0,1	-0,2
8 Non-manual workers	0	0,0	-0,1	-0,3
9 Self-employed	0	-0,5	-0,7	-1,0
10 Unemployed	0	-0,5	-0,8	-1,1
11 Retired	0	-0,4	-0,7	-0,9
12 nactive	0	-0,5	-0,8	-1,1
13 Pop.density: densely	0	0,0	-0,1	-0,2
14 Pop density: sparsely	0	-0,3	-0,5	-0,7

Figure 1. Overview of modelling of the main economic and energy/environment impacts with E3ME model



Source: Background study horizontal issues concerning energy savings in the EU, E3ME Model

Annex VI: Detailed explanation and analysis of options E1-E5 on national reporting

1. BACKGROUND INFORMATION

The ESD introduced an obligation for Member States to submit **National Energy Efficiency Action Plans** (NEEAPs) every three years. The Plans are intended to describe national strategies and measures to achieve the energy saving targets set out in the Directive. The NEEAPs should aim at achieving significant energy savings in end-use sectors.

The purpose of the first NEEAP was to indicate specific measures that Member States intended to implement in order to ensure that their national energy saving targets are achieved. The NEEAP also had the role of showing how in practice Member States intend to comply with the Directive's provisions on the exemplary role of the public sector, the provision of information and advice on energy efficiency to end users, obligations for the energy sector to contribute to energy saving, etc. The Commission presented its assessment of the first NEEAPs in the form of a Staff Working Paper in July 2009 (SEC889/2009)[2].

Under the current legal framework of the ESD, Member States are required to submit the following NEEAPs:

- a second NEEAP not later than 30 June 2011;
- a third NEEAP not later than 30 June 2014.

Although the indicative target of ESD refers to energy savings in 2016, the Directive does not include any obligation on reporting on the achievement of this target.

NEEAPs have to describe the energy efficiency improvement measures planned to reach the targets set out in the Directive and to comply with its provisions on the exemplary role of the public sector and on provision of information and advice to final customers. The second and third NEEAPs also have to:

— include a thorough analysis and evaluation of the preceding NEEAP;
— include data on progress towards energy savings targets;
— include plans for — and information on the anticipated effects of — additional measures which address any existing or expected shortfall vis-à-vis the target.
The second NEEAP is also the vehicle for a number of reporting requirements under the recast Directive on the Energy Performance of Buildings (EPBD, 2010/31/EU)[3].

The Commission has recommended that Member States extend the scope of their second NEEAPs to cover overall primary energy consumption and savings up to 2020. However, informal feedback in the framework of the Concerted Action on ESD shows that at least half are likely to follow the minimum legal obligations on NEEAPs.

2 Synthesis of the complete assessment of all 27 National Energy Efficiency Action Plans as required by Directive 2006/32/EC on energy end-use efficiency and energy services: "Moving Forward Together on Saving Energy", Commission Staff Working Document, SEC(2009)889 final

3 These relate to lists of measures and instruments to promote the objectives of the recast Directive (Article 10), measures undertaken instead of establishing an inspection regime for heating or air-conditioning systems (Articles 14 and 15) and possibly also their national plans for increasing the number of nearly-zero energy buildings (Article 9).

Under the Europe 2020 Strategy, starting from 2010, Member States are asked to report on their national 2020 targets for energy efficiency and on the main measures to achieve them. The reporting is expected to be carried out using **national reform programmes** (NRP).

2. DESCRIPTION OF THE POLICY OPTIONS

Option E1: Retaining current approach (business-as-usual)

Under business-as-usual option reporting would continue to be required on the basis of ESD for 2nd and 3rd NEEAPs. After the 3rd NEEAP there would be no requirement for the Member States to take further action.

In parallel, in the framework of the national reform programmes following Europe 2020 Strategy, Member States would be required to report annually on their contributions to the overall EU 20% target for primary energy saving in 2020 target. However, as the EU 20% target for 2020 does not have a formal legal basis, the level of information provided by the Member States in their national reform a programme is not guaranteed.

Under business-as-usual option, the frequency of the current NEEAPs is every 3 years (2011 and 2014), which is also valid for the voluntary extensions to all savings in 2020 and the EPBD reporting items. However, the EPBD reporting schedule sometimes does not fit with that of the ESD (starting year 2012 or not every 3 year). The Europe 2020 energy indicators on primary energy consumption are calculated every year, but are incorporated in the NEEAP every 3 years.

Option E2: Simplification

Under this option, reporting on national plans and progress with achieving energy savings would be simplified compared to the current level of specific requirements for reporting as specified in the framework of ESD. In practice, many tasks of the current ESD are still executed. It is assumed that the (voluntary) calculation of early savings could remain an option. The voluntary extension of the scope to all savings in 2020 has now become standard and must be further extended in time to 2030. It has been assumed that the partial EPBD reporting is always part of the NEEAP. Also the overall strategy of MS and the evaluation of all EU policy effects is part of this case. Finally, the interaction between savings in end-use and savings at the supply side needs attention in this case.

Most burdensome elements related to definition and exclusion of final energy savings generated in undertakings involved in EU ETS and detailed reporting on ex-ante and ex-post impacts of individual measures[4] would be dropped. The reason for the simplification comes from the fact that the new legislative proposal will cover all energy sectors (including ETS) and in such case there would not be any more any "ineligible" energy savings.

On the other hand, the original role of NEEAPs would be formally extended to cover all sectors (both end-use consumption as well as transmission/distribution and energy generation). As such, NEEAP would become an overall policy document comprising reporting on the national efficiency strategy, monitoring of the national implementation of EU energy efficiency policy measures, monitoring of all energy saving taking place in the Member States.

As regards frequency of reporting, it is assumed that the third NEEAP, planned according to the ESD for 2014, is already replaced by a NEEAP for total primary savings. In order to see

[4] Using bottom-up methodologies for measurement and verification of energy savings as specified in Annex IV of ESD

the achievements of the Member States concerning the original ESD target for 2016 it would be important to introduce a requirement for another NEEAP in 2017. Further on, the frequency of reporting is set the following reporting e.g. at 4 years intervals, so that the following enhanced NEEAP will report on the achievements up to 2020 (due in 2011) with subsequent reporting at least in 2025. Such approach would ensure that more detailed reporting on energy saving measures and savings is available at the moment of reaching the 2020 target year and beyond.

Under this option, the annual reporting on the overall progress on national 2020 energy targets is carried out on a regular basis using National Reform Programmes with basic energy efficiency indicators (primary and final energy consumption, energy intensities) verified later by Eurostat. It would also provide useful annual updates on important policy measures introduced by the Member States to contribute to the national and the overall EU 2020 energy efficiency targets. Especially with the slightly reduced frequency of the more detailed national plans (e.g. four years compared to three as originally foreseen by ESD) annual updates would allow for early warnings in case some Member States have problems with the implementation of energy efficiency measures.

As regards the more detailed reporting using NEEAPs, modalities for higher/lesser frequency for in-detail reporting were analysed with three sub-options: (1) annual reporting, (2) reporting every 3 years, (3) reporting every 5 years.

Annual report would not enhance longer term planning while ensuring comprehensiveness of national plans has a more important role than the current role of NEEAP to report on savings. Therefore, the frequency should be lower than the 5 years. As a compromise between extra costs and quality of support to savings policy, a frequency of every 4 years is chosen. However, annual reporting via NRP would complement the picture with annual updates on key energy efficiency indicators and policy new measures taken by the Member States.

Option E3: Enhanced reporting

Under this option, the role of NEEAPs, the current level of complexity of the methodologies to measure and verify energy savings as required by ESD would be kept. Furthermore, same level of complexity would be formally extended to cover all sectors (both end-use consumption as well as transmission/distribution and energy generation). As such, NEEAP would become not only an overall policy document comprising reporting on the national efficiency strategy, monitoring of the national implementation of EU energy efficiency policy measures but also a very detailed monitoring document on all energy saving taking place in the Member States and the impacts of every single energy efficiency measure taken by the Member States.

Option E4: Repealing ESD reporting without replacement

Under this option, the use of detailed NEEAPs would be abolished. In practical terms, Member States would still prepare their 2nd NEEAP but further NEEAPs would not be required.

Certain tasks related to measures addressing energy saving in buildings as specifically required by EPBD will have to be reported using separate reporting tools anyway.

There would be annual policy reporting on Europe 2020 objectives covering among many other targets also energy efficiency. However, as the EU 2020 energy efficiency target has no legal basis, the level of information provided by the Member States would not be guaranteed. Furthermore, due to limited space for reporting, information on energy efficiency measures planned and taken by the Member States would be much lower than available today.

Option E5: Combine reporting with NREAP and other similar reporting obligations

Under this option, the current obligation on Member States to report on advancements on renewable energy production in their National Renewable Energy Action Plan (NREAP) is combined with reporting on energy efficiency measures and energy savings. Also other existing regular reporting obligations could be merged with the reporting on energy efficiency indicators and measures e.g. reporting on reduction of greenhouse gases emissions, as well as reporting on the progress towards increasing the share of high-efficiency cogeneration[5]. It is assumed that regular reporting obligations set in Directive on energy performance of buildings[6] are already incorporated in NEEAPs.

In this option with integrated savings/renewable reporting the same frequency as for case E2 is chosen. Given the yearly monitoring already taking place under the framework of national reform programmes, this can be combined with an obligation on a parallel annual reporting of the RES achievements. The latter is also performed in the framework of national reform programmes using Eurostat data verification a year later.

The main challenge related to the combination of different regular reporting obligations would be to align the duration of periods covered and harmonise the deadlines for submissions to the European Commission. This would require amendments of the related Directives. As this proposal repeals CHP Directive, integration of obligation to report of the progress with increasing the share of high-efficiency CHP would be easiest[7].

3. EVALUATION OF THE IMPACT

Depending on the legislative context, the purposes of planning and reporting requirements can be some or all of the following:

- To encourage the setting of a clear comprehensive plan and the monitoring of progress at national level;
- To present comparable information on progress in Member States in a form that allows Member States with good performance to be identified and recognised for this, and Member States with poor performance to be identified and put under pressure to improve;
- To permit the Commission to provide feedback, enabling weaknesses in planning to be identified and corrected in a timely way;
- To serve as the basis for enforcement action where progress towards binding targets is insufficient.

The **direct** impact of each option depends on the extent to which they permit each of these purposes to be fulfilled. That will be assessed in this sub-section, as will

- The administrative burden imposed by each option.

The **indirect** impact – that is, the extent to which fulfilment of the above purposes contributes to the overall object of a 20% energy saving - will be assessed in the sub-section “comparing the options”.

As regards the **encouragement of Member States to set clear and comprehensive plans with monitoring of the progress**, the most effective are option E2 and E5. According to the

5 Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market

6 Directive 2010/31/EU

7 CHP Directive originally assumed that Member States should prepare and submit national progress reports every 4 years (before 21 February 2011, before 21 February 2015, etc)

survey made in the framework of Bucharest Forum on the Role of NEEAPs, all interviewed representatives from the Member States have been enthusiastic about the NEEAPs and keen to and felt it was an important exercise worth contributing to. The main perceived benefits of the NEEAP are that:

1. it provides a structure for energy efficiency
2. it raises the profile of energy efficiency in the country

Almost all Member States indicate that the drafting of the first NEEAP led to a strengthening of cooperation, either between ministries, between ministries and agencies, or between ministries and stakeholders in society. NEEAPs have been effective in raising the profile of energy efficiency and bringing ministries and other governments and stakeholders closer together.[8] Most often, improved cooperation between ministries is stated as an important benefit of the NEEAP. In some countries inter-ministerial working groups were formed for the drafting of the 1st NEEAP, some of these structures are still in use for national purposes. A number of MS have plans to involve more stakeholders in a consultation process during the drafting of the 2nd NEEAP. It could be considered that these recent developments raised certain momentum in many Member States to strengthen national energy efficiency policies using NEEAPs as a vehicle. For the effectiveness of the national efforts to achieve broader 2020 objectives on energy efficiency, keeping that momentum would be best encouraged in option E5 and E2.

According to the responses to the questionnaires sent to Member States in November 2010, current approach to reporting in most cases generated positive results especially as regards launching longer terms strategies (rather than single short-term measures).

However, with the extended scope of reporting to all sectors (rather than only part of end-use consumption as it is in the current ESD scope) but significantly lighter measurement methodology in NEEAPs (submittable regularly every 4 years), Member States would be prompted to set more comprehensive longer term strategies and plans that would include policy measures and related savings in all sectors. The annual reporting in national reform programmes (NRPs) would then play an important role of closer watch after the implementation of the key measures included in the NEEAPs collecting data on basic energy efficiency indicators verifiable later by Eurostat.

As national energy saving measures often are supposed to be carried out in parallel by different governmental departments and services (ministries of economy, ministries of transport, ministries of infrastructure, ministries of regional development, etc), reporting on what is happening in the Member States concerning energy efficiency would remain significantly fragmented in option E1 and E4.

The option E1 would continue the limited incomprehensive scope fixed on non-ETS end-use sectors, which would be incompatible with the annual reporting on primary energy savings using NRPs. Option E4, using NRPs only, would encourage Member States to focus on short-term priorities without setting longer term planning while light form of reporting might encourage some Member States to focus only on the easier policy measures (e.g. only related to setting a framework for new buildings). However, the worst would be option E3 which theoretically could cover all sectors in a comprehensive way but would focus the monitoring on verification of energy savings generated by single policy measures.

As regards ensuring **comparability of presented information** that would allow the Commission to provide **useful and timely feedback to the Member States** as well as **enforcement action where progress towards binding targets is insufficient**, the best option

[8] Maclagan L, Bruel R, Draft report on Bucharest Forum telephone interviews, March 2011

would be option E2 and E5. Regular reporting in NEEAPs (every 4 years) would set longer term strategies and planning, in which it would be relatively easy to establish which Member States are more ambitious, which cover only some sectors or type of policy measures[9]. More importantly, annual reporting via NRPs would enable quick identification of problems and delays with the implementation in different Member States.

The use of complicated verification methods for achieved savings as foreseen under ESD (option E1) could create difficulties in comparability of information. Such problems with comparability of information was already observed during the analysis of the first NEEAPs[10]. Basic reporting in option E4 would lead to reporting on basic energy efficiency indicators (e.g. changes in primary and final energy consumption, energy intensity) and main energy saving measures would not allow sufficient comparability and easy spotting problems with the implementation. The option E3 would also be sub-optimal as it would frequently require arbitrary experts judgements[11], which would then cause unclarities about the overall impacts of the national policies thus leading to incomparability of results.

As regards **administrative burden**, the continuation of the current ESD approach (option E1) is recognised by a number of Member States as heavy. A number indicate that the first NEEAP required between 0,3-5 person-years. Clearly more time-effort was usually required in countries that had to prepare such comprehensive energy efficiency plan for the first time. Higher time effort was also required in federal countries (Germany, Spain, Austria) where regional authorities had to be involved and where major stakeholders had to be consulted. In real terms, Member States reported on actual costs varying from € 10,000 (Estonia) to € 1,000,000 (Germany). A number of Member States complained about current complexity of methodologies to be used for reporting (e.g. lack of clarity about what should be excluded from the scope of ESD reporting, requirement for ex-ante reporting on impacts of individual measures covering at least 20-30% of inland energy consumption, etc).

As regards second NEEAP due by 30 June 2011, Member States will also need to report on achieved savings. A number of Member States indicated that this might require contracting out some part of the analyses (especially as regards using bottom-up methodologies to define impacts of individual measures implemented in a given Member State). The full cost for the preparation the second NEEAP is several countries is expected to exceed € 50,000-2,000,000 (every three years).

The optimal reduction of the administrative burden would be achieved in option E2. The administrative cost would significantly drop as the most expensive tasks usually requiring contracting external experts for ex-ante and ex-post evaluation of the impact of single policy measures would not be necessary. Instead, the reporting on expected/achieved savings would focus on the synergic impacts of groups of policy measures addressing energy saving potential in main sectors of national economies.

Administrative burden would depend mainly of frequency of reporting. If NEEAPs are to play not only a reporting role but also stand for a the main longer term national policy document covering all policy measures on energy efficiency, the annual reporting would be virtually not operational as in many countries due to the lengthy administrative procedures for the adoption of longer term measures, the growing need to involve stakeholders, etc, the process of

[9] In the first NEEAP some member States focused mainly on legislative measures while non-legislative measures (financing schemes, awareness-raising campaigns, etc) were forgotten, which could reduce effectiveness of the policies in certain sectors

[10] SEC(2009)889

[11] Otherwise, determining impact of certain measures (e.g. related to energy audits) which normally work in synergies with other measures would be extremely costly

developing and adopting such stronger policy documents would often exceed the period of one year. Increasing the more detailed reporting intervals using NEEAPs from three to four years would further reduce the administrative burden to € 20,000–800,000 every four years (depending on the number and volume of national policy measures).

For the effectiveness of the implementation of the new Directive, it would however be positive if such plans were developed regularly in order to enable easier assessments and feedback to the Member States from the Commission about the status of implementation across the EU. Yet, additional the administrative burden related to annual reporting in NRPs with updating information about the implementation of the national energy efficiency policies and basic energy efficiency indicators would negligible as it would be based on statistical data and information normally possessed by the relevant governmental while employment of external experts for more detailed calculation would not be necessary. Such annual reporting would also be suspended every 4th years when more detailed reporting would be provided using NEEAPs.

The highest administrative burden is generated in option E3 which would introduce in which current already burdensome ESD detailed reporting methodology would be extended to all energy sectors. Even though usually policy measures addressing energy saving in energy generation and transmission/distribution are less numerous than those addressing end-use consumption, detailed ex-ante and ex-post assessments of the impacts of each single policy measure would significantly add to the costs related to the preparation of such reports. It can be considered that this would lead to very high costs as it would usually require contracting external experts to analyse all the impacts, while obtaining detailed data from energy supply companies (e.g. on own energy consumption) might be very complicated in itself. Also getting data from energy companies involved in energy generation could be complicated and potentially costly if external consultants had to be employed. It could be assumed that such reporting option could at least double the costs related to the preparation of reporting compared to business-as-usual raising them to € 100,000-4,000,000.

Theoretically, the least administratively burdensome is option E4. However, such reporting would not provide sufficient information on the strategic planning of the Member States. It would also provide less value to the member States themselves as the preparation and adoption of serious long term planning usually takes more than a year[12]. As such, this option is considered less optimal than option E2.

The option E5 would have the similar weight as the option E2. Effectively, the option would add efforts needed to comply with the existing reporting obligations but it would not reduce it substantially. Some reduction of efforts could be considered for reporting obligations arising from existing legislation (e.g. EPBD, simplified reporting on progress in CHP). However, combining reporting on renewables in NREAPs and other reporting on reduction of CO2 emission would bring no extra added value. It would however, generate some administrative burden related to formal aligning of the reporting periods set in RES and GHG legislation as amendments of these other legislation would be necessary. Especially in smaller countries where same officials often have to cover different policy fields, cumulating of the reporting on different topics at the same time could sometimes create bottlenecks in governmental departments responsible for the reporting.

[12] Several Member States including Hungary and Sweden included NEEAPs in their national legislation, which usually requires longer administrative procedures sometimes requiring approval of the national/regional parliament(s); this ensures longer term commitment for the implementation of different measures

Comparing the options on national reporting

The NEEAPs in themselves are not a stand alone issue. Without the NEEAP the ESD would not have been as effective as it has been so far.

An extension of the scope to primary energy consumption can indirectly provide extra savings because it enables a more integrated and effective savings policy. The reporting obligation is more effective when it indeed encourages Member States to make their national energy efficiency policies more comprehensive and better monitored (e.g. allowing quicker corrective actions in case some groups of policy measures are insufficient).

In practice, it can also be assumed that the stronger and the more comprehensive national plans and their implementation are, the higher environmental impact is (energy saved directly translates into reduced emissions (both from the energy sector itself and from the end-use of fuels) with higher impacts (especially as regards CO2 emissions) in countries where energy sectors are based on fossil fuels.

The following table summarizes the outcomes of the analysis for each policy option.

Table 4. Summary of policy options

Evaluation criteria / Policy options	Subsidiarity/ proportionality	Effectiveness	Efficiency	Coherence	OVERALL
Option E1 Retaining current approach	R	=	=	=	=
Option E2 Require light form of reports	R	++	+++	C	+++
Option E3 Required detailed calculation of savings and evaluation of measures across the whole economy	R	+	-	C	-
Option E4 Reporting only in National Reform Programmes	R	-	-	C	-
Option E5 Combine reporting with other relevant instruments	R	+	+	C	+++

In general, all options respect **principles of subsidiarity and proportionality.** The obligation for the Member States to report on the progress towards achieving is necessary to ensure that comparable and sufficiently detailed information is available for the European Commission to regularly assess the progress towards achieving the overall EU energy efficiency objectives. The strategic planning on measures and monitoring of main energy efficiency indicators is important for the Member States themselves to properly manage their portfolios of policy measures. In any case, the reporting obligations in none of the options intend to prescribe how national strategies and plans for energy efficiency should be designed.

As regards **effectiveness,** in relation to an overarching need to check the progress towards EU 2020 targets it is important that Member States possibly on annual basis should report on basic indicators (e.g. primary and final energy consumption, energy intensities) and inform about important changes in their national strategic portfolios of policy measures. As the overall EU target is linked to primary energy consumption, the reporting must cover all sectors (not only end-use consumption but also energy generation and energy transmission/distribution). However, in order not only to ensure better EU overview of all the national energy efficiency measures but also keep the stimulus for the Member States to further strengthen their overall energy efficiency policies it would be important to keep the obligation for the Member States to report on their overall national policies, measures and sector-related energy efficiency indicators.

As such, from the effectiveness point of view, only options E2, E3 and E5 would qualify.

As regards **efficiency,** in particular from the point of view of resources needed to carry out the reporting requirements mentioned above, option E2 would pose the optimal administrative burden. Even though option E4 would be the cheapest (repealing ESD reporting without replacement) it has to be disqualified as it would not ensure an important objective to keep the strong stimulus for the Member States to further strengthen their overall energy efficiency policies.

As regards **coherence**, the reporting obligations themselves have limited leverage for the establishment of strong synergies with other policy fields. On the other hand, coverage of all sectors including ETS will require closer looking at the consequences of introducing energy efficiency measures on the EU ETS scheme as well as analysing how EU ETS contributes to the EU 2020 objective for the primary energy savings. Keeping the obligation for regular preparation and adoption of comprehensive NEEAPs may also encourage such designs of the sets of energy efficiency measures that these may contribute not only to energy objectives but to broader objectives (environmental, job creation, etc).

Annex VII: Detailed explanation and analysis of options B1-B5 on energy saving obligations

1. BACKGROUND INFORMATION

In case no additional EU action is taken, the mainly voluntary provisions of Article 6 ESD would continue to be in place. Rather than lowering the barriers impeding the uptake of energy services, these provisions aim at safeguarding fair and equal competition for energy service providers.

All Member States have taken provisions to implement Article 6 ESD, but the level of ambition with the implementation differs strongly between Member States.

The feedback from the questionnaires for the mid term evaluation of the energy service Directive underlines that the provisions stated in this article have been difficult to implement due to the large choice in taking action and the mostly too generic action to create big direct and tangible impacts.[13] As the mid-term evaluation underlines, the option to take no further EU action would signify that the large discrepancy between the uptake of energy services the different Member States will continue to exist (overview see Table 5).

Table 5. Situation of energy service providers in the EU

Member State	Number of energy service providers	Turnover (EUR)	Yearly investment in projects (million EUR)	Comments
AT	5-14	10-15 M	14	Only EPC market for 2008
BE	14	n.a.	21	150 million EUR budget of Fedesco (main EPC supplier) in 2008-2014
BG	20	6 M	16	In 2007 Enemona (main Esco)invested in ESCO projects for more than 5.5 M EUR and only in the first two months of 2008 for 4.3 M EUR. Average figure calculated.
CY	0	0	n.a.	n.a.
CZ	10	2-4 M	1	EPC projects during the years 2007-2009
DK	10	8-25Mo	280	EES market 2010 (increased from 110 million per year in 2009)
EE	n.a.	n.a.	n.a.	
FI	8	4 M	n.a.	
FR	110	4 - 5 Bio	7000	Total energy services market (including equipments, workforce and services)over 7 G€, but real EPC market may be under 100 M€/year. Probably for 2007 or 2008.
DE	250 - 500	1,7 - 2,4 Bio	2000	
HE	n.a.	n.a.	n.a.	
HU	20 - 30	n.a.	n.a.	
IE	15	n.a.	n.a.	
IT	100 - 150	387 M	1830	1.830 million euros for total Esco market

[13] For example, Article 6 (2) a ii asks Member States to ensure the availability to their final customers, and the promotion of competitively-priced energy audits conducted in an independent manner. However, this does not guarantee that these audits are put in place, even if they are available.

Member State	Number of energy service providers	Turnover (EUR)	Yearly investment in projects (million EUR)	Comments
LV	5	1 - 1,5 M	1 - 1,5	total value of ESCO energy saving projects (five Escos) 2009
LT	6	n.a.	n.a.	
LU	3	n.a.	n.a.	
MT	0	n.a.	n.a.	
NL	50	n.a.	n.a.	
PL	3 - 10	3 - 10 M	5- 10	EES market
PT	10 - 12	10 - 30 Bio	n.a.	
RO	14	n.a.	n.a.	
SK	5	10 - 12 M	n.a.	
SI	2 - 5	n.a.		
ES	15	100 M	28 - 128	Mainly for household new buildings and district heating, hospitals, office buildings and street lighting, industry
SE	5 - 10	60 - 83 M	85	ESCO projects
UK	20	400 M	n.a.	
Total	**700 - 1036**	**5 - 10 Bio**		

Source: JRC (2010) ESCO report; ChangeBest Project (2010)

This implies that the energy services market in Europe will stay well behind its estimated potential to reach a turnover of some EUR 25bn per year which would translate into additional hundreds of projects all over Europe.[14] It is at present impossible to estimate the opportunity costs (missed economic, social and environmental benefits) of not further developing the European energy services market, as no consolidated estimates exist. However, the opportunity costs of missing to trigger effective energy services markets in all EU Member States can be qualitatively assessed by looking at the impacts of some single key ESCO projects (see Box 1).

Box 1: Impact of successful energy service projects across Europe

The Energy Saving Partnership (Berlin, Germany) [15]

Berlin's Energy Saving Partnership (ESP) was established in 1992 as a public-private partnership. It was founded by 4 shareholders (Federal State of Berlin, Vattenfall Europe, GASAG and KfW Banking Group). As of 2009 it disposed of 2.5 million EUR of capital stock for an annual turnover of 6 million EUR. The staff provides a wide range of energy services from consulting (to the public sector, the housing industry and private companies) to contracting (planning, financing and operation of CHP, cooling, air compresses, lighting, etc.) and international know-how transfer. The ESP uses Energy Performance Contracting with Third Party Financing. The ESP relies on the innovative idea of bundling small projects to push down transaction costs. The ESP's main results include more than 1300 buildings, guaranteed savings in total 10.5 million EUR and annual CO2 reductions 63,844 t. Total net investments were 44.43 million EUR. The key success factors of the ESP initiative that help remove risk perception barriers are the support of local policy-makers, readily available information on the legal framework (EPC, tender and award procedure), the existence of standard procedures and contracts and the perceived neutral position of the ESP.

[14] Bertoldi 2007, EEP

[15] Source: EU Energy Efficiency Policy – Achievements and Outlook (LBST, Hinicio, CEPS, COE) for the European Parliament December 2010

Customized EES project financing: Latvia

Energonams, a local ESCO and an industrial enterprise have established a third company named KER (Latvian acronym for Climate Energy Solutions) whose shareholders are represented by Energonams and the industrial enterprise themselves. The industrial enterprise has the majority of shares. An energy delivery contract between KER and the industrial site has been concluded. KER has started with the implementation of basic measures. In the first year of operation the company has achieved a profit of 370000Euro. KER is Special Purpose Company (SPC) to finance a project, while keeping the SPC's assets separate from those of the companies fostering the new project (so called promoters). The SPC is financed by promoters' equities (typically representing the minor part of the company capital) and by bonds usually provided by banks. This particular financial operation allows to better keep under control the project development while hedging the promoters against the risks of project failure." Source: Change Best project.

EES for local municipalities (Middelfart ESCO): Denmark

The municipality of Middelfart signed a contract with Schneider Electric for 7 years including renovation of 100 older buildings (190,000 m2) as an ESCO business. The investment of 6 million € over a three years was not possible due to government regulation but on request Middelfart received a dispensation from the Ministry for the project. In case the savings will be less than 20%, Schneider Electric will pay the difference up to 20%. In case of more savings than 20%, the municipal receive the first percentages and hereafter Middelfart and Schneider Electric will share the savings equally.

Sources: ChangeBest project (2010)

In the case of deregulation, Article 6 ESD would be abolished. As a consequence, only national regulations guaranteeing a level playing field for the provision of energy services would stay in place. As explained before, the provisions given by Article 6 have left a large room for adaptation to national circumstances which Member States have made use of. It can thus be concluded that even if Article 6 ESD is abolished the national legislation triggered by this article will remain in place. Accordingly, the impacts of option D2 are estimated as equivalent to option B1.

2. DESCRIPTION OF THE POLICY OPTIONS

Subsidiarity: Institutional level of fixing the obligation

The obligation could be introduced as 1) an EU-wide scheme or as 2) a mandatory requirement on each Member State to safeguard energy savings implemented through the energy suppliers and/or distributors or 3) the obligation for each Member State to set such scheme with or without a certain amount of EU level harmonization (to be discussed later).

European saving obligation

With a large variety in the implementation of the European energy services market and the remaining final energy saving potentials (see Table 5), all economic textbook arguments tend to favour a single European saving obligation, possibly combined with tradable certified savings to fully capture the cost-effectiveness of the system.

Table 6. Estimated final energy saving potentials in the EU Member States in 2020 and 2030

Economic (HPI) - Total saving potential all sectors

	Unit	2020	2030
EU27	ktoe	254699	418885
EU15	ktoe	216161	348819
EU12	ktoe	38534	70073
Austria	ktoe	5444	8457
Belgium	ktoe	7718	13376
Bulgaria	ktoe	2067	4479
Cyprus	ktoe	255	426
Czech Repul	ktoe	6883	14664
Denmark	ktoe	3343	5141
Estonia	ktoe	546	1098
Finland	ktoe	4221	6531
France	ktoe	35457	57260
Germany	ktoe	51378	85578
Greece	ktoe	5295	9246
Hungary	ktoe	3272	5894
Ireland	ktoe	2391	3742
Italy	ktoe	26081	40142
Latvia	ktoe	756	1457
Lithuania	ktoe	1044	1879
Luxembour(	ktoe	492	841
Malta	ktoe	80	140
Netherlands	ktoe	8780	15250
Poland	ktoe	14660	23955
Portugal	ktoe	3930	5947
Romania	ktoe	5693	10037
Slovak Repu	ktoe	2073	3993
Slovenia	ktoe	1240	2178
Spain	ktoe	26223	39885
Sweden	ktoe	7353	11179
United King(	ktoe	28296	47388

Economic (HPI) - Total saving potential all sectors

	Unit	2020	2030
EU27	%	18.9%	29.8%
EU15	%	19.1%	30.0%
EU12	%	17.8%	29.0%
Austria	%	17.3%	26.2%
Belgium	%	19.4%	33.4%
Bulgaria	%	16.1%	29.7%
Cyprus	%	11.9%	18.7%
Czech Repul	%	22.0%	43.6%
Denmark	%	20.3%	31.0%
Estonia	%	14.2%	26.4%
Finland	%	15.8%	24.1%
France	%	20.3%	31.8%
Germany	%	22.1%	36.3%
Greece	%	20.4%	34.5%
Hungary	%	14.9%	25.5%
Ireland	%	15.8%	23.7%
Italy	%	16.0%	23.2%
Latvia	%	12.3%	21.1%
Lithuania	%	16.6%	26.0%
Luxembour(	%	9.3%	15.4%
Malta	%	11.1%	18.4%
Netherlands	%	15.2%	25.6%
Poland	%	19.3%	28.5%
Portugal	%	16.9%	23.6%
Romania	%	15.9%	23.3%
Slovak Repu	%	15.5%	27.2%
Slovenia	%	20.2%	33.5%
Spain	%	21.5%	31.8%
Sweden	%	20.1%	29.6%
United King(	%	17.9%	29.3%

Source: European Climate Foundation (2010); only numbers for the high policy intensity (HPI) scenario are displayed.

Economies of learning, increased market liquidity, reduced risk of market power and cost effectiveness for obliged parties in meeting their targets are the main rationales of establishing a Community-wide scheme.[16] In addition, a community-wide saving obligation system would have the merits to be in line with the single market[17], reduce the administrative burden for Member States[18] to plan and design national systems and fully tap the cost-effective saving potential across the EU territory.

National saving obligation schemes

The existing national saving obligation schemes in the EU have very different design options (energy aggregate addressed level of ambition, obliged parties, eligible projects or certification and tradability). An overview of the different characteristics is presented below.

16 JRC (2009) Energy Savings and Tradable White Certificates

17 In case a European saving obligations were put in place, competitive aspects regarding cross border trading might arise as an issue and would need to be analysed in more detail.

18 The administrative costs will be addressed in the next section.

	UK (CERT)	Italy	France	Denmark	Flanders region (Belgium)
Obligation period	2002-2005 (EEC-1)* 2005-2008 (EEC-2) 2008-2012 (CERT)	2005-2012	2006-2009 (only first period)	2006-2013	2003 –
Compliance with the target	3 years	Annual	3 years	Annual	Annual
Target size (ongoing phase)	185 $MtCO_2$ lifetime savings in 2012 (EEC-2: final energy in MWh, carbon weighted, see details in text)	Cumulative savings of at least 22.4 mtoe in 2012	54 TWh lifetime discounted in 2009 (over the period July 2006-July 2009), target raised to 154 TWh for second period	2.95 PJ annual (first year savings) As of 2010: 5.4 PJ/y	Approx. 580 GWh (2008 target) 2% of the amount of electricity supplied to household customers two years previously and 1.5% for the non-residential sector.
Target in annual end-use energy savings (TWh)[a]	3.5[b] (EEC-2)	4.5[c]	1.3[d]		
Target unit (ongoing phase)	Carbon Lifetime Cumulative Previously: final energy, carbon weighted	Primary energy Annual target 5-year lifetime Cumulative	Final energy Lifetime Cumulative	Final energy Annual target 1-year lifetime	Primary energy Annual target 1-year lifetime
Target apportionment	For the period, on the basis of number of domestic customers supplied	Annual, on the basis of market share. Annual targets increase over time	For the period, based on turnover and market share in residential and commercial	Sectoral targets (el. and gas) annually apportioned on the basis of 3-year average market share	Annual, based on the amount of electricity supplied two years previously
Restrictions in achieving the target	40% priority group (EEC-1 and EEC-2: 50% priority group)	Until 2008 50% on own energy source	None specific	None specific	The actions must always consist of financial contribution and an awareness-raising element
Obliged parties	Electricity and gas suppliers with at least 50,000 domestic customers as of the end of 2007	Electricity and gas distributors (grid companies) with at least 50,000 customers two years previously	Suppliers with sales above 400 GWh/y for electricity, gas and heating/cooling. 100 GWh/y for liquefied petroleum gas. No threshold for heating oil	All electricity and gas distributors (grid companies), Approx. 250 out of 350 DH companies	Electricity distributors Separate targets for low and high voltage consumers (before) Separate targets for residential and non-residential (2008 on)
Sectoral coverage	Residential (40% priority group)	All	All excl. ETS	All except transport	Residential and non energy intensive industry and service

Table 7. Design characteristics of various energy saving obligations in EU Member States

[a] Source of the entire row: Eyre, N., M. Pavan and L. Bodineau (2009). Energy company obligations to save energy in Italy, the UK and France: what have we learned? European Council for Energy Efficiency summer study, La Colle sur Loup, ECEEE;
[b] Based on evaluation of 2005-2008;
[c] Based on 2005-2007 certified savings
Source: JRC (2009), Bertoldi et al. (2010), Energy saving obligations and white certificate schemes: Comparative analysis of experiences in the European Union

At present, saving obligation schemes already exist in five Member States, i.e. the UK, France, Italy, Denmark and the Flanders region of Belgium. Reductions of 0.05% to 5.6% of final energy consumption have been realized by the energy companies concerned (typically suppliers or distributors) over the duration of the various schemes[19]. On annual basis, the average savings range between 0.6 and 1.5 percent of final consumptions per annum.[20]

Strong local benefits of energy saving projects present the major difficulty related to the establishment of a Community-wide white certificate market. These benefits comprise increased competitiveness, job creation, improved housing stocks, reduced fuel poverty, reduction in local pollution, market transformation – These benefits are likely to raise competition, distribution and equity issues of implementing savings projects abroad – or purchasing certificates from projects implemented abroad – because suppliers may cross-subsidise customers in country B, while possibly recovering their costs on their customer base in country A. In principle a Community-wide scheme would be beneficial for Member States that offer high cost-effective energy saving potentials, i.e. Member States that have historically been less committed to energy efficiency. These distributional and equity aspects are relevant because even though obliged parties are responsible for meeting the target from the operational point of view, end-users bear the financial implications. Even if in principle this implements the polluter pays principle, it appears politically challenging if end users in one Member State get the financial benefits of improved energy efficiency, while passing on the costs of investment to end-users in another Member State.[21] There are profound differences across Member States related to important features of energy markets, such as experience with demand-side management and levels of energy taxation.

The existing schemes prove that energy saving obligations can be an effective tool for realizing energy efficiency measures. With growing energy prices or saturating energy consumption the interest of energy companies will increasingly focus on service market. Savings potential at EU level estimated with a conservative savings target of 4% of final energy consumption, based on an average savings targets of the current national schemes, would yield up to 46 Mtoe of end-energy savings if all end-use is counted, or 24–34 Mtoe, if only the residential, the services and the non-energy intensive industrial sectors are included. A more ambitious, but still realistic, target of 6% of primary energy savings, based on a wider roster of eligible sectors, would yield more ambitious savings in the range of 109 Mtoe in 2020[22].

Evidence suggests that creating incentives to encourage energy efficiency action by energy companies is very cost-effective triggering investments in energy efficiency in the range of about €1 bn in the bigger member states such as France, Italy and UK [23,24]. The cost of compliance of the realised programs can be put in the range of 1 - 3 Eurocent per kWh for companies, while the cost for households is estimated to be only €2.5 per fuel bill per year for households.

The existing schemes create almost no extra costs for the government as they are in general completely financed by either energy prices or grid charges, or if certification and trading

19 Study to Support the Impact Assessment for the EU Energy Saving Action Plan, Ecorys, 2010

20 Background study supply side (2011); Thomas (2010), Success and failures of energz efficiency funds and obligations. What five European systems have achieved and what can be learnt from them – a criteria-based policy analysis. http://iopscience.iop.org/1755-1315/6/20/202010

21 JRC. 2009. Energy Savings and Tradable White Certificates

22 SEC(2011) 277

23 IEA (2009) "Progress with implementing energy efficiency policies in the G8" citing Waide & Buchner, 2008

24 Lees, 2007

exist by a financial charge per certificate given[25]. In addition, the administrative structure for administrating the saving obligation is in case, with the energy regulators, the responsible bodies according to Article 4(4) ESD or the bodies managing the emissions trading scheme taking care of the implementation of the saving obligation.[26] The cost for the UK government is a £330,000 per year (or less than 0.3% of the budget of the authority administering the scheme[27]), in France – approx. €700,000 per year.[28] However, in Italy, where trading of savings certificate is an essential part of the system, the costs are slightly higher, i.e. in the range of €1 mln per year[29]. Overall, total administrative costs of around 0.002 Eurocent per kWh can be assumed which has a negligible impact on power prices.[30]

Asking Member States to implement national saving obligations would also open up new opportunities for businesses in emerging markets, creating a range of high-skilled jobs, and securing accelerated access take-up of innovations. It would incentivize the development of a market for energy efficiency services. This can be done by either directly involving ESCOs in the implementation of the saving projects[31] or by realising an offer for energy services that address saving options which are not cost-effective for ESCO projects and are in consequence not taken up to the extent possible.[32]

Some of the possible drawbacks of a saving obligation could include double counting of energy savings and guaranteeing the additionality of projects[33]. The EU has an important role

25 Harmelink M., Blok K. Chang M., Graus W. and S. Joosen, Mogelijkheden voor versnelling van energiebesparing in Nederland, Ecofys rapport in opdracht van Ministerie van Economische zaken, 2005.

26 ECN (2009), Energy efficiency obligations in the Netherlands?; Eyre, Pavan, Bodineau (2009), Energy company obligations to save energy in Italy, the UK and France: what have we learnt?

27 Based on administrative cost for EEC-1 and total expenditure on energy efficiency for EEC-2.

28 In terms of staffing, an average of some 10-15 persons work on the administration of the energy saving obligation schemes in the different countries.

29 JRC. 2009. Energy Saving Obligations And White Certificates

30 Harmelink et al., 2005

31 This is the case mainly in the Italian and the Danish scheme. Cf. Bertoldi et al. (2010); Bach (2011).

32 Some estimates refer to a minimum project size of 100 kWtherm for energy service contracting projects. Cf. Bleyl, Eikmeier, Seefeldt (2010), Energy Contracting: How much can it contribute to energy efficiency in the residential sector? Transaction and Life Cycle Cost Analyses, Market Survey and Statistical Potential.

33 Additionality refers to projects which would not have been carried out by the obliged parties without the saving obligation. JRC (2009) Energy saving obligations and tradable white certificates.

in drawing the minimum design requirements that would tackle these deficiencies. Requirement to implement a given proportion of the energy efficiency improvement measures for 'fuel poor' households (e.g. 40% in the UK) would ensure a positive direct redistribution impact for low income households. Effective verification and monitoring mechanisms would guarantee that additional savings to business as usual are achieved and no double counting occurs. The proper selection of participating sectors would avoid possible overlaps with existing instruments, such as ETS[34], the green certificates or industrial permitting procedures.

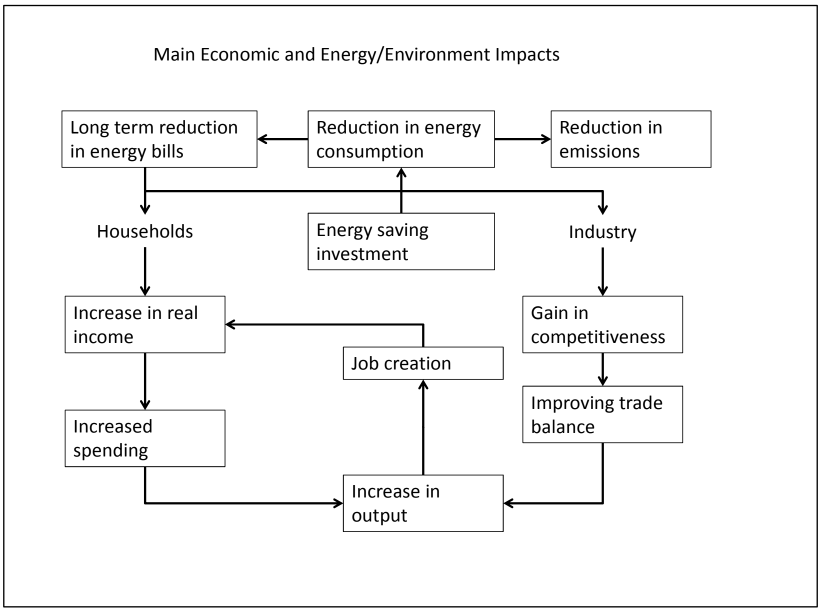
Developing a harmonised European saving obligation would lead to extra administrative burden and costs for the Member States that have introduced saving obligations, as they would need to change some or all of their administrative models to the harmonised EU scheme. In sum, the extra economic, social and environmental benefits generated by a harmonised EU scheme would need to be considerably higher compared to the national solution to make a case for a single EU saving obligation.

[34] The possible negative effects on carbon and green certificate markets of such a scheme if coupled with trading of savings certificates (white certificates) were analyzed in details in "I*nteractions of the EU ETS with Green And White Certificate Schemes*", Nera Economic Consulting, 17 November 200

3. EVALUATION OF THE IMPACT

The analysis of the economic, social and environmental impacts of a European or national saving obligations was modelled using the macro econometric E3ME model following the model depicted in Figure 2.

Figure 2. Model analysis of economic, social and environmental impacts of saving obligations



As baseline the PRIMES Energy Efficiency Scenario (2009) was chosen, the latest EU energy efficiency regulations and contains the impacts of both the Energy Services Directive and the CHP Directive.[35]

The energy saving obligation scheme is designed according to the retained options from chapter four:

- Obliged parties are retail energy sales companies, energy distributors, distribution system operators either directly or indirectly if the obligation is put on the Member States or at EU level.
- Obligations are defined as a percentage of annual sales (0.6 or 1.5 pc per annum)
- All types of energy carriers are targeted
- Savings from all final energy users can be counted
- In total, 9 different variants to the base case were modelled for the saving obligation scheme. The variants take into account the two different levels of ambition, the different levels of placing the saving obligation (EU level, Member State level, and company level), different mode of financing (government backup through increased income taxes, revolving fund, 75% and 100% pass over of additional costs of implementing the saving obligations passed over to the final customers.
- Baseline case – **A0**
- Saving obligation put on Member States, Saving obligation –all – **A3A**
- Saving obligation (low ambition) -no transport (income tax) – **A3Bi**
- Saving obligation (low ambition)-no transport (75% energy price) – **A3Bii**
- Saving obligation (low ambition)-no transport (100% energy price) – **A3Biii**

35 DG ENER (2010), EU energy trends to 2030 update 2009.

- Saving obligation -no ETS& transport – **A3C**
- Saving obligation –EU – **A3D**
- Saving obligation (high ambition) -no transport (income tax) 1.5pa reduction – **A3Ei**
- Saving obligation (high ambition) -no transport (75% energy price) 1.5pa reduction – **A3Eii**
- Saving obligation (high ambition) -no transport (100% energy price) 1.5pa reduction – **A3Eiii**

The summary of economic, social and environmental impacts of saving obligation on Member State and on EU level is presented in Table 7. It can be seen that the overall economic effects of an obligation at EU level tend to be positive in terms of GDP development, investments and exports. The social effects show a slight reduction in consumption in comparison to the baseline in the national case and a (short term) decrease of household income[36], but a clear increase in employment. In terms of environmental impacts, the national option tends to outperform the European option in terms of greenhouse gas These overall figures deserve however a closer look, as the impacts vary considerably for the Member States. For example, the obligations can lead to much higher energy savings if modelled close to the existing national potentials. This will also increase the positive impacts of this option (see background study in annex for further detailed analysis).

[36] The losses in real household incomes are due to the financing of the saving obligations through increased costs for energy and energy services provided. However, these costs are only short term and will be (over)compensated through a reduction of energy consumption. Cf. Background Study Supply Side .

Table 8. Comparison of a saving obligation at Member State level and EU level

	A0	A3A	A3Bi	A3Bii	A3Biii	A3C	A3D	A3Ei	A3Eii	A3Eiii
GDP (2000 m euro)	12519336	22033	41953	46787	35229	32221	38459	69259	80150	77155
Consumption (2000 m euro)	7154416	-6416	11994	18288	13605	11272	174	17704	29915	27613
Investment (2000 m euro)	3176238	11995	5630	5758	5965	5102	18165	15321	15972	15394
Exports (2000 m euro)	6139283	16056	23333	22987	15857	14325	24292	36651	36364	35195
Imports (2000 m euro)	5751410	-398	-996	247	198	-1523	4172	417	2101	1046
Consumer prices (2000 = 1.0)	1,62	0,02	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00
Employment (000s)	226894	590	235	430	386	339	666	438	754	731
Real household incomes (2000 m euro)	8674601	-20481	14021	19206	12906	10125	-6776	16782	28708	26043
Energy demand (m toe)	1909	-115	-50	-53	-56	-64	-122	-108	-114	-118
CO2 emissions (m tonnes carbon)	1063	-88	-34	-37	-38	-37	-88	-71	-76	-77
GHG emissions (th tonnes carbon)	1249	-108	-43	-46	-47	-46	-100	-86	-90	-92
ETS Price (08 euro/tCO2)	28,7	4,7	10,4	7,7	8,0	13,9	9,5	12,0	5,2	4,9

Source: E3ME, Cambridge Econometics.

In summary, energy saving obligation can lead to significant reductions in energy consumption and greenhouse gases with relatively neutral if not positive overall economic, social and environmental impacts. The modelling results suggest that the case for a single European saving obligation scheme, possibly allowing trading of energy savings between Member States, could be economically beneficial, but only marginally. It can be expected that the distributional impacts and the additional administrative burden put on Member States with existing obligation models would outweigh these positive impacts.

The distributional impact of the main options is presented in the table below.

Table 9. 2020 EU27 Real income (% diff from base)

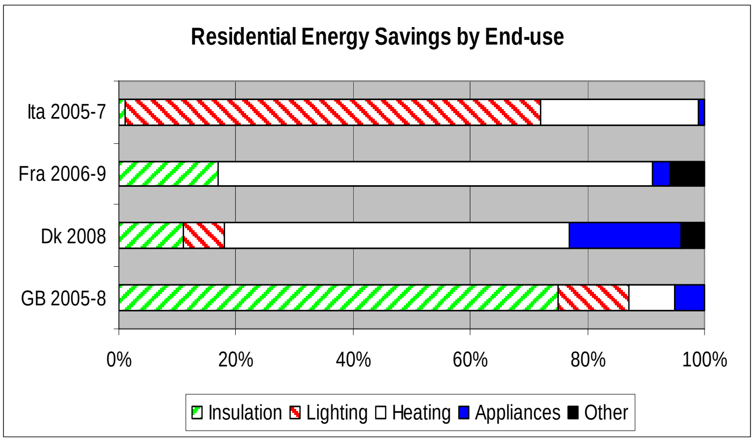
	A3Bi Income tax	**A3Bii** Energy price increase	**A3Biii** Revolving fund	**A3Ei** Income tax	**A3Bii** Energy price increase	**A3Biii** Revolving fund
1 All households	0,01	0,06	0,037	0,11	0,213	0,177
2 Exp groups: first qun	-0,051	-0,022	-0,052	-0,039	0,021	-0,028
3 Second quintile	-0,025	0,005	-0,023	0,026	0,087	0,043
4 Third quintile	-0,001	0,033	0,006	0,081	0,153	0,114
5 Fourth quintile	0,006	0,057	0,034	0,112	0,219	0,185
6 Fifth quintile	0,054	0,122	0,103	0,189	0,327	0,301
7 Socio-econ:manual wor	0,01	0,066	0,046	0,121	0,232	0,199
8 Non-manual workers i	0,039	0,09	0,074	0,184	0,294	0,27
9 Self-employed	0,11	0,154	0,132	0,243	0,333	0,297
10 Unemployed	0,116	0,137	0,102	0,184	0,242	0,192
11 Retired	-0,018	-0,02	-0,062	0	0,01	-0,052
12 Inactive	-0,051	-0,015	-0,05	-0,039	0,027	-0,027
13 Pop.density: densely	0,035	0,07	0,043	0,145	0,223	0,183
14 Pop. density: sparsely	0,035	0,09	0,066	0,126	0,23	0,188

Further design options which could ask for EU harmonisation

Types and sectors of savings eligible

As discussed in chapter four, the realm of eligible savings will probably need to be limited to avoid "cherry picking" in the first phase of a saving obligation system, that is the achievement of the quota through low cost but largely ineffective measures like distributing energy saving light bulbs or offering standardised information on energy savings.[37] In fact, Denmark has excluded these measures from eligibility for the second phase of the saving obligation.[38] Results of the existing schemes in the Member States suggest that also in Italy, the first phase of trading lead to a large part of cherry picking, whereas the UK system with its focus on the residential sector favoured building insulation (see Figure 3).

Figure 3. Share of measures taken under saving obligation schemes



Source: eceee, 2011 (Bucharest forum presentation)

37 In practice this could be achieved by limiting the eligibility of these measures to a specific percentage share of the quota.

38 Bach (2010), The Danish Energy Obligation Scheme

In order to avoid investment in low-cost/low-impact measures, the share of these measures within the obligation system would need to be capped to avoid similar developments in other EU Member States setting up saving obligation systems.[39] This can be identified as one issue where a European harmonisation will have a positive effect.

By the very nature of the obligation scheme, most obliged parties will strive to reach their quota by recurring to standardised stand alone measures like changing light bulbs or boilers which at some point in time might lead to sub-optimal solutions that harvest only partially the existing saving potential in a building.[40] This could be tackled by further "ring fencing", i.e. putting the obligation to include x% deep building refurbishment or the use of energy performance contracts in the quota. As a similar effect could be achieved by choosing long lifetimes of savings with relatively low discount factors for savings in future years[41] the decision to put further ring fencing quotas in the system should be on Member State level for subsidiarity reasons.

Whereas the European level can contribute greatly to reduce administrative costs of developing deemed saving default values, a European harmonisation of the sectors covered by the saving obligation might rather impede a coherent fitting of this instrument to the other policy measures in place. Therefore the sectors eligible should be chosen at Member State level. With the possibility to enlarge the realm of savings by allowing buying savings achieved by "accredited" parties (e.g. building associations selling the savings achieved in their building stock) to the obliged parties, the circle of participants can be kept flexible.

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39 In practical terms this would mean that the obliged parties can only credit a maximum of 5-10 % of their obligation through these measures.

40 EACI (2011), Boosting the Energy Services Market in Europe, Conclusions - IEE workshop, Brussels, 23 February 2011 .

41 The present systems use discount rates of 3.5-4 pc for this purpose.

Table 10. Projects undertaken in the various national saving obligation schemes

Italy 2005–2007			
		Savings (toe)[a]	No. of installations [b]
1	CFL[c]	1,036,360	20,761,940
2	Low-flow shower heads (residential)	195,404	9,474,586
3	Substitution of mercury vapour lamps with high-pressure sodium lamps in public lighting	116,412	422,621 lamps
4	DH systems [d]	73,767	
5	Low-flow faucets in residential	66,303	16,215,760
6	Solar collectors	54,855	229,419 m²
7	Domestic appliances class A [e]	21,190	839,169
8	Double glazing	12,272	221,441 m²
9	Luminosity regulators in public lighting	11,140	22,888,678 W of lamps regulated
10	Small-scale cogeneration	8150	
UK 2005–2008 (total activity in the period)			
		Savings (fuel-standardised GWh)	No. of installations
1	Cavity wall insulation	76,654	1,760,828
2	Loft insulation (virgin)	31,267	493,515
3	CFL	21,911	101,876,023
4	Loft insulation (top-up)	18,824	1,286,787
5	DIY loft insulation	9073	799,573
6	All boilers	7837	2,082,812
7	Fuel switching	4462	78,010
8	iDTV	3471	9,450,182
9	Solid wall insulation	2250	41,410
10	Standby savers	2005	2,943,384
France 2006–2009			
		Savings (GWh cumac) [f]	No. of installations [g]
1	Individual condensing boiler	14,670	137,000
2	Individual high performance boiler	8346	180,000
3	Collective heating condensing boiler	4629	43,000
4	Air–air heat pump	4499	43,000
5	Roof insulation	3782	2,842,000
6	Acotherm labeled windows or equivalent	2999	1,363,000
7	Air–water heat pump	2608	20,000
8	Variable speed drive	2152	*Not estimated*
9	Collective heating high performance boiler	1760	37,000
10	Detached firewood heating appliance	1695	32,000

[a] Total savings generated 2005–2007.
[b] Total installations 2001–2007.
[c] Tradable white certificates issued on the basis of gift tokens distributed to end-users for CFL purchase are not included. The regulator assumes that 50% of these will end as CFL installations; yet the regulator has verified that the percentage of tokens determining CFL installations is well below 50% for 30 projects submitted for certification and is currently (August 2009) following the issue.
[d] The application of engineering estimates for the evaluation of savings due to DH and small-scale CHP has been suspended as of June 2007 because of a decision of the Lombardia Regional Administrative Court. The savings reported related to projects with metered baseline evaluation. It has been estimated that DH and CHP projects whose evaluation has been suspended may determine the issuance of 100 000 TWC (100 Mtoe) for 2007. Energy-saving engineering estimates will be revised and certificates issued once the Court sentence motivations are announced.
[e] Energy-saving estimates for class A domestic appliances are being revised. Class A refrigerators, dish washers and washing machines are likely to be considered as baseline for the new deemed estimates compiled by the regulator.
[f] Official data as of 30th of June 2009.
[g] Estimates of number of installations in general or m² for roof insulation and windows.

Source: Bertoldi et al. (2010)

Measurement and verification

The measurement and verification of the savings achieved with the final customers can be done through metering or, in the case of larger projects, engineering calculations. As most measures proposed by the obliged parties will be standardised, technical ex ante calculation schemes could be developed that display the "deemed" savings of a measure[42] As the concept of technical ex ante calculations is a central feature of minimising the administrative costs of a saving obligation, the European level can contribute greatly to minimising the administrative costs of the saving obligation by putting forward default ex ante saving values for some of the most common standardised saving actions. For reasons of subsidiarity and to fit the calculations to the national situation[43], Member States should be allowed to devise their own national deemed saving values. With the ex ante values and the deemed saving values catalogues from the UK, Denmark, France and Italy publicly available, Member States have well over 200 ex ante values ready at hand.[44]

Certification and Level of tradability

Further to a measurement and verification, the achieved savings could formally be certified and made tradable. Trade could take place bilaterally between obliged parties ("over the counter"), or on a market ("white certificates"). Market trading would allow for a least cost implementation of the savings, as the obliged parties have the freedom to either implement the saving measures themselves or recur to the market. On the other side, the installation of an administrative framework to allow and monitor trading will necessitate administrative costs equalling the costs of the installation of the emissions trading scheme. Costs and benefits need to be established level to make a sustainable decision whether or not a free tradability of certified savings is creating a net benefit.

Level of ambition of the obligation and time horizon

The level of ambition, that is effectiveness of the saving obligation, depends directly on the size of the quota established and on the parties included in the scheme. As discussed above, a reasonable span for the level of ambition on annual basis seem to be final energy savings in the amount of 0.5-1.5 pc of national final energy sales per annum. Whereas in principle the timing horizon of the obligation can be put flexible, harmonising an annual feedback of the savings achieved through this instrument will guarantee an easier exchange of best practices and may lead to a further harmonisation of the national schemes.

Compliance: administration of the obligation, penalties

In case a saving obligation is put in place, the compliance needs to be checked by a government body. In practical terms, this would need to be a body having access to the obliged parties' sales data to track and monitor the implementation of the obligation. With energy regulators and the authorities set up by article 4 ESD, two alternative bodies exist with all Member States who could take over this task with relatively low extra costs. In order to ensure effective compliance, penalties for not reaching the quota would need to be set up. Here again, a harmonised approach or a default regulation at EU level would need to safeguard the proper functioning of the system by asking Member States to put penalties in place.

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42 E.g. the amount of annual kWh savings attributed to the replacement of a conventional 75 W light bulb by a 7 W CFL. However the concept of deemed saving implies the proper and unchanged use of the new technology (the technology is implemented and there is no rebound effect).

43 The national situation may take into account climatic zones, building typologies, preferred saving action and other national particularities which cannot be taken into account fully with a European harmonisation.

44 E.g. http://www.ens.dk/da-DK/ForbrugOgBesparelser/EnergiselskabernesSpareindsats/Documents/Standardvaerdikatalog/Januar%202011%20-%2026.%20udgave/Standardvaerdikatalog.pdf; http://www.autorita.energia.it/it/ee/schede.htm; http://www.ofgem.gov.uk/Sustainability/Environment/EnergyEff/Pages/EnergyEff.aspx; http://www2.ademe.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=15024

Annex VIII: Detailed explanation and analysis of options C2-C4 on the promotion of the leading role of the public sector

4. BACKGROUND INFORMATION

The public sector can be an important trigger for stimulating market transformation towards more efficiency products, buildings and services and in promoting best practices examples. Due to the large volume of relevant public spending[45] (19% of GDP, or roughly €2,200 bn in 2009) it could serve as a strong driver for higher market uptake of energy efficiency and development of the skills and knowledge required.

Energy efficiency is relevant for the most of the public expenditure items. For example, some part of the budget used for health, education, public procurement, is spent on renovation of buildings, purchasing of energy using equipment or services. Implementation of energy efficiency measures can reduce the bills for fuel for energy (which is estimated at about € 300 bn in 2009[46]).

There is no reliable EU 27 statistical data on the energy use and the potential for energy savings in the sector. A detailed study PROST[47] of 2003 covering EU-15 and some candidate countries gives some indication of the significant possibilities. The study estimated that public sector is responsible for about 10% of the total final energy used for heating and electricity in 2001 and that there is at least 20% cost-effective energy savings potential with majority of the measures having short pay-back times (2-3 years).

5. POLICY OPTIONS

Option C1: Retain the current approach: existing provisions on the role of the public sector

Measures to enhance the **role of the public sector** in promoting energy efficiency market uptake and in general environmental protection at EU level are already included in various legal (Energy Star Agreement, Clean Vehicles Directive[48], Energy Services Directive[49] (ESD), Energy Labelling Directive[50] (ELD), Energy Performance of Buildings Directive[51](EPBD)) and soft-law tools (Green public procurement initiative). This was possible because in the general Public Procurement Directive[52] (PPD), that sets the procedures for the award of public works contracts, public supply contracts and public service contracts

[45] The total expenditure of the EU governments is about 50% of the GDP. Here public spending is the part that is used for purchasing of goods, immovable assets and services

[46] DG MARKT, unpublished, preliminary data

[47] PROST report: Harnessing the power of the public purchase.

[48] Directive 2009/33/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles

[49] Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services

[50] Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products

[51] Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings

[52] Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts

above certain thresholds, allows for including environmental considerations and referring to eco-labels in the public procurement. The Directive does not govern the purchase or rent of buildings.

At present, energy efficiency is a **mandatory consideration in the public procurement of office equipment and of road transport vehicles**. Energy Star Programme[53] defines energy performance levels for office equipment and Regulation (EC) 106/2008 obliges central government authorities of Member States and EU institutions to procure equipment not less efficient than Energy Star. The thresholds of the PPD apply. This obligation is in force until the end of 2011 when the current five-year Energy Star Agreement expires and thus it is not certain that the approach would be continued. As regards vehicles, Directive 2009/33/EC requires that energy and environmental impacts linked to the operation of vehicles over their whole lifetime are taken into account in purchase decisions. These lifetime impacts of vehicles shall include at least energy consumption, CO2 emissions and emissions of the regulated pollutants of NOx (nitrogen oxide), NMHC (non-methane hydrocarbons) and particulate matter. This could be done by setting technical specifications for energy and environmental performance, or including energy and environmental impacts as award criteria in the purchasing procedure.

The **Energy Labelling Directive contains non-binding provisions** which encourage MS to procure products that are in the highest energy performance class of the energy label for their product group. The thresholds of the PPD apply. So far the planned or adopted delegated acts to implement it cover mainly products used in the residential and some in the tertiary sector[54] and exclude office equipment as it is covered by the Energy Star. Nevertheless, the Directive is important as public spending is much broader than the products for direct use of the public authorities.

The **Energy Services Directive also contains binding but very vague in formulation obligations** on Member States as regards public procurement. For example, they shall ensure that the public sector fulfils an exemplary role, realizes energy efficiency improvements, and effectively communicate its actions. They are provided with a list of broad measures (listed in an Annex) across their own building stock, transport fleets, use of equipment from which they shall choose at least two. Member States also shall publish investment and purchasing guidelines on energy efficiency and energy savings in public sector contracting and facilitate and enable the exchange of best practices.

The **exemplary role of the public sector is emphasised also in the recast EPBD** with an earlier deadline for all new buildings that are occupied or owned by public authorities to be nearly zero energy buildings (end of 2018, instead of end 2020 for all others) and requirements for issuing and display of certificates for public buildings. Further, to intensify the market transformation, Member States are encouraged to develop policies and measures (such as energy targets) that will stimulate the refurbishment of the public buildings into nearly zero energy buildings.

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53 http://www.eu-energystar.org/

54 The following delegated acts for the household sector were adopted by the Commission in 2010: televisions, household electric refrigerators, freezers and their combinations, household washing machines and dishwashers. In the course of 2011 delegated acts on boilers, air-conditioners, water heaters and laundry dryers will follow. An updated label on lighting will be adopted in 2011. Future products to be legislated in the near future are e.g. commercial refrigerators, vending machines and display cabinets in the commercial sector.

The Commission is also **promoting the voluntary approach towards broader green public procurement** based on a communication "Public procurement for a better environment"[55] of 2008. It encourages public authorities to take into account a number of environmental criteria in their purchase. To this end, a dedicated toolkit[56] was prepared for use by public purchasers and by GPP trainers or for integration in general public procurement training courses and workshops.

At Member States level, there is a proliferation of various measures (incl. targets, requirements or initiatives) on green/sustainable/smart or energy efficient public procurement that target different levels of governance.

Option C2: Binding public sector saving target

There are various possibilities for setting binding target on the public sector. This target could cover all energy use of the sector and be specific for each Member State or provide equal effort and is to be achieved in 2020 or 2030 or be an annual one. The target can also be for retrofit of publicly owned building to high energy performance level of for replacement of inefficient equipment.

It should meet the following basic requirements: (i) it should be easy to measure and monitor the process; (ii) the measures implemented should serve as a best-practice example; and (iii) it should stimulate the market transformation.

From the possibilities listed above only the target for the refurbishment of the publicly owned buildings meet all these conditions.

Public buildings represent a relatively small but still considerable part (i.e. 12%) of the total (residential and non-residential) building stock. They have a high visibility in public life (e.g. schools) and their status and performance have a significant impact as negative or positive examples for the private building sector. Data on their overall number and their renovation is easier to collect than for example data on energy consumption for various purposes (e.g. electricity for equipment, public transport, heating of buildings).

As regards the scope of the target, it is suggested that it covers all buildings that are owned by the public sector, excluding the social housing. The later is because of the different ownership structure of the social housing that could lead to significant burden on the social housing associations as in many countries they are not directly profiting from the state budgets.

To establish which renovation rate is ambitious enough but realistic it is important to note that the pre-crisis energy-related renovation rate was 1.5% per year and as a baseline an average energy-related renovation rate of 1.7% per year over 2010-2020 is expected under the business-as-usual because of the impact of the current policy mix (mainly the recast EPBD and the national support schemes)[57].

Currently the refurbishment cycles are of 30-40 years. This signifies that approximately 3% of the building stock is renovated per year but only in half of the cases energy efficiency improvements are included (1.5% energy related renovation rate). Energy efficiency improvements are in most of the cases cost-effective when they are combined with ongoing maintenance and refurbishment work. Therefore, an upper limit of 3% could be set to the speed of energy-efficient renovation that can be cost-effectively. This means that if all

55 COM (2008) 400
56 http://ec.europa.eu/environment/gpp/toolkit_en.htm
57 Ecorys, Ecofys and BioIntelligence (2010): Study to Support the Impact Assessment for the EU Energy Saving Action Plan.

refurbishments are combined with a comprehensive package of measures to improve energy performance (which is still not the case) the energy-related renovation rate would also be 3%.

To go beyond the 3% would force investors to carry out energy-related improvements on their buildings outside the refurbishment cycles, which prevents the synergies of a coupled renovation and thus leads to significantly lower cost effectiveness of the measures.[58] Furthermore, the construction sector would not be able to meet the increased demand and suboptimal renovations can be expected. Going below the 3% would not be ambitious enough to show the leading role of the public sector.

Still, energy-related retrofit rates beyond 3% are possible in the short or medium term when refurbishments have not taken place for a large part of the stock for some time (e.g. in some Eastern EU countries) and could be tackled in a condensed timeframe. However, in the longer term the full coupling of energy-related renovation to average refurbishment cycles sets a ceiling at 3%. This would mean double the pre-crisis energy-related refurbishment activity in Europe, which would already be a challenge (but also present good business and employment opportunities) for the EU building industry.

Option C3: Energy efficiency as a criterion in public procurement

Energy efficiency could be make mandatory criteria in the public procurement of products/equipment, buildings, services and works. This approach can be successful only if the criteria are not complex and are easy to use and cost-effective. The analysis focuses only on energy aspects as energy usually is responsible for most of the environmental impact over the lifetime of the buildings and products (e.g. 75% for buildings) and there are already established criteria for certain aspects.

There are several possible approaches for establishing such criteria. They could be based on existing labelling schemes or performance requirements or could be based on methodology/formula that establishes the least-life cycle cost to be calculated every time tender specifications are developed. Because of the diversity of possible energy efficiency improvement measures or services, the former approach could be preferable, and would be analyzed in detail, as it decreases the complexity for the participating parties.

For products: the current approach provided under Energy Star could be used for office equipment. For the products not covered by the Energy Star the energy label under ELD could be used. The obligation could be that product/equipment is in the highest (or the highest two) bands of the label. It is important that still certain flexibility is left and Member States are allowed to make the application of those criteria subject to cost-effectiveness, economical feasibility and technical suitability and sufficient competition.

For buildings, including renovation works: the criteria could be developed on the basis of the EPBD. One criteria (or condition) could be that new or renovates buildings should met at least the cost optimal requirements as calculated by the Commission cost-optimal calculation methodology. Such an obligation would facilitate the updating of the national requirements, if not already based on cost-optimal levels, as knowledge of the possibilities would be gained. Further a second condition could be that upon renovation buildings shall be upgraded to one of the three highest bands of the energy performance certificate for the particular country. For new buildings it should be to the two highest bands.

For services: The equipment/buildings that are used by the service providers should be meet the requirements as specified above (energy star requirements, two highest classes for energy label, two/three highest classes for new buildings or for their refurbishment).

[58] Ecofys, Cost-Effective Climate Protection in the EU Building Stock, report by Ecofys for EURIMA.

In addition, **the removal of the existing legal, accounting or budgetary barriers also needs to be addressed.** This can be done in a legal obligation on Member States to adopt legislation that would ensure that this is the case.

As regards the estimated value of the contract above which the criteria would have to be used, it is proposed that the financial threshold as established in the PPD are used. Such obligation can be placed on central government institutions or cover lower governance levels.

Option C4: Voluntary measures to promote energy efficiency via public procurement

This option would entail that MS are encouraged to develop guidelines and information portals that provide information and active support to procuring authorities and to eliminate any legal, accounting or budgeting barriers to public procurement. For example, shift form procurement that is based on lowest product purchase price towards the “economically most advantageous offer” should be recommended. Also they should put in place measures that tackle the split incentives problem and identify and abolish all national or local rules that prevent the inclusion of energy efficiency conditionality in public purchase. MS shall encourage higher penetration of energy performance contracting.

As a conclusion, the following options were selected for in-depth analysis as regards the leading position of the public sector in promoting its exemplary role and in driving the market transformation process towards more efficient products, buildings and services:

- C2 Binding target for energy saving by public bodies
- C3 Obligatory use of energy efficiency as a criterion in public procurement
- C4 Voluntary measures to promote energy efficiency via public procurement

Within the options C2-C4 there are a number of possibilities as regards scope, level of ambition and design:

- Option C2: the most suitable and easy to measure target for the public sector is a 3% annual renovation target for publicly owned and occupied buildings (excluding social housing). The energy performance to be reached upon the renovation of particular building could be set at the cost-optimal level (Option C2a) or at the nearly zero energy level (Option C2b).
- Option C3: to decrease the administrative burden and facilitate their use, the mandatory energy efficiency criteria to be used when public spending decisions are made (in a very broad sense, e.g. including social housing) should be based on existing labelling schemes (the highest classes of the Energy Label or Energy Performance Certificate) or established best performance requirements (Energy Star). These are relevant for energy using products/equipment, buildings (incl. buying, renting or renovating) and for services as far as the service providers use equipment or buildings. The focus is in principle on the energy use but, in certain cases (e.g. Energy Labels), other major environmental impacts are also taken into account. Measures also include greater use of energy management systems by the public authorities. In addition, MS would be obliged to eliminate the legal, accounting and budgeting rules that hinder the uptake of energy efficiency measures (in particular the role of ESCOs) for public authorities.
- Option C4: would imply encouragement for MS to develop guidelines and information portals that provide information and active support to procuring authorities and to eliminate any legal, accounting or budgetary barriers to public procurement.

6. EVALUATION OF THE IMPACT

Only the direct impacts of the options are estimated here. However, all options considered under this section would have a more profound impact. Increased demand from the public sector could be expected to lead to economies of scale and would support the establishment of a market for energy efficient products, buildings and services. This would lead to further energy savings and job creation.

The impact of the individual options is estimated using the BEAM model of Ecofys[59] (for Options C2a and C2b). The impact of Option C3 was considered on an aggregate level and not as a sum of individual measures (e.g. purchasing of better computers, buildings, motors for lifts, etc) and the PROST study was used as a main reference source for further calculations[60]. Due to its broad and voluntary scope only qualification of the impact of Option 4 was possible. The E3ME modelling could not provide results for these options, as the impact of the options was too small to make changes to the model outputs. Details on the model/studies used and the assumptions made are presented in greater detail in Annex VII and also in the studies mentioned.

- **Impact on energy consumption and environmental impact**

In order to establish the impact on energy CO2 emission reductions, investment needs and cost savings and job creation of **Option C2a and C2b** the Ecofys BEAM (Built Environment Analysis Model) model is used[61]. No new runs of the model were made but the results of the already available options for various renovation rates and levels of ambition for the whole building stock were extrapolated only to cover the public sector owned or occupied buildings.

Ecofys estimates that the publicly owned buildings are 2.5 bn m2[62] and thus represent 12% of the EU building stock in 2008[63]. It can be assumed that on average the potential for the public sector is similar as the one for the EU's building stock as a whole. This allows that extrapolations are made of the results of the BEAM model runs for renovation rate of 3% in 2020 leading to cost-optimal levels or to very high energy performing levels (close to nearly zero energy buildings). An average retrofit rate of 2.8% is considered over the 2010-2020 period because it is expected that the new provisions will enter into force with a certain delay (e.g. possibly after 2013).

To arrive at primary energy, a system efficiency of 74% is considered; therefore the final energy value can be multiplied by an average primary energy factor of 1.35.[64] Carbon intensities of heating energy used in the buildings as implemented in the BEAM model are used and vary for the buildings sector between 230-240 gCO_2/kWh (2.7-2.8 Mt/Mtoe).

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59 Ecorys, Ecofys and BioIntelligence (2010): Study to Support the Impact Assessment for the EU Energy Saving Action Plan.

60 PROST SAVE supported study. 2003. Harnessing the Power of the Public Purse. Final report.

61 Input to the model calculation is a database containing the EU-27 building stock distinguished by climatic regions, building type/size, building age, insulation level, energy supply, energy carrier, energy costs and emission factors. This can be applied in a scenario tool used for calculating the development over time of the building stock as a function of demolition rate, new building activity, renovation and energy efficiency measures in retrofits.

62 Ecorys, Ecofys and BioIntelligence (2010): Study to Support the Impact Assessment for the EU Energy Saving Action Plan. It is assumed that on average EU27 public floor area per inhabitant (PFA/I) is 5 m². This is based on various national numbers, i.e. the German ratio is approx. 5.5 m² PFA/I, Denmark 7 m² PFA/I, the Netherlands 5.5 m² PFA/I and UK 4 m² PFA/I.

63 IA for the recast EPBD, Annex V (SEC(2008) 2864, vol 5). The total conditioned floor area is 21 bn m2, of which about 15 bn m2 fof the residential sector and about 6 bn m2 in the service sector. The data are for 2005 and does not include the offices in industry and agricultural sectors.

64 Calculated on the basis of the assumed energy mix and data from GEMIS.

In the scenarios presented here, the average energy price per year varies between €0.09/kWh in 2010 to €0.11/kWh in 2020.

Regarding **Option C3**, it is not possible to calculate the individual results of energy improvements for each particular product group, buildings type or services. However, the overall impact of energy efficiency improvements being taken into account for the public sector can be calculated the energy savings of Option C3 the results of the PROST study[65] were used.

The study concludes that the public sector (very broadly defined, e.g. including social housing) is responsible for about 10% of the total final electricity and heat use for the EU15 and 20% for selected EU12 countries in 2001[66]. It is assumed that this share remains the same for the EU15 in 2020 but is lower for EU12, i.e. to 15%, because of the increased privatization and possible convergence to the EU15. Therefore, on average in 2020 the public sector would consume 96 Mtoe.

To verify the results of the PROST study, data on the share of the public sector were collected from several other reports. The main challenges are that there is no EU27 study or officially collected data regarding the energy use of the public sector. Still, there are a number of individual studies for EU-15 and from various Member States. For instance, a study of ADEME[67] mentioned the figure of 23% of the service sector final energy consumption being taken by public administrations in the EU15 in 2001. Another study for Germany[68] identifies a final energy consumption value for the public sector to 221,68 PJ in 2005. To these values, the social housing energy consumption values were taken into account in the calculation as well. The table below summarizes the results of the studies on the public sector energy consumption that confirm the results of the PROST study.

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65 PROST SAVE supported study. 2003. Harnessing the Power of the Public Purse. Final report.

66 Ibid 59. The public sector (national, regional and local) in most EU15 Member States corresponds to about 10% of the total national energy use. In some countries, notably in Germany and Ireland it's clearly less, or closer to 5%. In Austria, the share is 11% of electricity and 14% of heat, respectively. In Sweden, the public sector stands for 30% of the total heat use due to large public housing companies. In the some EU12 (Slovakia, Estonia, Poland, and Hungary), the estimate for the public sector's share is around 20%, or twice that of EU15.

67 ADEME & EC, Energy efficiency monitoring in the EU, 2005, pg. 91

68 Prognos AG, Potenziale für Energieeinsparung und Energieeffizienz im Lichte aktueller Preisentwicklungen, 2007, pg. 65, 71

Table 11. Overview of studies on the public sector energy consumption

MS	Comments	Value used in the study	Calculations	Year	Study public sector final calculated value (ktoe)	**PROST** Public sector final energy consumption (ktoe)
EU15[a]	Service sector final consumption EU15, 2001: **23% administrations**, 21% wholesale/retail, 20% private offices, 13% hotels/restaurants, 8% education/research, 7% health/social (*Only administration final energy consumption)	23%	**23%** x 106.385 ktoe = **24.468 ktoe** (Administration, 2001); (*If social housing added for 2000, according to Eurostat[b]; 13,2**%** x 250.912 ktoe = 33.120 ktoe ; Σ = **57.588 ktoe**	**2001**	**57.588**	**54.186**
DK[c]	Public sector consumption broken down by categories: 635 GWh Electricity, gas, water and heat supply; 441 GWh Sewage and refuse disposal, sanitation and sewage; 684 GWh Teaching and research; 465 GWh Health and veterinary services; 505 GWh Social institutions; 273 GWh Post and telecommunications; 862 GWh Public administration; 387 GWh Street and road lighting; 206 GWh Electric railways	4.458 GWh	Total public sector energy consumption, 1993: 4.458 GWh = **383 ktoe;** (*If social housing added for 1994, according to Eurostat[b]; 21% x 4.259 ktoe = 894 ktoe ; Σ = **1.277 ktoe**	**1994**	**1.277**	**946**
DE[d]	Public sector final energy consumption, 2006: Heating = 167,68 PJ; Electricity = 53,99 PJ; S = 221,68 PJ (*Social housing and public transport not included)	221,68 PJ	221,68 PJ = **5.295 ktoe** (*If social housing added for 2005, according to Eurostat[b]; 6% x 67.366 ktoe = 4.042 ktoe ; Σ = **9.337 ktoe**	**2005**	**9.337**	**11.263**
IE[e]	Public sector primary energy consumption, average 2001-2005 = 9.816 GWh (*No breakdown into categories of energy consumption)	9.816 GWh	9.816 GWh = **844 ktoe**; Public sector final energy consumption, average 2001-2005 = 844/1,35 = **625 ktoe**; 1,35 = conversion coefficient Primary/Final energy consumption for Ireland	**2001-2005**	**625**	**516**
UK[f]	Service sector energy consumption, 2000, Public administration = 8,1 Mtoe (*No breakdown into categories of energy consumption)	8,1 Mtoe	8,1 Mtoe = **8.100 ktoe**	**2000**	**8.100**	**7.996**
	Service sector energy consumption, 2005, Public administration = 7,2 Mtoe (*No breakdown into categories of energy consumption)	7,2 Mtoe	7,2 Mtoe = **7.200 ktoe**	**2005**	**7.200**	

Sources:

[a] ADEME & EC, Energy efficiency monitoring in the EU, 2005, pg. 91

[b] Eurostat, The social situation in the European Union 2009, 2010, pg. 107

[c] Danish Energy Agency, Teknologikatalog – energibesparelser i den offentlige sector, Energistyrelsen, 1995, pg. 14

[d] Prognos AG, Potenziale für Energieeinsparung und Energieeffizienz im Lichte aktueller Preisentwicklungen, 2007, pg. 65, 71

[e] Sustainable Energy Authority Ireland, questions 3 and 5 http://www.seai.ie/Your_Business/Public_Sector/Reporting/Frequently_Asked_Questions/

[f] Department of Trade and Industry, Energy consumption in the United Kingdom, 2001, annex table 5.9

Based on Fraunhofer[69] the remaining potential for the tertiary sector is 5% and for the residential is 16% compared to PRIMES 2007 or 5% and 17%, respectively, compared to PRIMES 2009. As data on the split of the two sectors is not available as regards the public sector it is assumed that the savings in the range of 5% to 10% can be achieved.

The impact of the proposed options on energy consumption is presented in the table below.

Table 12. Impact on energy consumption[70]

	Final energy savings in 2020 (Mtoe)	Primary energy savings in 2020 (Mtoe)
Option C2a (cost-optimal levels)	3.4	6.4
Option C2b (nearly zero energy levels)	4.6	8.6
Option C3 (EE criteria in public spending)	4.8 – 9.6	8.9-17.9
Option C4 (voluntary provisions)	Higher than BAU but smaller than C2a	Higher than BAU but smaller than C2a

Due to its wider coverage, the impact of Option C3 on energy savings is the highest. The range presented depicts the wide range of possible measures to be covered and the different levels of ambition of the highest performance classes of the labels or certificates. Therefore, the remaining potential is estimated to be 5% to 10% reduction in 2020 compared to the baseline (PRIMES 2009 EE scenario). An important part of the savings will come from the uptake of energy efficiency improvements in the building stock.

The requirement that very ambitious renovation levels are achieved upon renovation (Option C2b) would not only lead to higher savings than if only cost-optimal levels are required (C2a), but also limit the possibility of a 'lock-in' effect. The lock-in effect could be a real problem in the long-term for the building sector, as it means that, if sub-optimal renovation has been undertaken, subsequent, more comprehensive measures become less cost effective until the next major renovation (in 30-40 years).

The impact of Option C4 is expected to be higher than the business as usual, as it can be expected that more Member States will take some measures if there is a reminder in a legal text to do so. However, no significant improvements compared with BAU are to be expected.

The CO_2 emissions reductions forecast in 2020 due to the options analyzed are presented in the table below[71]. Like the impacts on energy consumption, the highest reductions will come from option C3, followed by C2(b and a), while the lowest would be C4.

Table 13. Impact on CO_2 emission reductions in 2020 (Mt)[72]

	CO_2 emission reductions in 2020 (Mt)
Option C2a (cost-optimal levels)	9.2
Option C2b (nearly zero energy levels)	20.0
Option C3 (EE criteria in public spending)	12.8-25.7
Option C4 (voluntary provisions)	Higher than BAU but smaller than C2a

Comparing the options on further measures to realize the potential at the end-use stage

- **Economic impact**

69 Fraunhofer ISI et al. 2009. Study on Energy Savings Potentials in EU Member States, Candidate Countries and EEA Countries

70 Based on Ibid 59, 65

71 The conversion factor for the residential and commercial sector used is 1.35 Mt per 1 Mtoe

72 Based on Ibid 59, 65

As regards the economic impacts, the additional energy-related investment costs describe the additional cost of energy savings measures (e.g. adding of insulation during façade renovation) when **coupled** to renovation measures that are due anyway.

Energy efficiency improvements (e.g. adding of insulation during façade renovation) are only part of the investment needs when renovation is carried out (e.g. painting, scaffolding, renewal of roof tiles, renewal of bathrooms) and are assumed with a factor of 2.3 above additional energy-related investments.[73]. Total investments (energy- and non-energy related) include other maintenance and improvement measures that do not have a direct impact on energy savings such as renewal of roof tiles, renewal of bathrooms etc. and are assumed with a factor of 1.5[74] above total energy-related investments. That is why it is important that energy efficiency measures are carried out when general renovation works are done. Various costs are presented in the table below for Options C2a and C2b. It should be noted that even the total investment needs are still a very small fraction (0.03% for Option C2a and 0.01% for option C2b) of the current GDP of the EU as a whole. The expected annual energy cost savings over the period 2010-2020 exceed the total energy related investments for Option C2a, but are about 2.7 times lower for Option C2b. Still they are equal for Option C2b over the lifetime of the measures (when looking at the annualized investments).

Table 14. Investment needs and energy cost savings[75]

	Option C2a (cost-optimal levels)		**Option C2b** (nearly zero energy levels)	
	2020	Average 2010-2020	2020	Average 2010-2020
Additional energy related investment [bn €]	1,2	1,56	5,28	5,04
Total energy related investment [bn €]	2,64	3,48	10,56	10,2
Total investment (energy and non-energy) [bn €]	4,08	5,16	13,68	13,2
Annuities additional energy related investment [bn €]	0,96	0,48	3,24	1,56
Annuities total energy related investment [bn €]	2,16	1,2	6,48	3,12
Annuities total investment [bn €]	3,36	1,68	8,4	4,08
Energy cost savings	4,32	1,92	8,16	3,72

Under a requirement for very high performance levels (Option C2b), CO_2 emissions savings would be one-third higher than a *currently assumed* cost-optimal level (Option C2a), while investments would be about 50% higher than the cost-optimal level. The step from a cost-optimum to nearly zero energy level would therefore come with a higher lifecycle cost than an economic optimum. However, it can be assumed that the cost optimum and nearly zero energy levels will (and need to) converge in the period up to 2020, due to better market penetration and related lower costs, higher energy prices, etc.

No detailed evaluation of the investment needs for Option C3 is available, but, as the design of the options provides that cost-effective equipment is purchased (i.e. not the highest class but the two or three highest ones) and that renovations are made to cost-optimal and not nearly zero energy levels, it can be expected that they would not be especially high compared with Option C2a.

[73] Forschungszentrum Jülich (2003) Klimaschutz und Beschäftigung durch das KfWProgramm zur CO_2-Minderung und das KfW-CO_2- Gebäudesanierungsprogramm, Endbericht und Zusammenfassung.

[74] Klimaschutz und Beschäftigung durch das KfWProgramm zur CO_2-Minderung und das KfW-CO_2-Gebäudesanierungsprogramm, Endbericht und Zusammenfassung, Forschungszentrum Jülich, 2003.

[75] Based on Ibid 59

Conditionality on public spending would lead to higher investment needs, but would, on average, decrease overall costs for public organisations[76]. This is because the higher purchase prices of efficient goods and buildings are compensated by lower operating costs and savings on energy bills. Analysis of various 'green' goods and services[77] show that the cost-reduction (when using Life Cycle costing approach) is on average around 1% and CO_2 emissions are on average decreased by 25% when using green public procurement (GPP). It is interesting that two product groups are highlighted as leading to significant cost reductions through GPP: construction and transport. However, when also taking into account the volume of CO_2 emissions, construction and electricity are the proposed product groups to focus on.

To reduce the total investment costs for Options C2 and C3, additional policy measures and support tools could be established. These could, for example, include the promotion of public-private partnerships and the role of energy services companies which would take the burden of capital costs from the public sector and finance projects from future savings on energy bills. This would be particularly important for small public authorities that may not have the budgetary means to invest in energy efficiency improvements.

Option C4 would not lead to significant changes in current practices and thus is expected to have a limited impact on public budgets.

The administrative costs of all options is not considered high as: (i) option C2a and C2b would require data on publicly owned buildings and their renovation rates which should be rather easily available; (ii) option C3 uses current labelling schemes and thus does not ask public authorities to carry out additional calculations; and (iii) option C4 is voluntary in nature.

- **Social impact**

The impact of energy-efficiency measures **on job creation** is influenced by various dependencies and specific market situations, tax systems etc. in each country. A detailed analysis would demand quite complex models including input-output analysis, a task which would be out of the scope of the current assessment. It is important to keep in mind the fact that the construction sector is by far the largest employer in the EU with 25m jobs, contributing about 10.4% of GDP, with 2.7m enterprises, most of them SMEs. Any significant development of this work or objectives implies a similar effort in training, knowledge transfer and elaborated policies. It has an enormous potential of transformation from a resource-based industry to a knowledge-based one.

However, a simplified method can be chosen that neglects smaller effects but still offers a good indication of possible employment-related impacts of energy-efficiency measures. The assumed additional turnover from energy-efficiency projects is divided by the average turnover per employee in the construction sector and multiplied by a specific factor, a methodology which was used in the impact assessment for the EPBD recast.

$$job\_creation = \frac{additional\_turnover}{turnover\_per\_employee} * factor$$

This factor depends on the specific labour intensity of the measures carried out. Depending on the exact kind of activities, this factor may vary between 0.5 (share of material costs of energy-efficiency measures twice as high as the usual mix of material and labour costs as presently observed in the building industry of the EU-27) and 1.0 (share of material costs

76 PWC, Significant and Ecofys (2009) Collection of statistical information on Green Public Procurement in the EU

77 Ibid 76

according to the usual mix). In the present scenarios, the factor was therefore assumed to be 0.7. According to Eurostat, the average turnover per employee in the construction sector of the EU-27 in 2005 was €103 000 per employee and year.

The increased activity caused in the construction sector would have an impact on job creation and retention. The direct employment effects of options C2a and C2b are summarised in the table below. For Option C3 the employment impacts would be higher but within the same range as shown in the table, because increased uptake of the majority of energy using products does not lead to a significant number of jobs being created or retained[78]. Therefore, the main driver for more jobs would be measures applied for increased energy performance of the public buildings. The impact of option C4 on employment would be insignificant.

Table 15. Job creation[79]

	Option **C2a** (cost-optimal levels)	Option **C2b** (nearly zero energy levels)
Jobs created and maintained due to additional energy-related investment, average 2010-2020	6 840	10 200
Jobs created and maintained due to total investment, average 2010-2020	15 720	23 640
Jobs created and maintained due to total investments (energy and non-energy), average 2010-2020	23 520	35 400

Beyond the crude numbers, it is important to mention that these jobs are usually created at a local level in support of European cohesion. Because of the need for dramatic reductions of emissions from the buildings sector, so that the 2050 greenhouse gas emission objective is met, and the need for high renovation rates to be sustained over a long period, it can be expected that the impacts will be upheld over a long-term.

Option C3 would also have a positive impact on people living in publicly owned social housing, because new investments would mean lower energy costs in the long run.
The following table summarizes the outcome of the analysis for each policy option.

Table 16. Summary of policy options

Evaluation criteria / **Policy options**	**Subsidiarity/ proportionality**	**Effectiveness**	**Efficiency**	**Coherence**	**OVERALL**
Option C1: Retain the current approach	R	=	=	=	=
Option C2: Binding target for energy saving by public bodies					
C2a at cost-optimal levels	R	+	++		++
C2b at nearly zero energy levels	R	++	+	C	+
Option C3: Obligatory use of energy efficiency as a criterion in public procurement	R	+++	++	C	++
Option C4: Voluntary measures to promote energy efficiency via public procurement	R	+/=	++	C	++

78 IAs for Eco-design and labelling
79 Based on Ibid 59, 65

As regards consistency with the **principles of <u>subsidiarity</u> and <u>proportionality</u>,** Options C2a, C2b impose strong obligations on Member States in an area that is of national competence (C2a and C2b) or are strongly prescriptive (C5) and could be considered as excessively interventionist. However, Options C2a and C2b will contribute to the realization of the climate and energy policy objectives and, in particular, to the objective of development of energy efficiency markets that cannot be sufficiently tackled at national level. Therefore, the EU intervention can be justified.

The option on inclusion of energy efficiency conditionality on the spending of public funds (Option C3) is also in line with the principles, as it would counter the proliferation of national and local approaches on public procurement that could present a barrier to competition. Option C4 is fully in line with the two principles as it is not prescriptive and give full flexibility to Member States.

As regards **<u>effectiveness,</u>**. Options C3 and C9 would have considerable direct (i.e. higher uptake on efficient goods and buildings) and indirect (i.e. market transformation) impact and that is why their effectiveness is evaluated as high (+++). Option C2a would lead to lower savings medium (++).Because of the voluntary nature of Option C4 and the experience so far with the current policies, it can be expected that they would lead to insignificant savings.

As regards **<u>efficiency</u>**, the application of Options C2a is marked as medium efficient (++), as they would require increased costs at the time of purchase and slightly higher administrative burden but this would be compensated by lower operation costs. C2b has low efficiency, as the measure is above the cost-effective level in the short and medium term. C4 would not lead to significant costs or energy savings.

As regards **<u>coherence</u> with the current policy mix**, all options discussed will support the uptake of energy efficiency measures and thus the implementation of the existing legislation. Options C2 and C3 on the role of public authorities are not fully in line with the existing voluntary approach adopted in two Public Procurement Directives[80] and applied in the Commission's Green public procurement initiative and the recast Energy Labelling Directive, but are partially in line with the Energy Star Regulation. However, there are already precedents of mandatory public procurement for efficiency goods at EU level such as the Clean Vehicles Directive[81] and the Energy Star Agreement which could be explored further.

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[80] Directive 2004/18/EC and Directive 2004/17/EC which permit for certain environmental and social considerations to be taken into account in the procurement process but does not makes them a mandatory element.

[81] Directive 2009/33/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles

Annex IX: Detailed explanation and analysis of options C5-C6 on metering & billing

1. BACKGROUND INFORMATION

Studies[82] indicate that accurate metering of energy consumption combined with improved billing[83] is one of the most effective methods of enabling consumers to rationalise their energy use. In the short term, the more clearly people can link consumption to specific appliances and activities, the more obvious it is to them how behaviour patterns affect the size of the energy bill. In the longer term, such feedback can demonstrate the benefits of better insulation and more careful use of timers and thermostats, or the energy cost of new equipment or increased living space[84].

It needs to be recognised that selling energy is very different from selling 'solid' commodities such as groceries. The kWh is easy to meter, for the utility, but 'irrelevant' to the buyer. It cannot be assumed that people will know how to act in order to reduce demand if they have little or no idea how much each end-use contributes to that demand, and how it might be altered. In educational terms, they need to be able to add accurate, trustworthy information (information that they cannot easily get hold of themselves) to what they already know about their own energy using habits. Ideally, a consumer needs to know the relative importance of different end-uses (disaggregated feedback), and also how effective his/her attempts to use less energy have been (historic feedback). The first of these is possible, approximately, if the customer pays attention to real-time information, or to hourly data on a day-late basis[85]. The second is helped by day-late data and by more frequent and informative billing.[86]

Advanced meters can only enable consumers to better manage their energy consumption if equipped with direct displays providing on-line information to consumers. Research on demand response shows that other methods such as personalised web pages and telephone services (e.g. call centres provided by energy suppliers) can be useful as a complement to advanced metering but are less effective on their own than the combination of advanced metering and improved billing.[87]

Article 13 of ESD[88] calls for billing to "accurately reflect the final customer's actual energy consumption and that provide information on actual time of use". In some countries[89] this has

[82] European Smart Metering Guide, 2008, European Smart Metering Alliance (IEE project) http://www.esma-home.eu/downloads/

[83] By ensuring that the basis for billing is actual consumption and not prognoses for future consumption, ensuring better clarity of billing and increasing its frequency.

[84] Fischer, C (2008) Feedback on household electricity consumption: a tool for saving energy. Energy Efficiency 1(1), 79-104

[85] Disaggregation of electrical appliance usage is now becoming possible to a high level of accuracy, through advanced signal recognition

[86] Kempton, W and Layne, LL (1994) The consumer's energy analysis environment. Energy Policy 22 (10), 857-866

[87] Darby S (2011), Literature review for the Energy Demand Research Project Environmental Change Institute, University of Oxford

[88] Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC

[89] Manchester Business School, Generis Technology Limited, Smart Metering in the UK. Policy, Technology and Market Drivers, June 2008

been interpreted to mean some form of real time display, possibly coupled with a smart meter. However, the opinion of energy suppliers in many Member States is that ESD is not requesting real-time in-home displays and that smart meters could rather be provided in a cheaper form without any in-home display.

Table 17. Overview on the provision of information to consumers

Country involved in market research	Information on screen / direct display	More detailed bills	Personalized web page(s)	Telephone services
Finland	**68%**	46%	34%	10%
Norway	**54%**	29%	32%	10%
Sweden	**49%**	28%	39%	5%
Denmark	**58%**	29%	41%	10%
Netherlands	**39%**	25%	23%	10%
France	**57%**	53%	28%	9%
Germany	61%	**66%**	32%	5%
Great Britain	59%	**61%**	30%	20%
Spain	50%	**73%**	29%	23%
Portugal	22%	**32%**	18%	5%
Average	55%	**57%**	30%	11%

Source: European Smart Metering Alliance (IEE project, European Smart Metering Guide, 2008)

Improvement of accuracy of metering alone is likely to have only short term impact on consumers' behaviour, unless clearly correlated with information provided later in billing based on actual consumption[90]. It can be therefore concluded that the optimal solution for direct feedback to consumers is combination of metering and billing enhanced by additional informative feedback to consumers on historical consumption and advice on how to save energy.[91]

As regards web-based display, the research literature to date, largely based on the use of utility websites, suggests that this type of feedback is mostly for enthusiasts and/or people who have been engaged by skilful marketing and good relationships with the supplier. The most promising uses of the utility-based websites seem to be with particular subsets of the population and/or specific, focused programmes. Experience from different trials shows that Substantial demand reductions cited above came from:

- a group of householders (mostly home owners) who used a site to check their data when they received a bill, typically every two months;
- participants, which combined elements of competition and advice with the use of feedback – own-meter reading by the families, and web-based feedback from the utility;
- households who were given information and training online, from a non-profit company, i.e. one that did not have a perceived interest in volume sales.

The evidence to date suggests that online data is more likely to be useful as a complement to in-home displays than as a substitute, but this is a fast-changing area of research and development. There are already many new web-based energy applications now available via mobile phones, personal organisers etc, with one developer commenting that around 50% of the population now engage hourly with some form of online material. It can be concluded, that web-based feedback should be promoted.

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[90] van Dam, SS, Bakker, CA and van Hal, JDM: Home energy monitors: impact over the medium-term. Building Research and Information 38 (5), 458-469

[91] Darby S (2011), Literature review for the Energy Demand Research Project Environmental Change Institute, University of Oxford

As regards district heating, in the past, supply of heating and hot water used to be some kind of social welfare, i.e. consumer used to believe it should be provided for free or at a very low price. Consumers had no sense for need of paying in accordance to consumption, which however is normal for other utilities. As a result, today many consumers still do not see a direct link between their behaviour and their heat consumption leading to wasting a lot of energy. Also district heating managers often do not see a need for investment in heat metering (not even to better control production and supply). Individual metering of heat consumption especially in Eastern Europe is very limited (e.g. around 1% of households in Bulgaria[92]) while in some countries in Western Europe some development in this field has already started[93]. As a result, in multi-apartment buildings, billing of individual consumption is still often based just on distribution of costs by m2 rather than energy consumed or cost distribution based on indications from imprecise evaporating heat allocators.

92 Direct communication from the Bulgarian authorities on transposition of Art.13 of ESD in Bulgaria

93 In 2007 around 20% of all heat cost allocators in Germany were based on radio control, 80% were still subject for re-installation as electronic radio devices. Apart from enabling more accurate feedback to consumers, the key advantage of such devices is that there is no need for meter readers to access the flats. Tenants no longer have to wait for meter readings. Landlords should appreciate radio systems because they reduce administrative expenses and save costs: no alternative arrangements for meter readers, no intermediate reading on site, no reading errors, less hassle with tenants (Armin Anders, White Paper on Enabling Intelligent, Green Buildings, 2007, EnOcean GmbH: http://www.enocean-alliance.org/fileadmin/redaktion/pdf/white_paper/wp_cleantech_en.pdf)

2. DESCRIPTION OF THE POLICY OPTIONS

Option C5: Obligations for smart metering and billing by energy companies

Advanced meters can be used to give feedback to final customers about their energy consumption, and this can lead to greater awareness about the energy use and potential energy savings. The potential for energy savings can be expected to be different from one final customer segment to another and from one country to another. However, a number of studies show that the introduction of advanced meters combined with improved billing and other feedback to consumers may lead to around 10% of final energy savings. Other benefits include:

- avoiding investments in networks and generation (primary energy savings plus € savings),
- reducing primary energy losses in transmission/distribution of energy due to more stabile energy demand (caused by peak shaving),
- improving access to services that improve energy efficiency and help to save energy,
- enhancing business efficiency and service performance of distribution system operators, energy retailers, energy service providers and energy final customers.

In order to ensure that introduction of smart metering empowers the consumers to better manage their own energy consumption and save energy it is recommended to set clear obligations on the Member States on minimum requirements for advanced metering and billing. It would enable narrowing the current range of interpretation by the Member States and ensure that the consumers in all EU countries are given sufficient minimum feedback to rationalise their energy consumption and better respond to time-of-use tariffs, which could generate energy savings also in generation as well as transmission/distribution of energy.

Option C5a: Mandatory instruments for advanced metering

Experience from countries, which already introduced advanced metering in a relatively quick way (Italy, Sweden) shows that introduction of stricter national requirements on the type of meters to be deployed is difficult without clear EU framework. As such, it is recommended to introduce at EU level several critical requirements to ensure that the type and functionalities of advanced meters provide consumers with full transparency concerning energy pricing, data on real-time and historic consumption and enable them to link their behaviour with energy consumption as well as the actual billing of that energy consumption.

It is recommended to set minimum EU requirements to ensure that advanced meters are always equipped with an in-home display which provide minimum feedback to consumers and that the meters always allow for a two-way communication to allow interaction between the end-use of the energy grid/network management and open possibilities for the integration of domestic energy generation into the local grid/network.

The in-home displays should provide information enabling the consumer better control his/her energy consumption indicating as a minimum: (a) a clear analogue indicator of current rate of consumption, (b) current rate of consumption as a rate of spend in local currency per day (numeric), (c) cumulative daily spend in local currency (numeric). The in-home display should offer the consumer a possibility to consult historic consumption levels (in kWh and local currency). The historic periods should match the utility's billing periods in order that the display is consistent with household bills.

To reduce growing numbers of complaints from citizens concerning inaccurate metering of centralised heat it is recommended to introduce an EU requirement for metering of consumption not only for the entire building but also for individual apartments. However, due to specificities of district heating/cooling in buildings with different owners/tenants (e.g. multi-family housing) metering of actual consumption of heating/cooling in individual apartments would still be distorted by the physical heat transfers between different apartments of such building. As a result, users of apartments disconnected from the local heating network would still benefit from heat transfers from apartments using the local heating network. Current practices in many Member States show that the metering of centralised heat is most often left to the local energy providers, which often leads to unfair treatment of citizens and does not encourage energy saving. Therefore, in order to enhance protection of vulnerable consumers it is recommended to introduce an EU requirement for introduction of common national rules for local district heating/cooling providers and/or building administrators on corrections of heating/cooling metering in multi-user buildings.

When metering of heat consumption in single apartments is technically not feasible, it is recommended to oblige Member States to introduce clear rules for DHP/CHP companies on cost allocation of such individual heat consumption. It is recommended that evaporating type of cost allocators as much less useful for enabling consumers to better manage their heat consumption.

Option C5b: Mandatory instruments for the frequency and clarity of billing

Billing is one of the most effective instruments of direct feedback to consumers enabling them to better understand consequences. However, the effectiveness of billing depends very much on the clarity of provided information and the frequency of actual consumption[94]. It general, it is considered that billing based on prognoses rather than actual consumption does not send signals to the consumers encouraging energy savings as the billed amount is not corresponding to the amount of energy actually consumed. Obligation for the provision of billing based on actual consumption has already been introduced by Art.13 of Directive 2006/32/EC.

However, Directive 2006/32/EC did not clarify how frequently such billing should be provided. This resulted in a broad range of interpretations with Member States requiring billing based on actual consumption on monthly basis (eg. Sweden) or sometimes annual or even triennial basis (e.g. Austria). Research indicated that the frequency of billing based on actual consumption should not be higher than two months to still enable the consumer to establish a sufficiently strong link between his/her behaviour and the amount of energy he/she actually consumes[95].

In this option an obligation for minimum frequency of billing based on the actual individual consumption would be (2-monthly for electricity or monthly if electricity if used for heating, 2-monthly for gas or monthly if gas is used for heating, monthly billing for centralised heating/cooling used during heating/cooling season, 2-monthly for hot water).

In order to strengthen feedback to consumers and reduce costs of billing it is recommended to introduce an obligation for retail energy supply companies to provide an option for the consumers to receive electronic billing via internet allowing detailed checks on historical payments and consumption.

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94 Darby S (2011), Literature review for the Energy Demand Research Project Environmental Change Institute, University of Oxford

95 Background study for the energy supply side efficiency framework, COWI, ECN, SEE, AETS, ENCO, Cambridge Econometrics, EC Contract Number TREN/A2/143-2007/SI2.573045, 2010

To improve clarity of energy billing, in this option an obligation is introduced for DSO/billing companies to provide advice to final consumers on how to read the energy bill and how to save energy.

Option C6: Voluntary measures on metering and billing

This policy option is focused on using soft measures to ensure that advanced metering, improved billing and other direct feedback to consumers would help them rationalise their energy consumption and generate energy savings.

Existing provisions of ESD lack requirements concerning means of direct feedback to consumers via meters. This has led to the situation that in countries, which already introduced smart metering such as Italy and Sweden, the new meters in majority of cases lack in-home display. As a result, the consumers received a black-box type of new meter which does not provide any information on real-time use of energy.

Finally, the lack of clear requirements concerning ensuring accuracy of clarity of energy billing has led to numerous complaints by consumers sent to national as well as international organizations including European Commission. In countries of Eastern Europe a significant amount of such complaints from citizens refers to inaccuracy of billing of centralized heat. As ESD is not clearly placing an obligation, a number of Member States did not introduce legally binding rules on billing of actual consumption of centralized heat delivered to multi-family housing. In many countries there is also a lack of clear national rules on a reflecting of heat transfers in multi-family housing in billing provided by district heating companies.

In this option the provisions of Art.13 of ESD are kept unchanged while additional supporting measures would be introduced to encourage dissemination and replication of good practices on advanced metering and billing of individual energy consumption.

Option C6a: Soft measures on metering

To encourage energy companies in all Member States to deploy advanced individual meters equipped with in-home displays, common European guidelines would be prepared. The guidelines would recommend minimum types/level of information that energy suppliers should provide to consumers directly via individual meter.

As the level of experience in metering of centralised heating/cooling is very different in different part of the EU, promotional activities would be considered to disseminate good practices. This would include promotion of good practices on cost allocation of individual heat consumption when metering of heat consumption is not technically possible.

Option C6b: Soft measures on billing

In order to promote use of billing based on actual consumption and to encourage improving clarity and frequency of billing, voluntary codes of conduct would be prepared at EU level and recommended to energy retail companies. This option also assumes launching a recommendation to energy retailer companies to provide an option to all consumers electronic for billing via internet. At EU level, exchanges of good practices between energy retail companies would be supported on how to set help desks to provide advice on demand to individual consumers on how individual consumption could be better managed.

3. EVALUATION OF THE IMPACT

Usefulness of obligations and voluntary measures addressing energy saving potential through improved metering and billing of individual consumption depends mainly on the following criteria:

- Impact on triggering energy savings by enabling the consumer to better manage his/her energy consumption
- Costs and benefits of implementing the measures
- Environmental benefits
- Social impacts on job creation, protection of vulnerable consumers, etc

Impact on energy savings

Primary energy savings on supply side of heating and hot water

In district heating, peak generation capacity is usually based on relatively high efficiency gas/oil boilers. Extreme peak loads usually occur during extreme weather conditions and as such are not really shiftable. However, advanced metering of heat consumption providing feedback to the operator of heat/hot water supply system could help avoid the usage of top load production sources (which often uses fossil fuel) by shifting to renewables (e.g. biomass) and to reduce energy consumption. Some studies indicate that it is possible to remove 10% of the heating load without affecting the quality of service delivered to individual consumers.[96] Intelligent metering could facilitate effective direct load control of the heat load usage by remote means allowing load shedding and load moving. Many district heating systems have problems with peak loads during certain hours of the day and the ability to effectively shed such peaks is desirable from financial as well as environmental aspects. Many district heating systems utilize combined heat and power generation, and by using peak moving in order to match spot-prices on the power market it is possible to improve the overall efficiency and economic benefits of such systems, which could then allow lower tariffs for delivered heat and hot water. These techniques are implemented by coordinating short-term temporary heat load management among the consumers within the district heating system.[97]

For example, when just restoring the wanted control level after a long reduction, e.g night time set-back, the forward flow temperature in the radiator system will rise much faster than the return flow temperature. This causes a substantial, although temporary, heat load increase in the radiator system which negates large portions of the energy saving done during the actual reduction. Apart from decreasing the local net energy saving this behaviour is also less than desired from a system wide perspective, since it causes massive heat load peaks if done in many buildings simultaneously, e.g. contributing to morning peak loads. In order to avoid this it is important to factor in the whole process of the reduction, and make sure that the control system properly handles the transition from the reduction level to the original level.

In option C5 with deployment of advanced individual heat meters up to 70% of the market for centralised heat it can be estimated that primary energy savings in supply and distribution of centralised heat and hot water by district heating/CHP companies due to better management of the systems could reach at least 2-3% (**ca. 1 Mtoe**)[98].

96 E.Wernstedt, P.Davidsson, Ch.Johansson, Demand side management in district heating systems (http://www.fukt.bsnet.se/~uncle/papers/WernstedtDavidssonJohanssonAAMAS2007.pdf)

97 Ch.Johansson, Towards Intelligent District Heating, Blekinge Institute of Technology, 2010

98 Ibid 95

In Option C6, the voluntary approach is likely to have a limited added value compared to the business-as-usual. Dissemination of good practices so far did not provided sufficient leverage for setting critical requirements for the roll-out of smart meters that would enable the consumers to save energy. Without clearer requirements at EU level, there is a risk that a number of Member States will tend to follow the directions set in Directives 2009/72/EC and 2009/73/EC on internal market in electricity and gas by taking the option for the cheaper type of equipment, which would not lead to any substantial energy savings.

Savings on supply side and transmission/distribution of electricity and gas

Introduction of advanced bi-directional meters with in-built feedback systems to empower the consumer to better manage his/her energy consumption would allow easier introduction and uptake of time-of-use tariffs. In the electricity sector, it would facilitate significant peak shaving and allow use of higher efficiency generation (e.g. combined heat and power with total efficiency over 80-90%).

Electricity consumption tends to peak at extreme levels for very few hours. About 7 GW of installed capacity will be needed to operate for only 10 hours across the continental European electricity system under the Union for the Co-ordination of Transmission of Electricity (UCTE) system, based on current patterns of consumption. This corresponds to 1.7% of peak load and about 1.5% of total installed capacity in that region. Most commonly, low efficiency (ca. 35%) Open Cycle Gas Turbines are likely to be the main generation resource to meet this load, if peak load cannot be met by optimisation and trade across the UCTE area.

Shifting 200 hours of the highest load for electricity consumption in the entire year (ca. 9% of the peak load) to the base load in the entire year at EU level would lead to primary energy savings of 5-6 TWh (**0,5 Mtoe**) due to the use of more efficient generation[99].

In case of transmission/distribution of electricity, the introduction of advanced metering with two-way communication would allow major improvement of the grid management and reduction of transmission and distribution losses. Ensuring bi-directional communication of meters would allow upgrading grid management infrastructure that could improve grid efficiency by reducing power line losses using networking distribution automation devices to minimize reactive power flows through adaptive voltage control. In USA, it has been estimated that the reduction of transmission/distribution losses due to better grid management facilitated by smart meters could reach 1-2%[100]. If the same level of savings was taken for the EU, the level of primary energy savings would reach around **0,5-1 Mtoe**.

In is assumed that in case of gas supply, peak shifting would have smaller impact on energy savings on supply side and transmission/distribution[101].

Energy savings in end-use consumption of heat

In district heating it is important that introduction of individual metering would allow changing tariff system with a billing based a lump sums (per m²) to a billing of actual consumption of heat (per kWh or GJ) thus allowing the consumer to measure his/her heat consumption.

99 Empowering Electricity Customers. Customer Choice and Demand Response in Competitive markets (draft), 2011, IEA

100 M.Jung, P.Yeung, Connecting Smart Grid and Climate Change, Silver Springs Networks http://www.silverspringnet.com/pdfs/SSN_WP_ConnectingSmartGrid-1109.pdf

101 Probably 5 times smaller than in case of electricity grid; (Mott MacDonald, *Appraisal of costs and benefits of smart meter roll out options*, April 2008)

It should be mentioned that in some types of older buildings with horizontal piping metering of heat consumption in each apartment may be expensive and technically difficult. In such buildings a two-level approach should be applied:

- A building meter is installed at the building entry or, in larger buildings, at the staircase entry,

- at each radiator heat cost allocators are installed.

Surveys show that consumers prefer electronic heat cost allocators rather, which are more precise than evaporating devices (but still do not register in-house heat transmission). Heating costs are then distributed according to the heat cost allocators.[102].

In multi-apartment buildings, individual metering of heat consumption is normally distorted by in-house heat transmission between apartments. As a result, even apartments disconnected from the local heating network would still benefit from the heat supplied to other apartments in the same building. Also, as much of the heat usually escapes from buildings through the roof, metered individual consumption in apartments next not the roof should not be corrected for heat losses that are common to the entire building. Therefore, in order not to discriminate responsible consumers it is important that Member States introduce clear common national binding guidelines for district heating companies on accounting for heat transfers in multi-family buildings and correcting for individual heat consumption.

Attributing energy savings to the use of heat cost allocators is difficult because very often they cannot be distinguished from savings due to other energy saving investments. Usually energy savings of 10-30% are quoted by manufacturers. Investigations were carried out in several European countries to determine the energy savings that can be achieved due to individual heat metering, usually in conjunction with individual control equipment. Typically, the savings are determined by comparing the performance of several buildings with individual heat metering with thermostatic radiator valves with the performance of similar buildings without such equipment. Heat energy savings of about 13-15% were confirmed by German investigations. Danish studies showed heat energy savings of 11-34%. On average, energy savings of about 20% can be expected with higher savings especially in northern and Eastern Europe. At EU level, improved metering and billing of centralised heat would translate to ca. **9-20 Mtoe** of primary energy savings[103]

Modern heat meters display a variety of information, for example kWhs/GJ consumed, instant heating capacities, temperatures of heating water, the consumption data for the previous periods and many other features, which make both housing management companies and residents more aware about energy consumption behaviour. Another more recent development is the integration of meters for all network communal services (electricity, gas, heat, hot and cold water) into one meter.

Correction of heat metering in multi-family housing

In several countries, such as Denmark and Poland, the consumption-based part of the bill takes into account the specific location of an apartment in a building. The reasoning is that the individual consumer does not have any influence over heat losses that occur simply because an apartment has more outer wall area than another or is located on the Northern side of the building

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102 B.Kalkum, District heating: Rationale for metering and funding opportunities for meters, Smart Metering Conference, Warsaw 07/04/2009

103 Eurostat data and Euroheat&Power statistics 2007 (http://www.euroheat.org/Statistics-69.aspx): (final heat delivered by district heating to residential buildings in 2007 was around 30 Mtoe, average efficiency ca. 70-80%; projection of PRIMES 2009 business-as-usual is that in 2020 the demand for heat from DHP/CHP might increase to 75 Mtoe final)

rather than on the Southern side. In Germany such compensation factors are not used since the fixed part of the heat bill to a large extent takes care of these factors. Furthermore, apartments with more outer wall area and/or Northern exposures usually come at a slightly lower price since buyers/consumers are aware of the higher heating costs.

In Denmark and Poland the use of correction factors is similar and fairly simple. The metered heat is multiplied by the correction factors shown in the figure, resulting in a lower variable part of the heat bill for apartments in disfavoured locations. For buildings built before 1987 which have worse insulation properties, correction factors for disadvantaged locations are "higher". Experience of other countries shows that application of correction factors must be simple as otherwise the billing of actual heat consumption may become too complicated[104].

Savings in end use consumption of electricity and gas

Where so-called "smart meters" have been installed (electricity and/or gas), consumers have reduced their energy consumption by as much as 10%[105], which would translate into ca. **69 Mtoe** Some pilot projects suggest that the number can be even higher.[106]

In-home displays (IHD) have been reported (Darby 2010) to result in 5-15% final energy savings in pilot-experiments. IHD may provide direct feedback to customers, who can directly observe the consequences of their behaviour.

Theoretically, in-home displays for advanced meters could be substituted for a relatively low cost clip-on real time display device. Such simple clip-on devices are already available to householders who can voluntarily install them themselves. However, there are concerns on the use of clip-on devices as they:

- have lower accuracy than a normally functioning domestic meter,
- are not synchronised with the actual meter reading leading to a possible disjoint with billing,
- are suitable only for metering consumption of electricity, not gas or district heating/cooling,
- have some maintenance needs with unclarity who should pay for and changes the battery,
- might cause possible health and safety hazards if consumers are left to do this themselves
- would be bound for stranding – if one supplier provides the device and a householder chooses to switch supplier then the clip-on real-time device would effectively be stranded.

However, trials with smart meters equipped with in-home displays carried out in the Netherlands show that consumers who returned their in-home displays after a few months of using it tended to return to their original consumption levels[107]. It is therefore important that

104 For example, according to many experts, the Swiss regulations introducing very complex system of corrections for heat metering in multi-apartment buildings have led to a confusing billing system, which defeats its purpose of providing consumers with information on their energy use and incentives to save energy (Heat Metering and Billing, Technical Options, Policies and Regulations, World Bank, 2002 www.worldbank.org.cn/english/content/heat.pdf)

105 Vincenzo Cannatelli, ENEL Telegestore Project is on Track, page 4. Available at: http://www.greey.ca/RelatedFiles/1/ENEL%20Telegestore%20Project%20IS%20ON%20TRACK.pdf

106 In the UK, the AlertMe project allows customers to turn off appliances by web interface or mobile, and in 8 months residents have saved roughly 40% of their electricity; in Spain, the forecasts developed by the GAD project show that a usual consumer could save 15% of his total energy consumption; in the US Smart Grid City, a pilot project to understand the potential impacts of a range of 'smart grid' technologies including OpenGrid software which allowed two- way communications on the grid and led to a 90% reduction in voltage problems which in turn reduced overall power requirements by 3-5% in a city of 100,000 people.

107 van Dam, SS, Bakker, CA and van Hal, JDM: Home energy monitors: impact over the medium-term. Building Research and Information 38 (5), 458-469

introduction of smart meters is not only requiring provision of functional in-home displays but is also supported by frequent improved billing synchronised with the information provided by the meter.

Increasing <u>frequency of billing</u> is important to reinforce and sustain that benefits of direct feedback provided by advanced metering of individual energy consumption.

A standard utility bill is a form of feedback in which the feedback loop is too far removed from the use of inputs to have any information value'[108]. There are only a few published records of trials that show the effect of informative billing in isolation from other factors. The highest recorded savings were achieved in Norway: 10% over controls when quarterly bills based on an annual meter reading were replaced first by accurate bills every two months, and then, after a year, by historic feedback – a comparison with the same period during the previous year. Including advice on energy efficiency with the bill added nothing to the savings (this contrasts with findings from several other sources), and the authors concluded that the main single stimulus to conserve had come from increased billing frequency[109]. It appeared that people knew what they needed to do in order to save energy, and that the improved, more frequent bill prompted them to do it and then, later, validated their actions by showing the reduced usage. A follow-up study, on a larger scale (2000 participants) in which customers phoned in their meter readings every month, gave comparable savings: 8% over controls, three years after the end of the trial[110]. It seems that the durable and relatively high impact from frequent, accurate bills in Norway was primarily due to their supplying a 'missing link': customers were already motivated to save and were then given something crucial for knowledge and understanding that they had lacked previously, plus a regular prompt to act.

Experiments with monthly or bimonthly billing report savings in the range of 0-10%[111]. The difference between bimonthly and monthly billing may therefore be considered relatively minor, although intuitively, consumers may be able to better relate monthly feedback to actual behaviour than bimonthly feedback. Given that bimonthly feedback basically requires automated meter readings anyway, and the additional costs of more frequent updates may be relatively minor if provided automatically and electronically, it is recommendable to consider to introduction of a requirement for a minimum bimonthly frequency of billing based on actual consumption with monthly electronic status updates when possible.

Concluding, an in-home display should be fully integrated with an advanced meter in order to ensure that direct feedback to consumer is accurate and compatible with the information provided through billing and other forms of feedback (e.g. web-based personalised advice). This would mean the option introducing stricter obligations on metering and billing of individual consumption and informative feedback to consumers reduction would lead to total primary energy savings at the order of **80-90 Mtoe**.

<u>In Option C6</u>, voluntary approach is likely to have a minimum added value compared to the business-as-usual. Because of the structure of the retail market in most of the EU countries where meters do not belong to the consumers but rather to energy utilities, decisions on the

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108 Gaskell, G, Ellis, P and Pike, R (1982) The energy literate consumer: the effects of consumption feedback and information on beliefs, knowledge and behaviour. Dept of Social Psychology, LSE, London

109 Wilhite, H and Ling, R (1995) Measured energy savings from a more informative energy bill. Energy and buildings 22 pp145-155.

110 Darby S (2011), Literature review for the Energy Demand Research Project Environmental Change Institute, University of Oxford

111 Ibid 110

choice of meters (e.g. with or without in-home display, with or without functions of meters supporting informative billing, etc) and a choice of feedback to consumers (e.g. continuation of billing based on prognoses rather than actual consumption) would be left to energy companies themselves. Several countries, which introduced stricter requirements (e.g. Swedish requirement for monthly billing of energy consumption based on actual consumption) might have difficulties to justify continuation of their strict national requirements.

Current legislation is not precise about frequency of billing based on actual energy consumption. This has resulted in a remarkable difference in interpretations in transposition by Member States. For example, in case of electricity, the actual practices in the Member States range from a requirement of monthly billing of actual electricity consumption in Sweden to annual billing in Austria with a requirement for actual meter reading every three years while using self-reading by the final customer or interpolation in between[112]. As regards the frequency of billing of actual consumption of natural gas and centralised heat most Member States do not have any legal requirements. The common practices in majority of Member States are that billing based on actual consumption is provided on an annual basis.

It can be though assumed that increased efforts to facilitate exchanges of good practices between energy suppliers, billing companies as well as regulators could lead to a small impact on deployment of two-way communicating meters and an increase in the deployment of advanced meters equipped with in-home display. However, based on experience of countries which already started the roll-out of smart meters, the amount of meters that can effectively enable the consumer to better manage his/her energy consumption is below 10%. Based on current flexible provisions of ESD with various recommendations produced on voluntary basis (Eurelectric, ERGEG) so far led to small changes in the national legislations[113] .

As such, it can be assumed that voluntary approach for the promotion of advanced metering and improved billing would lead to not more than 10% of the impact that could be achieved through introduction of EU-wide obligations. If so, the impact of the option B6 on primary energy savings would not exceed **8-9 Mtoe**.

Economic impacts

Costs

The general roll-out of advanced meters for electricity and gas is already assumed by Directive 2009/72/EC[114] and Directive 2009/73/EC. However, some critical requirements for such meters to enable consumers to rationalize their use of energy so far have not been clarified neither by the Third Electricity package nor Energy Services Directive.

In option C5, ensuring that the new advanced meter is bi-directional electricity/gas rather than one-way black-box type of a meter would increase the cost of the meter on average by ca. € 50-100. The introduction of an obligation to provide an in-home display integrated in an advanced meter would result only in minor increase of capital cost by ca. € 15-20 per meter. It can be assumed that installation costs would be the same as in the case of smart meters not equipped with an in-home display.

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112 Ibid 95

113 Only Sweden and the Netherlands introduced formal requirement for billing based on actual energy consumption to be provided to final consumers not less frequently than 1-2 months.

114 The costs of introducing a smart meter (two–way communication including installation cost) are assumed to be around € 120-200 per meter[114]. For *smart dual-utility electricity and gas meters* the meter cost per connection may range from €140 to €340 (ref ibid 95)

Metering of actual consumption of heat is required by Directive 2006/32/EC. However, with a soft character of the obligation, Member States have been given extended flexibility of choosing to set requirements in this field. Some investments in metering of individual heat consumption have been made especially in Nordic countries and in central Europe. However, in the view of a growing number of complaints on inaccuracy of heat metering and billing, the need for investments is significant. More sophisticated heat meters with remote controls normally have higher benefits to the consumer than simple heat allocators, such as showing clearly the amount of heat consumed which may lead to slightly higher savings. The cost for simple heat allocators with evaporation agent is low but requires regular changing of the evaporating agent after each heating season, data from readings are often illegible, "summer" evaporation and parallax error are distorting the readings. Electronic heat allocators cost € 10-25 for each radiator with more expensive models equipped with radio transmission for remote reading allow more accurate readings although the direct feedback to consumer is not expressed in units used later in billing. Most accurate are individual heat meters (€ 120-300) with more expensive models ready for remote reading, able to calculate all main components of the bill, with in-home display with many functions allowing the consumer to consult both real-time as well as historic information about consumption and related costs.

Energy savings due to heat metering and control have been relatively well documented in Western Europe. They range between 7 and 30%. Thus, the energy savings required to pay back for the cost of metering is achievable both with the simplest heat cost allocators and in most circumstances also with the other individual heat metering options.

In option C6, the costs of the preparation of common guidelines and facilitation of dissemination of good practices with advanced metering and billing would be relatively small. Assuming that the voluntary measures would lead to ca. 10% of the uptake of advanced metering, the total cost of this option would be more or less 9 times lower than the option C5.

Benefits

Direct financial benefits to consumer would come from a reduction in overall energy consumption as a result of better information on costs and use of energy which drives behavioural change, and a shift of energy demand from peak times to off-peak times.[115] The scale of saving would depend on the share of final energy consumption compared to fixed components of the energy bill.

With systems fully integrated with advanced metering, switching more frequent billing would not increase costs except from printing and postage. Introduction of electronic billing even with relatively small uptake of such services should still result in reducing the costs that could be shared between the supplier and the consumer.

The scale of money savings would depend caused by the reduction of heating/cooling consumption due to introduction of individual heat metering and more frequent billing would depend of the share of fixed costs of the district heating/cooling companies. Automatic meter reading could help with reducing losses in generation and distribution of thermal energy on supplier side due to improved management of the system, shaving peaks and reducing amount of fuel used for the production of heating/cooling and hot water.[116]

Other benefits would come from avoided costs of home visits for manual meter reading[117] and reduced costs related to handling complaints and requests from customers for the clarification

115 Impact assessment of a GB-wide smart meter roll out for the domestic sector (final), DECC, 2009

116 Heat Metering and Billing, Technical Options, Policies and Regulations, World Bank, 2002

117 In the UK, it was assumed that on average reducing home visits would bring GBP 6 of saving annually per meter (ibid 115)

of billing[118]. However, especially during the roll-out of smart meters it can be assumed that the need for on-line advice to customers the costs necessary for the use of call centres would be similar to the current needs for handling complaints.

An important benefit will come from enabling the consumer to more easily participate in the local generation of energy (introduction of micro-CHP, integration of PV, etc), reducing some costs related to embedding operating own energy generating installations and selling energy to the grid.

Suppliers would further benefit on reducing costs on remote switching and disconnection, debt management, and theft of energy. The introduction of smart metering should allow a rationalisation of the arrangements for handling the change of supplier process. Trouble shooting teams employed to resolve exceptions or investigate data issues would no longer be needed. Suppliers will be able to take accurate readings on the day of a change of supplier, resolving the need to follow up any readings that do not match and instances of mis-billing would reduce.[119]

It is likely that suppliers will profit from selling new energy products as a result of smart meters. This will probably represent a benefit to suppliers only, not to society, as it is unlikely that the profits from these products will be passed onto consumers.[120]

Introduction of metering would result in costs savings due to reduced losses in transmission and distribution[121]. These benefits would probably be attributed to DSO/TSO companies.

Suppliers of electricity would additionally significantly benefit from reduced demand for peak generation. Generation costs of an OCGT operating for only 9 hours per year, corresponding to a 0.1% capacity factor, is approximately USD/ MWh 10 000 (IEA, 2007). If it was possible to expand the prospects for demand response to 5% of peak load in a price range between USD/MWh 1 000 and 10 000, the prospects for savings and making the electricity system more robust would improve considerably. As a simple, illustrative example, assuming that 7 GW working just 9 peak hours at USD/MWh 10 000 are replaced by power at USD/MWh 1 000, the annual savings for the system are € 410 million[122]

Due to expected lower uptake of advanced meters and use of improved billing, the overall impact of the measures set in option C6 as regards economic benefits would be at least 10 times lower than in the case of option C6. However, with less strict requirements on the protection of consumers and the commercial interest of suppliers in ensuring that the levels of final consumption do not decrease significantly, it can be assumed that such approach could lead to slightly unbalanced share of benefits, with energy suppliers benefitting more than final consumers.

Environmental impacts

Reduction of final consumption of electricity/gas by 10% and heat by 20% will result in major direct reduction of emissions of greenhouses gases in the generation of energy. Additional environmental benefits will also come from enabling of peak shaving in generation of

118 In the UK annual savings due to reduced need for call centres were estimated to be ca. GBP 3 per meter (ibid 115)

119 The benefit to suppliers in the UK was estimated to be ca. GBP 100 million annually (ibid 115)

120 In the UK this revenue was calculated to be in the order of GBP 100 million or more per annum from 2020 (ibid 115)

121 In the UK, this has been calculated as GBP 0,5 per electricity meter and GBP 0,1 per gas meter. (ibid 115)

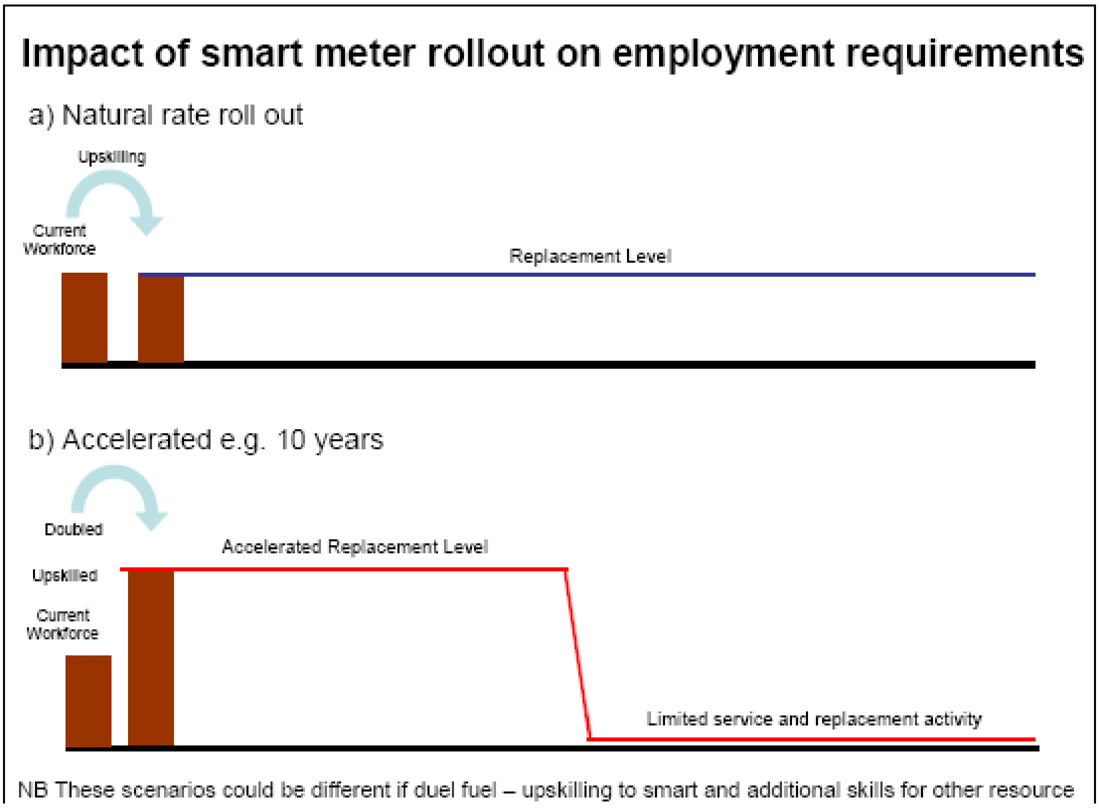
122 Empowering electricity customers: Customers choice and demand response in competitive markets, IEA report (draft), 2011

electricity and heat as well as improved management and reduction of losses in transmission and distribution of electricity, gas and centralised heat.
Elimination of the use of imprecise evaporating heat allocators would also have impacts on reduction of chemical waste and environmental pollution related to the production of chemical agents used in such devices[123]. Increased frequency of billing effectively would have no major environmental impact as the wider introduction of electronic billing of energy consumption would effectively result in lower used of paper (for printing and posting the billing).

Social impacts

The roll-out of advanced meters is already assumed by Directive 2009/72/EC. The impact on employment depends there on a scenario to be taken by different Member States, where with accelerated deployment there would be a need for a double amount of skilled installers than available today for meter reading operators.

Figure 4. Different scenarios for the impact of the roll-out of advanced metering on employment



Source: Manchester Business School, Generis Technology Limited, Smart Metering in the UK. Policy, Technology and Market Drivers, June 2008

It is estimated that by 2020 some 200 million of smart meters (electricity and/or gas) should be installed in the EU[124]. Assuming that the replacement of old meter or installation of a new

123 E.g. many evaporating heat allocators used especially in Eastern Europe use methyl p-hydroxybenzoate, which can cause allergies and may produce lasting bad smell in case of accidental damage of such heat allocator

124 DG ENER calculations based on DG INFSO report "Impacts of Information and Communication Technologies on Energy Efficiency". The 80% target of Directive 2009/72/EC corresponds to equipping 200 million European households with smart meters. The cost for this equipment amounts to another 40 billion €.

advanced meter on average would take 0,5-1 h for 2 skilled installers, which would lead to an average of 7-15 meters installed per day. This means that installation of 1 million of advanced meters would require training and employing 400-800 installers. Depending on the speed of the roll-out of smart metering (of electricity and/or gas) minimum of 10,000 skilled installers would be needed for the period of 8-10 years.

At the same time, introduction of advanced metering and improved billing would lead to major reductions in employments of manual meter readers. It can be estimated that on average a meter reader needs 5 minutes to collect and record data from manual meters, taking some 100 readings per day. The frequency of manual meter reading today varies among member States from 2-3 monthly (e.g. Bulgaria, Romania) to annual or even triennial (Austria). Some manual meter readers could be re-trained to provide maintenance and occasional checks of the advanced meters (ca. 10,000). It can be though estimated switching to automatic meter reading will result in at least 150,000 manual meter readers losing their jobs.

The needs for additional installers and servicemen for individual heat meters are more difficult to estimate. Such meters would normally require calibration and more frequent checks than electricity/gas meters. There would also be a need for additional employment in IT sectors[125] in processing and management of the heat consumption data. It can be assumed the introduction of the obligation to introduce individual metering of heat consumption (2/3 of heat meters and 1/3 of electronic heat allocators) would the generate needs for at least additional 10,000 jobs by 2020.[126]

It can also be assumed that due to improved clarity of billing through synchronisation with real-time and historic consumption data available via in-home displays of advanced meters, the number of people employed by suppliers in call centres dealing with requests for information and complaints on billing would also be significantly reduced. However, the need for telephone helplines to assist the introduction of smart meters and the activation of services related to energy advisory to consumers would probably compensate the reduction of employment in call centres dealing with complaints on inaccurate metering and unclear billing.

As regards metering and billing of centralised heating, evaporation heat cost allocators (HCA) are the most labour intensive metering device. A separate service company is usually in charge of the annual reading, ampoule replacement, calculation of individual consumption, and billing. This work has to be carried out within a period of a few months during the off-heating season. It is estimated that between 800 and 2600 people might be needed to read HCAs in every million of flats. Billing service companies deal with this seasonal peak by employing temporary personnel and cooperating with external companies.[127]

Apartment-level metering of heating/cooling could be the most direct way of billing households for their consumption, if these meters are remotely read once per month and if households have direct contracts with the heating company. In this case, no once-per-year reconciliation of repayments would be required, but instead the monthly payment would be based on the actual consumption.

Information of consumers is very important to actually realize the potential benefits from the introduction of heat metering. Consumers need to know how the heat metering is carried out,

[125] Either in CHP/DHP companies themselves or SMEs subcontracted to provide IT support
[126] Ibid 95
[127] Heat Metering and Billing, Technical Options, Policies and Regulations, World Bank, 2002 www.worldbank.org.cn/english/content/heat.pdf)

how the billing will be done, how their behaviour could impact on heat consumption and how this will impact on the final heating bill. All this is especially important when consumers have not been responsible in the past for paying their heating bills and have thus adopted behaviour which waste heat, such as installing radiator covers, opening windows, etc. Equally important is to make them aware of the potentially damaging impact of too little heat on their own health and on the integrity of building infrastructure.

Impact on consumers

The use of correction factors for heat metering (location compensation factors) might depend on concepts of fairness that could be different from one society to the next. However, regardless of the location, especially poorer households will find themselves increasingly unable to pay for heat if the amount depends on the size/location of their dwelling and cannot be influenced by them. As such, the obligation to set up simple system of correction factors for the heat metering in multi-family housing would help with encouraging especially poorer consumers to save energy and money by rationalising heat consumption in their apartments.

The access to heat metering and controls and consumption-based billing is especially important for poorer consumers, since it gives them the opportunity to control the amount of money they spend for heating. For the matter of incentivising energy saving, poorer households should not receive preferential tariffs. Rather, if heat expenditures are too high for poor households to be affordable, it would be more effective if those households are supported through general social support measures. In addition, those households might need financial support to pay for metering and control equipment, if required[128].

Another important social impact is related to reduced intrusiveness of metering and billing. In particular metering of heat consumption using evaporation or electronic heat allocators can be troublesome as it requires allowing readers enter the apartments and visit all rooms with radiators. Usually, such visits are arranged in a short period of time, which may cause extra costs for the owners of the apartments if the readers have to visit the apartment again because it was not available during the first visit. From this point of view, advanced remote reading meters for heat consumption would pose no problems even if the heat meter was installed in the apartment itself.

In general, manual meter reading of electricity/gas relatively troublesome as the meters are often not placed in the apartments themselves. Installing two-way communication meters for electricity and/or gas would practically eliminate intrusiveness.

Health impacts

The impact of introducing consumer-friendly metering will be positive especially as regards improving thermal comfort in heating/cooling in housing.

Comparison of the options

Respect of subsidiarity/proportionality

Directive 2006/32/EC required improved billing and metering but allowed Member States full flexibility concerning definition of frequency of billing and types of advanced individual meters. As a result, the development of smart metering in some countries (Sweden, Italy) has already led to the situation where introduction of new technologies do not enable the consumer to better manage his behaviour and save energy. Increasing number of complaints

128 Ibid 116

from citizens[129] on the lack of transparency and accuracy of metering and billing indicates that the problem has not been solved in many countries. Given this failure for a less interventionist approach to achieve the objective aimed at, a more interventionist approach, as embodied in option C5, is therefore considered compatible with the principle of subsidiarity, as is the less interventionist approach embodied in option C6.

Coherence

Introduction of clear obligations (option C5) would enhance implementation of other EU energy efficiency legislation such as eco-labelling in relation to home appliances, as better awareness of final consumers could encourage some of the to purchase more energy-efficient equipment. Ensuring two-way communication of smart meters would also allow easier introduction of dispersed generation (micro-CHP, PV, etc) that would be important for the achievement of the national targets for renewable energy.

Article 13(1) of the ESD states, *"Member States shall ensure that, in so far as it is technically possible, financially reasonable and proportionate in relation to the potential energy savings, final customers for electricity, natural gas, district heating and/or cooling and domestic hot water are provided with competitively priced individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use.*

When an existing meter is replaced, such competitively priced individual meters shall always be provided, unless this is technically impossible or not cost-effective in relation to the estimated potential savings in the long term. When a new connection is made in a new building or a building undergoes major renovations, as set out in Directive 2002/91/EC, such competitively priced individual meters shall always be provided."

Annex I to Directive 2009/72/EC[130] states that *"...Member States shall ensure the implementation of intelligent metering systems that shall assist the active participation of consumers in the electricity supply market. The implementation of those metering systems may be subject to an economic assessment of all the long-term costs and benefits to the market and the individual consumer or which form of intelligent metering is economically reasonable and cost-effective and which timeframe is feasible for their distribution. Such assessment shall take place by 3 September 2012.*

Subject to that assessment, Member States or any competent authority they designate shall prepare a timetable with a target of up to 10 years for the implementation of intelligent metering systems. Where roll-out of smart meters is assessed positively, at least 80 % of consumers shall be equipped with intelligent metering systems by 2020."

Same Annex I to Directive 2009/72 specifies that "(Consumers)… *are properly informed of actual electricity consumption and costs frequently enough to enable them to regulate their own electricity consumption. That information shall be given by using a sufficient time frame, which takes account of the capability of customer's metering equipment and the electricity product in question. Due account shall be taken of the cost-efficiency of such measures. No additional costs shall be charged to the consumer for that service.*

[129] Stajnarova M, Consumers experience with billing and switching, workshop on guidelines for good practices in billing and switching, Brussels 10 February 2011: in Italy, just between June 2009 and May 2010, there were over 12,000 complaints registered by the Italian Consumers Association on electricity billing)

[130] Directive 2009/72/EC concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC

Mirroring provisions are included in Annex I to Directive 2009/73/EC[131] in relation to the rules for the internal market in gas

These provisions lack certain coherence, because the lack of the definition for "sufficient time frame" for the provision of informative feedback to consumer, in which any period selected by the energy suppliers would comply with such provisions. Also the minimum capabilities of customer's metering equipment in sense of enabling better management of individual energy consumption remain undefined while emphasis of the economic reasonability may suggest using the cheapest options for advanced meters (e.g. without in-home displays one-way communication devices), which would not serve the purpose for enabling energy savings.

The introduction of clear obligations (option C5) would address this lack of coherence by fixing minimum requirements for meters and defining minimum frequency of billing based on actual consumption. Furthermore, option C5 would fill the gap as regards specifying critical conditions for improved metering and billing of centralised heat, which are not covered today by any other EU legislation.

As the option D6 would follow the flexible approach, it would not lead to solving the lack of incoherence between ESD and other EU legislation dealing with internal market rules in electricity and gas.

Table 18. Comparison of options on metering and billing

Evaluation criteria / **Policy options**	**Subsidiarity/ proportionality**	**Effectiveness**	**Efficiency**	**Coherence**	**OVERALL**
Option C5 Enhanced obligations for smart metering and billing by energy companies	R	++	++	C	++
Option C6 Voluntary measures on metering and billing	R	+/=	+	C	+

131 Directive 2009/73/EC concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC

Annex X: Detailed explanation and analysis of certain options to promote energy efficiency at supply side (CHP)

CHP – Analysis of current situation and obstacles to market development

Drivers of the problem

The CHP Directive (2004/08/EC) provides a common legislative framework for CHP in the EU. On one side, it establishes a common methodology for determining the benefits of CHP and sets out a definition of high-efficiency CHP based on this methodology. On the other side, it creates a number of legislative requirements for Member States aiming to stimulate the wider deployment of CHP.

The Directive requires EU Member States to establish a system of Guarantees of Origin (GO) for high-efficiency cogeneration (HE CHP) based on the harmonised definition for high-efficiency CHP and harmonised calculation method for primary energy saving. Furthermore Member States have to guarantee the distribution and transmission of electricity, ensure transparency and non-discrimination of grid connection charges; and that transmission system operators give priority dispatch for electricity from HE CHP. Member States must base the support scheme on the high-efficiency criterion as defined in the Directive. Furthermore they have to perform a number of evaluations and report the results. These obligation are: to analyse national potentials for cogeneration; to evaluate administrative procedures, including authorisation, regulatory and non-regulatory barriers, the transparency and non-discriminatory nature of procedures, the existence of streamlined and expedited procedures, cooperation of national authorities, existence of guidelines and fast track planning procedures and the appointment of mediators; to evaluate the accuracy and reliability of their GO systems. Every four year, Member States have to report on progress in increasing the share of HE CHP every four year on the request of the Commission.

The main objective of the CHP Directive is to promote the development of high-efficiency CHP as an energy saving measure. It requires Member States to establish via an analysis what their cogeneration potential is, evaluate barriers to realise this potential and report on progress in increasing the share of HE CHP.

Yet the focus on the Directive is on evaluation and reporting. Only the setting up of a GO system based on harmonised calculation methods and the priority dispatch obligation by TSOs can be considered as concrete operative action.

According to the analysis of the Member States, the EU has large unexploited cogeneration potential that is already economical, but is not realised due to market and regulatory barriers. This proven declared potential represents 655 TWh of CHP electricity under a conservative scenario.[132] This is the double of the average HE CHP production of the baseline period in 2004-2009 and almost twice as much as the 370 TWh produced in 2008, a peak energy production year.[133] In terms of capacity, the EU declared cogeneration potential corresponds to some 211 GW_e capacity, a double of the 100.2 GW EU installed CHP capacity in 2008.

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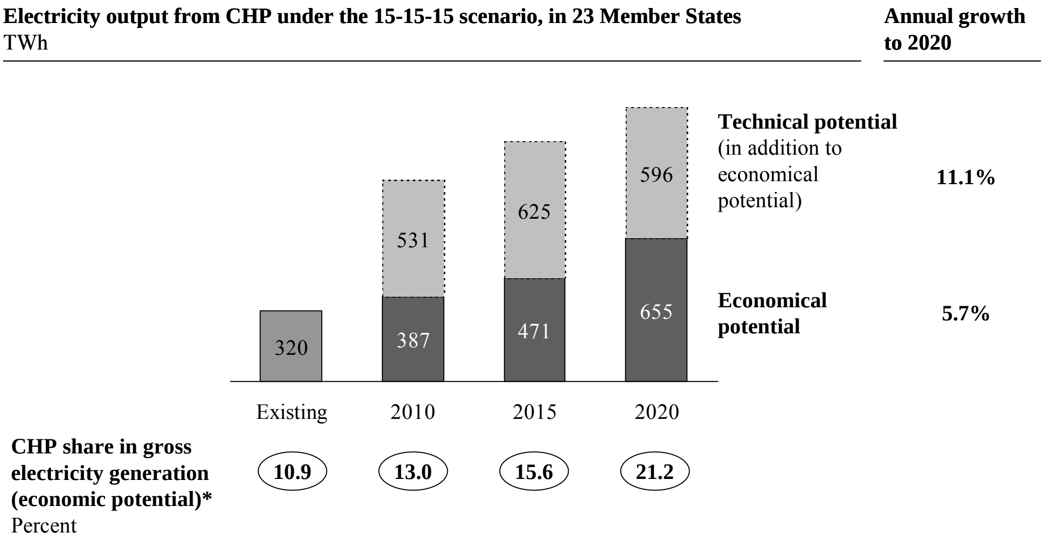
132 Electricity prices at low 2009 levels or before the price hike in 2008, sustained weakness in EU CO2 allowance prices of around 15 EUR/t until 2020.

133 JRC, Commission progress report on implementing the cogeneration directive, 2011 (unpublished)

Figure 5. Graphical summary of potential CHP output



* Estimation. For the column "Existing", the 2007 figure from Eurostat is used (10.9). For the other columns, the ratio of CHP output (economic potential, from the Templates) after subtracting the existing 2007 CHPs, to total EU-27 gross electricity generation 2007, is added to the 10.9.

The tables below provide an overview of the technical and economic potential Member States identified in their national report.

Table 19. Potential CHP capacity as derived from documentation submitted by Member States [GW electrical][134]

Member State	Scenario*	Present	Technical potential				Economic potential			
			2010	2015	2020	Annual growth to 2020	2010	2015	2020	Annual growth to 2020
Austria	15-15-15	0.924								
Belgium	15-15-15	1.908							1.515	
Bulgaria	15-15-15	0.657	0.669	0.777	1.259	5%	0.669	0.777	1.259	5%
Cyprus	15-15-15	0.000	0.016	0.162	0.308		0.013	0.079	0.150	
	15-25-25	0.000	0.020	0.164	0.308		0.017	0.099	0.188	
	15-50-50	0.000	0.024	0.166	0.308		0.020	0.119	0.226	
Czech Republic	15-15-15	5.273	23.865	27.266	30.634	14%	5.635	6.473	8.110	3%
Denmark	13-15-25	6.336	10.576	10.576	10.576	4%	6.376	6.349	6.532	0%
Estonia	15-15-15	0.150						0.397	0.397	
Finland	15-25-25	5.600					5.250	5.250	5.250	
France	15-15-15	6.336	35.345	34.835	30.340	14%	6.240	5.340	5.674	-1%
	15-50-50	6.336	35.345	34.835	30.340	14%	6.217	5.108	5.418	-1%
Germany	15-15-15	0.000								
Greece	15-15-15	0.052	1.190	3.019	4.857	42%	0.549	0.978	1.138	27%
	15-25-25	0.052	1.190	3.019	4.857	42%	0.549	0.990	1.154	27%
	15-50-50	0.052	1.190	3.019	4.857	42%	0.551	1.174	1.341	28%
Hungary	15-15-15	1.547	5.522	1.940	2.393	3%	1.592	1.647	1.707	1%
Ireland	15-15-15	0.290	0.490	0.630	1.310	12%	0.310	0.503	1.160	11%
	15-25-25	0.290	0.490	0.630	1.310	12%	0.310	0.503	1.160	11%
	15-50-50	0.290	0.490	0.630	1.310	12%	0.310	0.503	1.160	11%
Italy	15-15-15	7.060	40.880	40.587	40.297	14%	7.110	8.104	10.657	3%
	15-25-25	7.060	40.880	40.587	40.297	14%	7.110	9.858	10.878	3%
	15-50-50	7.060	40.880	40.587	40.297	14%	7.110	10.171	11.300	4%
Latvia	15-15-15	0.000								
Lithuania	15-15-15	0.000								
Malta	15-15-15	0.000	0.014	0.022	0.024		0.007	0.015	0.016	
Netherlands	15-15-15	12.870	23.971	22.570	24.338	5%	15.358	16.889	18.221	3%
	15-25-25	12.870	23.971	22.254	24.292	5%	15.358	16.841	18.751	3%
	15-50-50	12.870	23.971	22.502	24.178	5%	15.358	18.143	19.740	3%
Poland**	15-15-15	6.200	14.674	14.185	14.033	7%	12.783	12.130	12.033	6%
	15-25-25	6.200	14.674	14.185	14.033	7%	12.402	11.913	11.728	5%
	15-50-50	6.200	14.674	14.185	14.033	7%	12.022	11.696	11.652	5%
Portugal	15-15-15	1.399	2.917	3.442	3.867	8%	1.750	2.065	2.320	4%
Slovakia	15-15-15	0.077	2.714	4.200	4.766	37%	0.496	0.884	0.597	17%
	15-25-25	0.077	2.714	4.200	4.766	37%	0.496	0.889	0.619	17%
	15-50-50	0.077	2.714	4.200	4.766	37%	0.496	0.893	0.630	17%
Slovenia	15-15-15	0.335	1.238	1.275	1.417	12%	0.339	0.587	0.762	7%
Spain	15-15-15	3.761	8.651	9.162	8.646	7%	6.265	7.419	7.255	5%
	15-25-25	3.761	8.651	9.162	8.646	7%	6.265	7.265	7.112	5%
	15-50-50	3.761	8.651	9.162	8.646	7%	6.265	6.874	6.748	5%
Sweden	15-15-15	4.129	4.994	4.129	4.129	0%	4.994	4.580	4.429	1%
United Kingdom	15-15-15	5.469	47.003	48.274	50.958	19%	5.469	10.517	15.894	9%

* The scenario refers to the CO_2 emissions allowances price assumed for 2010/2015/2020, expressed in EUR per tonne of CO_2.
** Poland supplied two cases for each scenario: one with hard coal and one with natural gas. This document uses the former, because it is the most conservative of the two cases.

134 Not all MS provided national potential analysis for 2020.

Table 20[135]**.** Potential CHP output as derived from documentation submitted by Member States [TWh electrical]

Member State	Scenario*	Present	Technical potential				Economic potential			
			2010	2015	2020	Annual growth to 2020	2010	2015	2020	Annual growth to 2020
Austria	15-15-15	4.554								
Belgium	15-15-15	9.021							12.464	
Bulgaria	15-15-15	3.014	3.074	5.030	22.249	17%	3.074	5.030	22.249	17%
Cyprus	15-15-15	0.000	0.113	1.136	2.158		0.094	0.554	1.054	
	15-25-25	0.000	0.141	1.150	2.158		0.118	0.693	1.317	
	15-50-50	0.000	0.169	1.164	2.158		0.141	0.831	1.580	
Czech Republic	15-15-15	11.788	37.237	42.535	47.868	11%	12.636	14.365	17.419	3%
Denmark	13-15-25	22.900					23.323	21.917	24.910	1%
Estonia	15-15-15	0.000		4.000				2.100	2.100	
Finland	15-25-25	26.700					26.200	25.600	23.800	
France	15-15-15	21.645	133.973	130.140	111.669	15%	21.255	17.764	19.135	-1%
	15-50-50	21.645	133.973	130.140	111.669	15%	21.087	17.581	18.896	-1%
Germany	15-15-15	84.600							176.803	6%
Greece	15-15-15	0.121	8.340	21.155	34.040	54%	3.037	5.837	6.318	36%
	15-25-25	0.121	8.340	21.155	34.040	54%	3.039	5.960	6.369	36%
	15-50-50	0.121	8.340	21.155	34.040	54%	3.013	6.959	7.314	37%
Hungary	15-15-15	5.895	11.490	6.534	7.161	2%	5.595	6.095	6.131	0%
Ireland	15-15-15	1.820	3.420	4.120	9.040	13%	1.990	3.280	8.270	12%
	15-25-25	1.820	3.420	4.120	9.040	13%	1.990	3.280	8.270	12%
	15-50-50	1.820	3.420	4.120	9.040	13%	1.990	3.280	8.270	12%
Italy	15-15-15	22.990	133.708	133.914	134.133	15%	23.023	27.592	38.840	4%
	15-25-25	22.990	133.708	133.914	134.133	15%	23.023	35.322	39.818	4%
	15-50-50	22.990	133.708	133.914	134.133	15%	23.023	36.696	41.700	5%
Latvia	15-15-15	0.000								
Lithuania	15-15-15	0.000								
Malta	15-15-15	0.000	0.089	0.150	0.160		0.062	0.119	0.125	
Netherlands	15-15-15	61.470	102.107	100.933	109.801	5%	70.320	78.069	84.827	3%
	15-25-25	61.470	102.107	98.791	109.627	5%	70.320	76.833	87.043	3%
	15-50-50	61.470	102.107	100.677	109.194	5%	70.320	83.062	91.004	3%
Poland**	15-15-15	25.000	67.500	65.520	64.550	8%	58.800	55.800	55.350	7%
	15-25-25	25.000	67.500	65.520	64.550	8%	57.050	54.800	53.950	7%
	15-50-50	25.000	67.500	65.520	64.550	8%	55.300	53.800	53.600	7%
Portugal	15-15-15	5.407	13.197	17.819	22.348	12%	7.918	10.691	13.409	7%
Slovakia	15-15-15	0.070	4.885	7.979	9.656	46%	0.893	1.680	1.209	25%
	15-25-25	0.070	4.885	7.987	9.697	46%	0.893	1.691	1.259	25%
	15-50-50	0.070	4.885	7.993	9.719	46%	0.893	1.699	1.284	25%
Slovenia	15-15-15	1.106	4.731	4.903	5.541	13%	1.123	2.321	3.211	9%
Spain	15-15-15	19.870	45.675	46.686	45.979	7%	34.550	41.737	38.529	5%
	15-25-25	19.870	45.675	46.686	45.979	7%	34.550	40.819	37.764	5%
	15-50-50	19.870	45.675	46.686	45.979	7%	34.550	38.479	35.824	5%
Sweden	15-15-15	13.353	16.289	13.353	13.353	0%	16.289	14.986	14.448	1%
United Kingdom	15-15-15	27.911	239.885	390.729	412.455	23%	27.911	85.122	128.647	12%

* The scenario refers to the CO_2 emissions allowances price assumed for 2010/2015/2020, expressed in EUR per tonne of CO_2.

** Poland supplied two cases for each scenario: one with hard coal and one with natural gas. This document uses the former, because it is the most conservative of the two cases.

135 Not all MS provided national potential analysis for 2020.

The CHP Directive leaves Member States free to decide on the ways they wish to promote the wider deployment of HE CHP. Some Member States have been more active in introducing support measures than others; therefore the legislative impact of the Directive differs as well. Most Member States took action to promote CHP on the basis of the different soft requirements of the CHP Directive to remove barriers, streamline procedures, improve coordination between the administrative bodies on treatment of applications for authorisations, drawing up guidelines for the design and authorisation, fast-track planning procedures for CHP producers, and designating mediators for dispute between authorities responsible for issuing authorisations and applicants for authorizations. The content of these national measures, their scope, coverage and level of ambition differ widely.

The table below provides an overview of MS measures for the promotion of CHP.

Table 21. The extent to which the different points of Article 9(1) and Article 9(2) have been tackled in the Member States' reports about their administrative and procedural situation.

Member State	Encouraging	Removing barriers	Streaming procedures	Transparent rules	Coordination	Guidelines	Mediators
Austria	√	?	?	√	√	?	?
Belgium							
Bulgaria	?	√	√	√	√		√
Cyprus	√	√	√	√	?	√	?
Czech Republic							
Denmark	√	√	√	√			
Estonia							
Finland							
France							
Germany							
Greece	?	?	?	?	?		
Hungary	?	√	√	√			
Ireland	?	√	√	√	√	√	
Italy	?	?	?	?			
Latvia	?	?	?	?			√
Lithuania	?	?	?	?			
Luxembourg		√	√				
Malta	√	?	√	√	√		√
Netherlands							
Poland							
Portugal							
Romania	√						
Slovakia							
Slovenia	√	√	?	√	?	?	√
Spain							
Sweden							
United Kingdom			?		√	√	√

Source: JRC

Effect of policy measures on CHP market

Companies investing in CHP do so for a number of reasons, but all reasons are of a financial nature: CHP offers the opportunity to improve their bottom-line. The effect can be direct (such as lower energy costs), but also indirect (for instance customer retention and reduced network load). Table 22 shows a few examples of the benefits driving decisions to develop CHP for different market parties.

Table 22. Direct and indirect benefits driving decisions to develop CHP

Market actor	Direct financial benefit	Indirect financial benefit
Energy-intense industry	Lower energy losses in the process, resulting in a lower bill.	Lower exposure to fuel-price development.
Housing association	Lower total energy bill.	
Heating supplier (e.g. ESCo)	Reduce heat supply costs, allowing to charge lower prices (customer retention / satisfaction), or improving margins.	Customer retention / satisfaction
Grid operator		Reduce network load, potentially deferring grid upgrade investments.
Electricity utility – generation business	Lower CO_2 footprint of its power plant park, reducing ETS compliance costs.	
Electricity utility – trading business	Diversify supply portfolio, allowing better coordination with the market, avoiding balancing penalties.	
Energy utility – retail business	Create long-term revenue for its services business.	Win customers in competition over retail market by offering better products and services than competitors.
Gas utility	Ensure long-term market for gas.	Access new customers.

An example of successful promotion of HE CHP is the Renewable Heat Law in Germany that requires new housing developments to supply part of their heat demand by renewable sources, but accepts CHP energy as equivalent with renewable energy. The law made it less economically attractive to develop natural gas networks and often housing developers chose to provide the non-renewable part of heat electrically. In response, some gas companies started offering micro-CHP systems, as this also satisfied the requirements of the heat law, thereby giving them access to customers in new housing developments.

Competing technologies

The market actors that can invest in CHP systems can also decide to use other technologies to provide electricity, heating and/or cooling (table below). The choice will depend on requirements on the energy supply (e.g. in terms of heat temperature and pressure) and the economic performance of different options.

Table 23. Overview of competing technologies

Market actor	Competing technologies
Energy-intensive industry	Industrial steam boiler
Housing association	Individual gas condensing boilers Central heat boiler (renewable or fossil-fuel)
Heating supplier (e.g. ESCO)	Waste heat Heat boiler (renewable or fossil-fuel)
Grid operator	Strengthening network Electricity storage
Electricity utility – generation business	BAT power-only plant (e.g. CCGT)
Electricity utility – trading business	Various, depends on existing trading portfolio
Energy utility – retail business	Residential-scale renewable technologies Residential gas condensing boilers
Gas utility	Residential gas condensing boilers Gas heat pumps

Rational for choosing CHP in the different sectors are different and build on the many positive characteristics of CHP. For energy-intensive industry, such as refineries, chemical companies and pulp & paper producers, CHP is a means of providing affordable and reliable process heat. Such companies may opt for conventional steam boilers, if CHP is perceived to offer lower reliability or flexibility for the required process. If both boilers and CHP options are suitable, CHP requires a larger investment, so that the expected revenue from the electricity production must compensate this sufficiently to ensure an acceptable payback for the investment. With uncertainty of the development of energy prices, projects with payback periods over three years are often not realized.

Buildings owned by **housing associations** conventionally use a district heating systems based on CHP units (common in Central and Eastern Europe), or individual gas boilers, if each housing unit has access to the natural gas network. Small gas engine CHP has been used as an alternative when its heat and electricity production profile fits with the heat demand profile of the residents. Lack of access to financing can prevent housing associations from installing CHP if they would like to. The perception of district heating among residents can also prove an obstacle. In Hungary, for example, residents of apartment buildings previously supplied through central CHP heating systems are installing individual gas boilers, as a common heat supply is deemed old-fashioned and possibly unreliable. Residents also prefer full control over their heat supply.

For **district heat supply companies** CHP is usually attractive as the higher efficiency reduces their costs, while revenues are often fixed through supply contracts. They may still choose for alternatives, like a conventional heat boiler, if they cannot supply all electricity to local consumer and exporting surplus electricity to the public grid proves complex.

Situations in which **grid operators** choose CHP as an alternative to conventional approaches to mitigating network constraints are still uncommon. The lack of regulatory push for demand side management measures instead of network reinforcement, grid operators usually strengthen the network instead of encouraging CHP. Installing electricity storage at weak points in the grid is another alternative to network reinforcement for which CHP can be used, but this is yet relatively uncommon. Since grid operators usually do not own generating assets, they would need to offer suppliers appropriate network tariffs incentivizing the offering of CHP to alleviate network constraints.

Generation businesses of electricity utilities can choose from a wide range of power technologies when developing new production facilities. For companies without a heat business, power-only systems will be the default option. Renewable power sources are mostly developed to meet national targets and financial support makes this economically attractive. Generators develop CHP if it offers direct financial benefits, for instance the additional revenue from heat sales, or lower exposure to CO_2 emissions costs. An impediment for electricity generators to use more CHP is the complexity of satisfying simultaneously the requirements of the heat and the electricity market. Heat users in industries often need CHP to provide continuous high-pressure steam; this may be in conflict with the requirement in the electricity market to dispatch the system based on market price signals. If these demands diverge widely, it may not be possible to meet both within the flexibility limits of the CHP system.

The **trading businesses of utilities** also have a range of power sources to choose from when expanding their portfolio. Choices are again primarily based on price; i.e. selecting power plant that can supply electricity at a competitive price. Secondly, risk hedging determines choices, as traders generally wish to ensure a balanced mix of power sources in their portfolio to avoid too much exposure to a single factor. A portfolio with a high level of conventional fossil-fuel plants can benefit from adding CHP, as this would reduce the exposure to carbon prices, while for a portfolio dominated by intermittent renewable energy, flexible CHP plants can reduce the cost and risk of balancing supply and demand during market settlement.

As for **gas utilities**, CHP is a means to ensure a long-term market for gas and access to new customers. European gas companies have invested in developing and offering gas micro-CHP to secure market for their gas.

Economic characteristics of CHP systems

CHP can be based on a large number of technologies. The main types are: Combined cycle gas turbine (CCGT) with heat recovery, Steam backpressure turbine, Steam condensing extraction turbine, Gas turbine with heat recovery, internal combustion engine (ICE), microturbines, Sterling engines, Fuel cells, Steam engines, Organic Rankine cycles[136].

Steam backpressure turbines is traditionally the most well-known and implemented technology for cogeneration. During most of the 20th century it was the only available technology for industry for the simultaneous generation of heat and power. It is not considered the best available technology today, because of the low power to heat ratio; i.e. the unit of electricity produced with a unit of heat, and low electrical efficiency (max. around 40%). In cogeneration mode it can achieve however 85-90% efficiencies. Nevertheless there are many installations of this type throughout Europe and they have proven extremely reliable. Nowadays it is used with biomass and municipal waste.

Steam condensing extraction turbines are an upgraded version of the steam turbines. They are frequently used in refineries and paper mills.

Internal combustion engines (ICE) are based on reciprocating engines and used mainly in small-medium factories of food, textile and chemical industry. The simple cycle reciprocating engines used in ICE can also be used for trigeneration, when not only heat and power are produced but also chilled water. This technology can be used both in chemical and food industries, in small-medium sized factories.

One of the most mature and most frequently used technologies is gas-turbine with heat recovery. It is used in larger paper factories, refineries, and chemical and food industry. Combined Cycle Gas Trurbines (CCGT) can achieve very high power to heat ratios that can also be variable. They are more complex and high cost installations, but well suited to large operation up to 400 MW. They are widely used in refineries, chemical, paper and food industry. Gas turbines are also used for trigeneration in larger factories. In this case the chilled water is obtained from the heat in the exhaust gases.

Stirling engines and stationary fuel cells have emerged more recently and micro-CHP Stirling engines are now commercially available, while fuel cells are still being optimized in Europe.[137]

Table 24 summarizes the main characteristics of four CHP technologies.

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[136] Listed in the CHP Directive (Annex I)

[137] For detailed description of the CHP technologies see Deploying large-scale polygeneration in Industry, IEE, D-ploy project, Work package 2, August 2008.

Table 24. Investment and operating costs of the main CHP technologies

	CCGT	Gas turbine	ICE	Stirling engine
Capacity range	**10s – 100s MW_e**	**~1 – 100s MW_e**	**1 kW_e – 18 MW_e**	**1 – 100s kW_e**
Typical applications	Power sector Large industry District heating	Industry District heating	Industry District heating Commercial buildings	Commercial / domestic buildings
Investment costs (€/kW_e)	700 – 1,000	700 – 1,000	600 – 1,200	2,500 – 10,000
Operating costs				
Fixed (€/kW_e)	7 - 12	7 – 12	9 – 15	1 – 4
Variable (€/kWh)	0.4 – 0.8	0.4 – 0.9	0.7 – 1.5	-

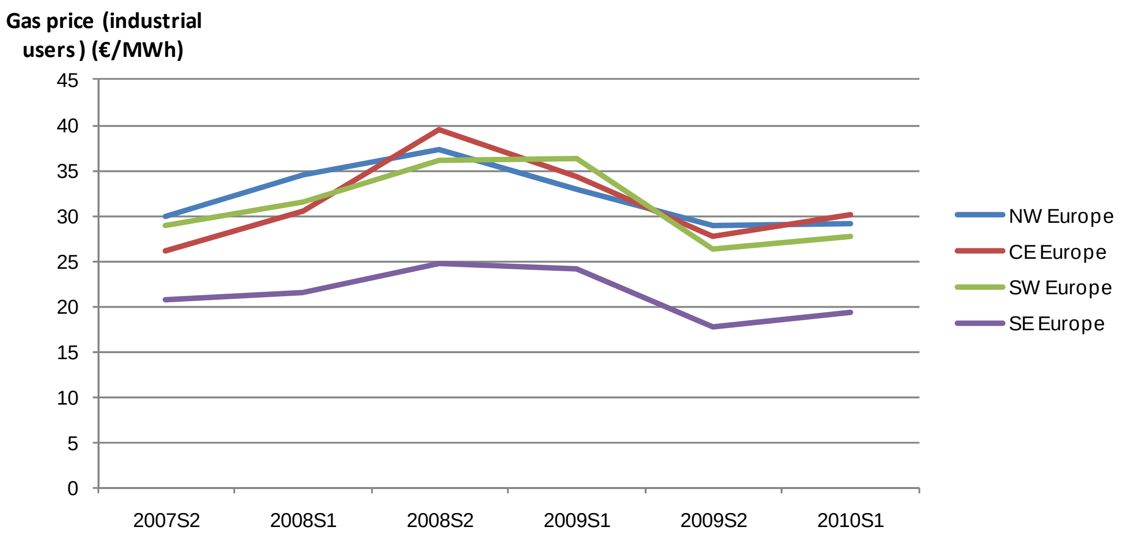
Source: ECN

The economic viability of CHP depends on many factors. The basic parameters are: fuel cost, electricity prices and network costs.

Natural gas is the most used fuel for CHP with a share of 39.4%. This is followed by solid fossil fuels 34.8. Renewable energy generates 11% of CHP. Other fuels (industrial waste and coal gases) and oil and oil products make up the rest with 9.3% and 5.5%, respectively[138]. When evaluating a CHP project, investors do not (yet) include carbon prices into the calculations to define future profitability. The carbon price instead is treated as a risk factor.

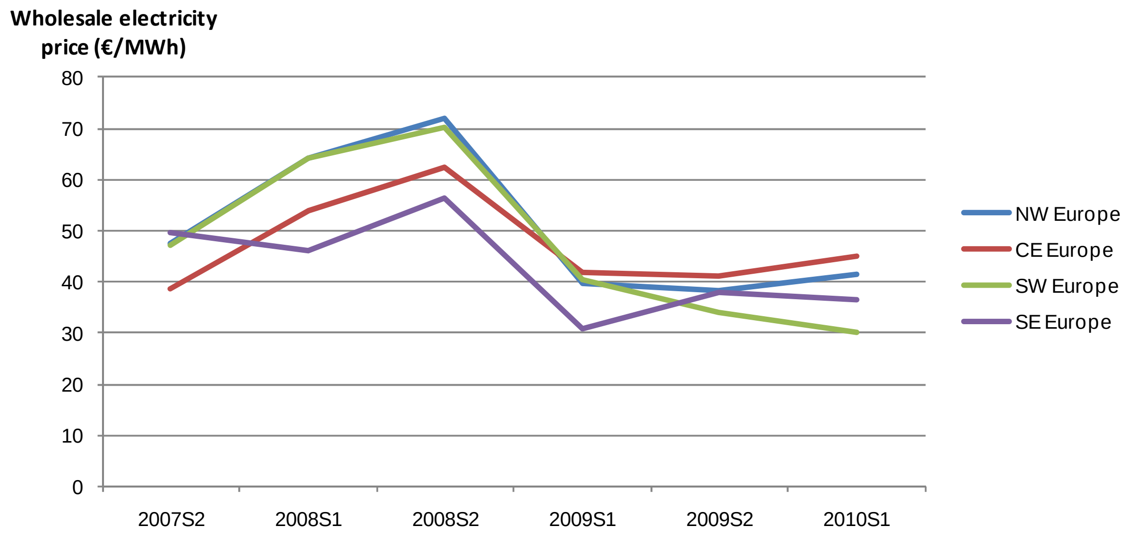
– Fuel price/gas price: The spread between the price of natural gas and electricity is one of the decisive factors for the economic viability of CHP. The larger the difference, the more profitable CHP is. The value of the heat output changes with the gas price. Gas prices widely differ in Europe (see Chart 1), therefore affecting its economic attractiveness.
– Electricity prices: The price of electricity has an impact on the revenues of CHP. Electricity prices also differ across Europe (see Chart 2), so do the revenues from selling the electricity on the market.
– Network costs: The costs of connecting to the electricity network and exporting electricity over the grid depend on grid tariffs, which are set at Member State-level.

Figure 6. Natural gas price for industrial users in European regions from 2007 to 2010[139]



[138] Eurostat, Data in focus 7/2010.
[139] Eurostat, 2010.

Figure 7. Wholesale electricity prices in European regions from 2007 to 2010[140]



Electricity network connection costs

The costs of connecting to the electricity network in Member State vary. In some places, CHP generators are only responsible for the connection to the nearest substation with sufficient capacity where the suitable voltage is available (shallow connection charging). In others, they have to pay for grid reinforcements further in the grid, if these are necessary (deep connection charging). The table below gives an overview of the connection charges applied in each Member State.

Connection costs differ from location to location within Member States as well. Even in Member States with shallow connection charging, for example, the available capacity at the nearest substation may be insufficient, so that the CHP plant developer has to pay for a longer line to another substation. Connection charges are therefore usually negotiated on a bilateral basis between the CHP plant developer and the network operator. Prospective investors often estimate that connection costs account for around 10% of the total capital cost of an installation. This is usually a conservative estimate and the costs may be lower if no obstacles prevent connection at the closest point.

Table 25. Connection charges

Member State	Shallow	Deep	Comment
AT			Grid user builds own connection line. If grid reinforcements are necessary the user has to pay for this
BE			
BG			
CY			
CZ			Customer pays connection lines up to connecting point of TSO. New generation pay a lump sum connection fee of 18.900€/installed MW,
DK			Shallow to partially Shallow (in some cases charges are calculated to a fictitious point that can be closer than the physical connection point)
EE			All the equipment, belonging to the connection + all reinforcements, needed prior to the connection are included in the connection fee.
FI			Shallow in most cases, but a possibility to deep in exceptional cases.
FR			The first connection is made to the nearest substation where the adapted voltage level is available and where this connection is technically possible.
DE			

140 EEAX, POLPX, APX, MIBEL, OPER, 2010.

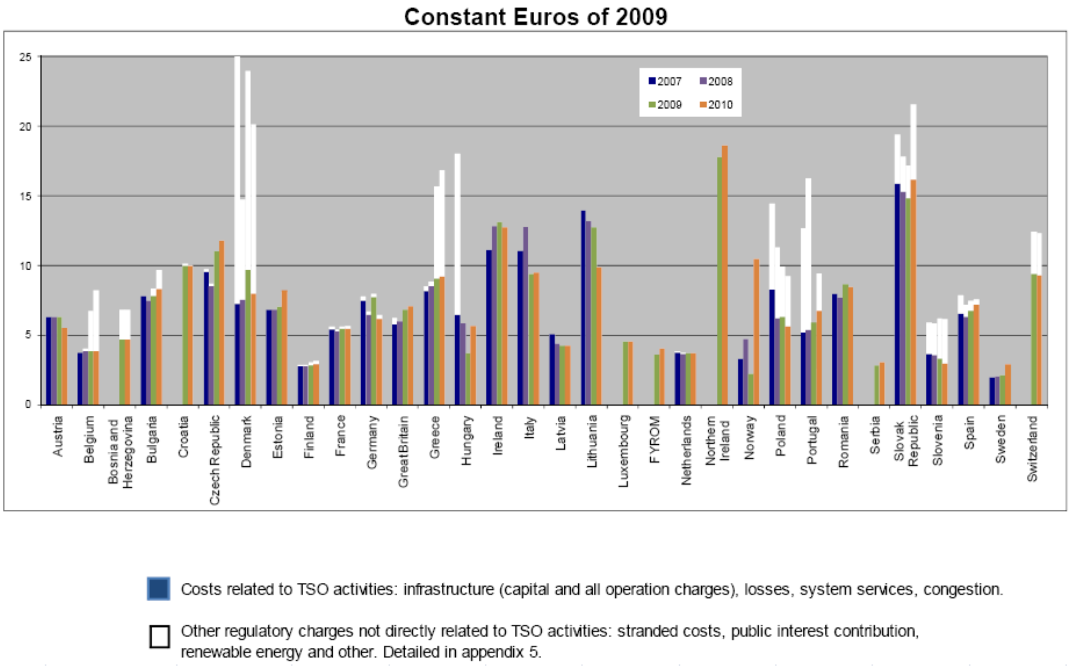
Member State	Shallow	Deep	Comment
GR	X		
HU		X	
EI		X	The connection charge is based on the Least Cost Technically Acceptable shallow connection method. However the Least Cost Technically Acceptable shallow connection method depends on the availability of appropriate transmission infrastructure in the area e.g. voltage level etc. Charges can also include station common costs or station extension costs (if higher).
IT	X		Grid user builds own connection line. Enhancements of the grid are socialized in tariff.
LT		X	Grid users builds own connection line. All connection equipment and reinforcement are included in the connection fee.
LI		X	
LU	X		Grid user has to pay for his own connection line and substation. General reinforcements of the grid are socialized in tariff
MT			
NL	X		
PL	X		The enterprise which is going to be connected finance all the expenditures to build the connection site which contains extension or rebuilding costs for the substation (if such necessary). The reinforcement and development of existing network is performed by TSO.
PT	X		
RO		X	
SK		X	
SI		X	
ES	X		The generator builds own connection line. Enhancements of the grid that affect the rest of system are socialized in the tariff.
SE		X	
UK	X		

Source: ENTSO-E, 2010

Tariffs for using the electricity network

The cost of using the electricity network ranges from €2.5 to close to €25 per MWh (See Figure 9).

Figure 8. Tariffs for using the electricity network in European countries from 2007 to 2010[141]



141 ENTSO-E, 2010, Transmission-grid tariffs, assuming 5000 hour utilization per year, and a maximum power demand of 40 MW_e. Sum of consumer costs and generator costs.

However, in most countries, the network costs are fully borne by electricity consumers. Generators pay a share of the tariff (usually less than half) in nine Member States (see table 26) only nine Member States,.

Table 26. Network tariffs of generators

Member State	Generator share	Estimated generator tariff in 2010 (€/MWh)
Austria	15%	0.8
Denmark	2-5%	0.5 – 1.2
Finland	11%	0.3
France	2%	0.18
Ireland	20%	2.5
Poland	0.60%	0.08
Romania	20.69%	1.7
Sweden	28%	0.7
United Kingdom	27% / 50%	1.9 – 3.5

Source: ENTSO-E, 2010

Effect of policy measures on the CHP market

Policy is a major factor determining investment decisions in CHP. For parties active in the CHP market, policy matters because of two main reasons:

- Policy and regulation determines which technologies, applications and/or projects are possible or allowed.
- Policy has a major impact on the costs and benefits of developing and operating a CHP plant.

Policy and regulation set the boundaries of the type of projects that an investor can and would consider. Once the project is conform with existing legislation, the next step is to calculate the financial impact of the regulatory framework.

To understand the possible effect of the measures in Table 19 on the market, an investor or CHP plant developer will translate these into financial terms:

- **Encouraging CHP**: this usually comes as financial support, so the respective value will be used as an (positive) input into the cash-flow analysis
- **Removing barriers**: barriers usually entail a cost. This could be a time cost, for instance when administrative procedures are cumbersome. Barriers can also reduce potential revenues, for instance when a CHP plant is not allowed to sell its electricity output to a third party but has to sell it to the grid operator, and receives a lower price as a result. Removing barriers can lower or remove such costs.
- **Streamlining procedures**: reduces the time and costs of receiving permission.
- **Transparent rules and guidelines**: reduces time-costs of obtaining information needed to assess the investment possibility. Moreover, if rules are not clear, CHP developers may assume a worst-case scenario when assessing their financial plan, for instance assuming the highest possible costs for connecting to the electricity network. This may lead to a project being rejected, even though the true costs would have been lower than assumed.
- **Coordination and mediators**: coordination between authorities and other stakeholders can help streamline the development process, thereby reducing time and costs for the company involved.

Policy measures therefore have an impact on the financial value of a CHP project and define the ease with which this can be translated into monetary terms.

Market and regulatory failures

The CHP Directive has not radically changed developments in EU CHP markets, although it may have had a slight positive effect by signalling for Member States the need to promote CHP. The effect on the market take-up of CHP remained small for several reasons. Firstly, due to the broad and vague wording and the lack of stringent measures the implementation of the CHP Directive was slow. The last national report was notified to the Commission in October 2011, almost five years past the deadline.

The Directive does not set an obligation or provide concrete guidance for the promotion of CHP, but leaves it for Member States to set their own objectives and measures. Consequently, supporting CHP has not received the focus that has been given to other policies where mandatory targets exist. This makes it easy for government to roll back their policy and financial support to the benefit of other priorities (stop and go policies).

Member States with growing CHP markets

The CHP market been has been growing in thirteen EU Member States since 2004 when the CHP Directive came into force, although the level of increase varies. All countries with growing markets have assessed their national potentials positively up to 2020[142]. The strong growth rates were based on strong legislative frameworks and well-designed support mechanism to promote the deployment of CHP. These countries also share the characteristics that they implemented the CHP Directive ambitiously.

Table 27. CHP Electricity generation (TWh) in Member States with growing CHP markets

Member State	2004	2005	2006	2007	2008	2009	Economic pot. in 2020
Austria (AT)	10.03	10.26	11.26	11.05	10.71	11.71	NA
Belgium (BE)		8.44	10.06	10.90	11.59		12.464
Bulgaria (BG)			2.77	4.05	4.49		5.030[143]
Germany (DE)	75.29	77.91	79.77	77.64	79.49		176.803
Greece (GR)			1,05	1,02	1,20		6.369
Ireland (EI)	0.66	0.62	1.59	1.83	1.86		8.270
Italy (IT)			30.89	32.33	30.45		39.818
Latvia (LT)	1.53	1.53	2.15	1.98	2.10		NA
Lithuania (LI)	3.06	3.43	2.82	2.88	2.66	2,94	NA
Portugal (PT)	5.39	5.82	5.96	6.07	5.65		13.409
Romania (RO)				6.62	6.21		NA
Spain (ES)				34.85	31.94	31.81	37.764
Sweden (SE)	6.13	5.90	6.10	7.01	7.22		14.448

However, not all increases can be assigned to legislation. Other factors also played a role, such as high electricity prices, improved access to fuels and more intensive competition. Table 28 gives an overview of the primary drivers.

Table 28. Primary drivers of the increase in CHP market

Member State	Strong climate and energy policy framework	CHP support policy	Increasing competition in the energy market	High electricity prices	Improving access to natural gas	Other
AT	■					
BE		■	■			
BG		■			■	
DE	■	■	■			

[142] See the country-by-country potentials in Tables 10-11.

[143] 2015 potential

Member State	Strong climate and energy policy framework	CHP support policy	Increasing competition in the energy market	High electricity prices	Improving access to natural gas	Other
GR		■	■			
EI	■	■				
IT				■		
LT		■				
LI		■				
PT		■			■	
RO		■				
ES		■			■	
SE	■					

Member States with stable CHP markets

In nine EU Member States the CHP market has remained mostly stable since the introduction of the CHP Directive in 2004. In two of these (Luxembourg and Malta) the lack of growth is partly due to limited potential, rather than lack of policy. In Cyprus additional potential exists, and the government has introduced CHP feed-in tariffs as a result of the Directive, but this has yet to have an impact on market activity.

Table 29. CHP Electricity generation (TWh) in Member States with stable CHP markets

Member State	2004	2005	2006	2007	2008	2009	Economic pot. in 2020
Cyprus (CY)			0.01	0.01	0.01		1.317
Czech Rep. (CZ)			12.71	11.43	11.88		17.419
France (FR)	23.52	22.71	21.84	21.86	21.65		19.135
Hungary (HU)			8.02	8.57	8.43		6.131
Luxembourg (LU)			0.47	0.40	0.42		NA
Malta (MT)	0	0	0	0	0	0	0.125
Netherlands (NL)	53.94	55.61	55.75	57.92	61.47		87.043
Poland (PL)	41.59	41.62	41.79	39.62	37.93	37,29	NA
United Kingdom (UK)	26.86	28.83	28.73	27.85	27.90	27,78	128.647

In the five other Member States with a stable market, the lack of growth is not necessarily due to a lack of potential. Some of them identified very significant economic potential, but deployment of CHP has stalled because drivers and barriers are in balance. This resulted when CHP support policies (driver) were ambitious, but competition in the energy market remains limited (barrier) or when attractive feed-in tariff has saturated market and tariffs were reduced (stop-end-go policies). In some countries, CHP growth in one sector was offset by decline in other sectors. An example is Poland where old industrial and district heating CHP plants have been forced to close due to low energy prices and lack of access to capital for refurbishment, but the use of small gas and biomass CHP plants has grown. In some other countries the CHP market stalled because of policy uncertainty and volatile gas prices, but prospects then improved due to ambitious policy packages, including CHP. The overall market trend therefore can disguise sector-specific developments, so it is possible that CHP has grown in particular applications. In France, for instance, biomass CHP has benefitted from a feed-in tariff for renewable electricity, while in the UK the deployment of CHP in the built environment has remained a growing market.

Member States with declining CHP markets

Five EU countries have seen the use of CHP declining since 2004. Four of these are new Member States where many CHP plants are old and in bad need of refurbishment. Plant operators in these countries, such as municipal district heating companies, often do not have access to sufficient financing; therefore some plants had to close down. The problem of aging plants and the lack of capital often is further aggravated by increasing costs of CO2 and other industrial pollutant emissions, making continued operation unviable.

Table 30. CHP Electricity generation (TWh) in Member States with declining CHP markets

Member State	2004	2005	2006	2007	2008	2009	Economic pot. in 2020
Denmark (DK)	33.78	29.59	39.43	32.03	29.62	29.56	24.91
Estonia (EE)	1.02	1.04	1.04	0.87	0.92	0.81	2.095[144]
Finland (FI)				26.76	26.50	24.20	23.800
Slovakia (SK)			8.66	7.19	6.96		1.259
Slovenia (SN)	5.72	5.77	5.98	5.30	5.36	5.20	3.211

An exception is Denmark, where the decrease in CHP production is mainly due to a shift towards renewable energy resources. The projected potential is therefore smaller in 2020 than the current CHP electricity production in Denmark; however installed capacity is projected to remain the same but used partly for different purposes, i.e. to provide balancing energy and storage. In Finland, Slovakia and Slovenia the 2020 potential is also smaller than the current output, partly due to declining heat demand from industries.

Market and regulatory barriers to realising CHP potentials

The analysis based on national reports and independents studies identified ten main types of barriers to CHP in EU Member States:

- Low electricity prices due to market liberalisaton and competition from depreciated generation assets, such as nuclear, large hydro and old coal plants
- High and volatile fuel prices
- Instable heat demand due to industrial restructuring and energy efficiency measures
- Limited access to energy sources, in particular natural gas
- Network connection and access, high connection charges and lack of transparency in connection conditions and charges
- Lack of access to capital for refurbishing ageing plants
- Regulatory uncertainty from complex permitting procedures and as regards access to support mechanisms
- Policy uncertainty, in particular as regards the future of support schemes and the functioning of the EU emissions trading scheme
- Lack of expertise and awareness
- Lack of heat infrastructure

Table 31 provides an overview of the most common barriers as perceived by Member States and the CHP sector.

[144] 2015 potential, 2020 potential not available.

Table 31. Overview of barriers to realising CHP potential per EU Member State.

Member State	Low electricity prices	High / volatile fuel prices	Decreasing heat demand	Access to fuel(s)	Access to capital	Grid access	Regulatory / legal complexity	Policy uncertainty	Lack of capacity
Austria	■		■					■	■
Belgium		■	■	■					■
Bulgaria		■	■	■	■	■	■		■
Cyprus			■	■			■		
Czech Rep.	■	■		■	■	■		■	
Denmark	■		■						
Estonia		■	■	■				■	
Finland	■	■	■	■			■	■	
France									
Germany	■	■	■	■				■	
Greece			■	■		■	■		■
Hungary			■						
Ireland		■	■	■		■			■
Italy		■	■			■	■	■	
Latvia	■				■		■		
Lithuania									
Luxembourg		■	■	■	■				
Malta		■	■						■
Netherlands	■	■				■		■	
Poland		■		■	■			■	■
Portugal		■	■	■	■	■	■	■	■
Romania	■	■	■		■	■	■		■
Slovakia	■	■	■	■	■	■	■	■	■
Slovenia					■		■		
Spain	■	■		■	■	■	■		
Sweden			■						
UK		■	■			■	■	■	■

Source: JRC, Cogen Europe

Support schemes

Member States have interpreted the Directive differently and national measures reflect widely diverging levels of ambition. This is especially true for the support mechanisms applied. These are of great variety and In terms of economic advantage per KW installed capacity range from no support to 919.8 EUR/kW. As a result, the EU remains a patchwork of national legislation. Many CHP developers operate internationally, so they develop their strategy comparing different countries, focusing their activities on the markets that offer the best financial support. This partly explains the different trends in Member States.

Table 32. Overview of support schemes for CHP used in all EU Member States

Member State	Feed-in tariff / guaranteed purchase price	Certificate scheme	Capital grants	Energy tax exemption	Accelerated fiscal allowance for investment	Business tax exemption
Austria			■			
Belgium		■	■		■	
Bulgaria	■					
Cyprus	■		■			
Czech Rep.	■		■			
Denmark	■		■			■
Estonia	■					
Finland			■	■		
France	■			■	■	■
Germany	■		■	■		
Greece	■		■			
Hungary	■					
Ireland			■		■	
Italy		▒	■	■		
Latvia	■		■			
Lithuania	■		■			
Luxembourg	■		■			
Malta						
Netherlands			■	■	■	
Poland		■	■			
Portugal	■		■			
Romania						
Slovak Rep.	■		■			
Slovenia	■		■	■		
Spain	■		■			
Sweden				■		
UK	■		■	■	■	■

Source: ECN

The level offered by the support measures varies between countries, technologies, size ranges and fuels. Table 33 below shows the indicative range for each type of measure.

Table 33. Indicative range of financial support per type of support measure

Policy measure	Type of support	Indicate range of value
Feed-in tariff / guaranteed purchase price	Operational	€15 - €80 per MWh
Certificate scheme	Operational	~€40 per MWh
Capital grants	Investment	10% - 50% of investement
Energy tax exemption	Operational	€2 - €12 per MWh (electricity produced)
Accelerated fiscal allowance for investment	Investment	5% - 10% of investment costs
Business tax exemption	Operational	Minor

The indicative value of the different support measures provides an initial indication of the associated level of ambition, and determines their effectiveness. However, support schemes are often combined, so the impact of the financial support on market activity depends on the comprehensive value of the measures. For instance, the feed-in tariff in Germany is lower than in Estonia, but the overall value of support is comparable. Meanwhile, the German CHP market has grown, while the Estonia market has remained stable.

Table 34 below shows the indicative value of the policy measures for a gas-fired 5 MW_e CHP system in a number of Member States, illustrating this effect.

Table 34. Indicative range of support in selected Member States for 5MWe CHP plant

Member State	Indicative investment support (€/kW)	Indicative operational support (€/MWh)
Belgium	5 – 20% of investment costs	~40
Estonia		~73
Germany		~72
Spain	~10% of investment costs	~77
United Kingdom	7-10% of investment costs	~6

Feed-in Tariffs and Price Premiums

Feed-in tariffs and price premiums are the most often used support mechanisms for CHP in Europe. This form of operational support guarantees plant operators either a fixed price for electricity delivered to the grid (feed-in tariff), or a fixed premium on the electricity market price (price premium).

Table 35 illustrates the range of feed-in tariffs and price premiums.

Table 35. Feed-in tariff and price premiums

Member State	Eligible systems	Tariff range (€/MWh)	Efficiency criteria
Cyprus	All	Indexed to fuel price. At fuel price of €50 / t: 25.6 (night) to 29.2 (day)	
Czech Republic	All	<1 MW_e: 9.2 to 50.4 1-5 MW_e: 5.8 to 35 >5 MW_e: 45	High-efficiency CHP
Denmark	<5 MW_e and renewable CHP		
Estonia	<10 MW_e replacing heat-only boiler CHP using peat, waste or shale-gas Renewable CHP <100 MW_e	73.5 to 80 51.7 to 58 51.7 to 58	High-efficiency CHP
Germany	All	Base price + 15 to 51.1	
Greece		Grid-connected: 73 Island-mode: 84.6	
Hungary			
Latvia			Conditions: CHP units have to reach an 80% efficiency threshold and sell 75% of their thermal energy production to district heating systems
Spain	0 – 100 MWe	7 to 12	
UK	<50 kWe		Satisfy CHPQA[145]

145 High Quality CHP satisfying the 10% primary energy saving criterion of the CHP Directive.

Ten Member States, six of which in Central and Eastern Europe, provide a fixed value of CHP electricity through a guaranteed price at which the buyer must purchase electricity supplied to the grid. In practice, the difference with a feed-in tariff is small, and one of form rather than substance. For the CHP operator, this works like a feed-in tariff, but the obligation to pay the fixed price is put on the buyer of the electricity, rather than being provided as a government subsidy.

Some countries combine a guaranteed (minimum) purchase price with a price premium. The guaranteed price then represents a ‘fair’ value for the electricity, while the premium serves to reward CHP for its other benefits, such as CO_2 emissions reduction. In Germany, for example, CHP plants receive at least the KWK-index (the average base-load electricity price on the European Energy Exchange of the previous quarter) for electricity delivered to the grid, on top of which they can get the price premiums as defined in the CHP law.

The popularity of feed-in tariffs and price premiums may be partly explained by their widespread application for renewable electricity. Arguably, such operational support is even more important for CHP, as operating costs dominates its economic viability, while renewable electricity sources are primarily defined by their capital costs. Ongoing operation support, such as feed-in tariffs, can therefore mitigate fuel cost risk, especially when indexed to the fuel price, as is sometimes done.

The effectiveness of feed-in tariff schemes is first of all determined by the value of the tariff: it has only proven a strong market driver if they reduce payback time to less than three to five years. The financing of the scheme also affects the effectiveness. Schemes that are paid by all electricity users through a premium on the end-user price are considered more reliable by investors than those financed directly from the government budget.

Some Member States have opted for supporting CHP through a specific certificate system as an alternative of feed-in tariffs (Belgium and Poland). CHP systems can also be eligible for certificate schemes for renewable energy, like in the UK, or for White Certificates, like in Italy, but these support measures are not specific to CHP, and therefore generally not introduced due to the CHP Directive. Italy has a White Certificate scheme, but this is not specific to CHP.

In certificate schemes, electricity suppliers are obliged to submit CHP certificates to the regulator for a certain share of their total supply every year. They can obtain these certificates from CHP operators directly, or buy them indirectly on the certificate market. The revenue of these certificates provides an extra revenue stream for CHP plants, so improving their financial performance.

Usually the percentage of supply that must be covered increases every year to ensure scarcity in the market and maintain the certificate price. The price can also be guaranteed by introducing a floor price at which the regulator will buy certificates from CHP plants if the price falls below this level. On the other side of the price range, systems often use a buy-out price, which serves as a ceiling. Certificates schemes are usually combined with targets for increasing the share of cogeneration (see Table 36).

Table 36. Targets and prices in CHP certificate schemes

Member State	Required share of CHP supply	Floor price (€/MWh)	Ceiling price (€/MWh)
Belgium			
Flanders	**2011: 4.9%** **2012: 5,2%** **From 2013: 5,23%**	27	45
Wallonia	**2011: 13.5%** **2012: 15.75%**	**75**	100
Brussels	**2011: 3.0%** **2012: 3.25%**	27	45
Italy		~ 95-100 EUR/toe[146]	
Poland	**2005: 12.4%** **2010: 16%**		

Investment support for CHP through capital grants is used in 20 EU Member States. Investment support is often targeted at specific technologies or applications, rather than applying broadly to the CHP sector as a whole. Innovative CHP technologies and applications receive the lion share of grant support, as these require relatively large investments compared to mature technologies. The Netherlands, for instance, offers grants for residential micro-CHP, and the Czech Republic, Finland and Ireland provide grants for biomass CHP.

Various new Member States have been using EU Structural Funds to help finance the refurbishment of ageing CHP equipment and district heating systems, contributing to the modernization of energy infrastructure and addressing one of the main problems for CHP in those countries. Latvia, Lithuania and Slovakia are among these countries.

Grants have proven effective where the initial investment is the main barrier for developing CHP, for example when companies have limited access to financing or for the use of higher-risk innovative technologies. Table 37 illustrates the use of investment grants.

Table 37. Capital grants

Member State	Eligible systems	Grant level (€/kW$_e$)	Efficiency criteria
Austria	New plants >2 MW$_e$ starting before 31 December 2014	**<100 MW$_e$: 100** €/kW$_e$ **100 – 400 MW$_e$: 60** €/kW$_e$ **>400 MW$_e$: 40** €/kW$_e$ (max. 10% of investment)	$\eta_e + \frac{2}{3}\eta_{th} \geq 60\%$
Belgium			Projects evaluated on individual basis
Cyprus			
Czech Republic	Renewable CHP	Max. 15% of investment costs	Projects evaluated on individual basis
Denmark	Small-scale and renewable CHP		
Finland			
Germany	Renewable CHP and DHC networks		
Greece		Vary, up to 55% of investment costs of SMEs	
Ireland	<1 MW$_e$ and biomass CHP		
Netherlands	Micro-CHP	4,000	
Slovenia	CHP outside the ETS	Max. 50% of costs of feasibility studies and preparatory project documentation	

146 White Certificates traded in the market

CHP plants are eligible for an energy tax exemption (e.g. in France and Germany) or reduction (e.g. in Netherlands and UK) in eight EU Member States.

Fuel tax exemptions have proven a useful source of operational support for CHP, mitigating one of the main risks: fuel price development. Moreover, they tend to be fairly resilient to political change, and therefore more secure than e.g. feed-in tariffs. However, they are rarely considered the decisive driver of the CHP market. In Germany, for instance, interest in investing large CHP plants only revived after the feed-in tariffs were extended to over 2 MW_e in 2009, even though such systems already benefitted from an exemption of tax on natural gas before that.

Other types of support schemes used are tax write-offs and accelerated fiscal allowances and exemption from business tax on these assets.

The effectiveness of the CHP Directive

The overview of CHP development shows considerable variation between Member States in legislative and regulatory frameworks, support schemes and market trends.

Table 20 summarizes the drivers of CHP developments in the different Member States and the impact attributable to CHP Directive. The rating is based on two considerations:

1. To what extent has policy driven market activity in the Member State?
2. To what extent were policy measures introduced as the direct result of the Directive?

The first point is influenced by the characteristics of the support measure, including its economic value and the ease with which it can be translated into monetary value. For the second point, it was considered whether the policy measures were introduced before or after the Directive, and whether they represent a real change compared to the previous policy. The key to the rating in column "Effect of the Directive" can be found in Table 38.

Table 38. Overview of effect of the CHP Directive

Member State	Market trend	Primary market driver	Effect of the CHP Directive
Austria	Increasing	Ambitious national CO2 targets drive switch to natural gas and biomass	1
Belgium	Increasing	CHP obligation policy	2
Bulgaria	Increasing	CHP feed-in tariff	3
Cyprus	Stable	NA	NA
Czech Republic	Stable	NA	NA
Denmark	Decreasing	NA	NA
Estonia	Decreasing	NA	NA
Finland	Increasing	Industrial and residential heat demand	0
France	Stable	NA	NA
Germany	Increasing	Improving feed-in tariff and building regulation	1
Greece	Increasing	Feed-in tariff and market liberalization	2
Hungary	Stable	NA	NA
Ireland	Increasing	Political support	1
Italy	Increasing	High electricity prices and improving policy framework	1
Latvia	Increasing	Feed-in tariff	2
Lithuania	Increasing	Feed-in tariff	2
Luxembourg	Stable	NA	NA
Malta	Stable	NA	NA
Netherlands	Stable	NA	NA
Poland	Stable	NA	NA
Portugal	Increasing	Feed-in tariff and wider availability of natural gas	2

Member State	Market trend	Primary market driver	Effect of the CHP Directive
Romania	Increasing	Feed-in tariff	3
Slovakia	Decreasing	NA	NA
Slovenia	Decreasing	NA	NA
Spain	Increasing	Feed-in tariff and wider availability of natural gas	2
Sweden	Increasing	Ambitious national CO2 targets drive switch to natural gas and biomass	1
UK	Stable	NA	NA

Table 39. Key to the rating of policy effects on the developments of CHP

Rating	Policy effect on market activity		Effect of CHP Directive on policy
0	Policy has not contributed to growth in the CHP market	and / or	The introduction of policy was not the result of the Directive
1	Policy support has had a slight positive effect on market activity	and	The Directive was not the primary driver for introducing the legislation
2	Policy has been a minor contributing factor to decisions to invest in CHP	and	The Directive was not the primary driver for introducing the legislation
3	Policy has been one of several factors leading to decisions to invest in CHP	and	The introduction of supportive legislation was partly the result of the Directive
4	Policy has offered direct financial value driving decisions to invest in CHP	and	The Directive was the main reason for introducing the support measures
5	Financial support has been a 'deal maker', and has attracted new parties to the market	and	The Directive was the main reason for introducing the support measures

None of the Member States have been assigned with a rating indicating a decisive impact of the CHP Directive. Overall, the role of CHP Directive has remained limited in driving growth and harmonizing the development of CHP across the EU.

Assessment of the impact of the CHP directive on the development of CHP

In the period of 2004-2008 installed CHP capacity grew only marginally from 95 GWe to 100.2 GWe. Most of the new capacity is in renewable cogeneration driven by not the CHP Directive, but the more stringent provisions of the EU renewable energy legislation (Directive 2001/77/EC and Directive 2009/28/EC).

Electricity from cogeneration grew only marginally, from 10.2% in 2004 to 11% in 2008.

Table 40 provides an overview of the growth in CHP capacity in key EU countries. The final three columns indicate whether the capacity is increasing, decreasing or broadly stable and the proportion of growth in CHP capacity that is actually attributable to the Cogeneration Directive. The table shows that the contribution of the CHP Directive is not decisive: it can be rated from no impact to a maximum of 40% effectiveness. The increase or decrease of CHP capacity was mainly driven by specific national policies and conditions and the CHP directive often played no or only a marginal role.

Table 40. Impact of cogeneration directive on CHP capacity

Member State	2005	2006	2007	2008	Trend	Market drivers	Policy effect
Belgium	1.9	2.0	2.1	2.4	Increasing	CHP obligation policy	40%
Bulgaria		1.1	1.3	1.4	Increasing	CHP feed-in tariff	40%
Cyprus		0.0	0.0	0.0	Stable	Little potential	NA
Czech Republic		4.9	4.6	4.8	Stable / decreasing	Feed-in tariff but limited competition in energy market	NA
Finland	5.2	5.2	5.2	5.6	Increasing	Industrial and residential heat demand	0
France	6.6	6.4	6.5	6.3	Increasing	Biomass feed-in tariff	20%

Member State	2005	2006	2007	2008	Trend	Market drivers	Policy effect
Greece		0.3	0.2	0.4	Increasing	Feed-in tariff and market liberalisation	40%
Italy		6.2	6.1	6.7	Increasing	High electricity prices	20%
Malta	0.0	0.0	0.0	0.0	Little potential	NA	NA
Netherlands	10.7	11.5	12.2	12.9	Increasing	Peak electricity prices and ETS benefit for CHP gas engines in horticulture	0
Portugal	1.2	1.2	1.2	1.2	Increasing	Feed-in tariff and wider availability of natural gas	40%
Romania		4.1	4.5	4.7	Increasing	Feed-in tariff	60%
Slovakia		2.8	2.2	2.2	Decreasing	Ageing CHP plants closing down, little capital for refurbishment	NA
Spain	5.7	5.8	6.0	6.1	Increasing	Feed-in tariff and wider availability of natural gas	40%
United Kingdom	5.5	5.4	5.4	5.5	Stable	Policy uncertainty and volatile gas prices	0

Potential for increased use of cogeneration

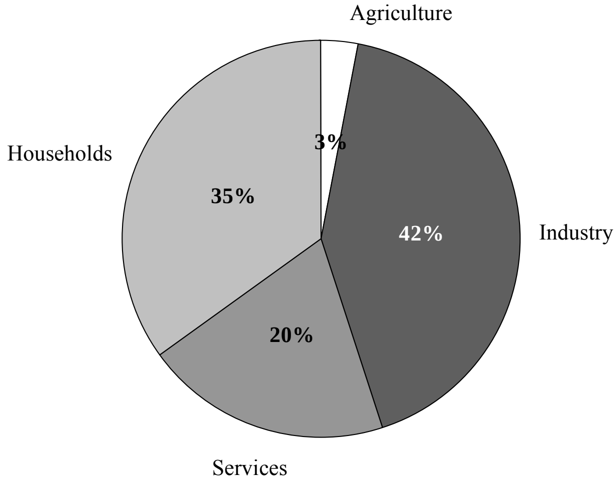
The technical potential of cogeneration is defined by the heat demand nearby, since heat, unlike electricity, cannot be transported long distances. The economic potential for cogeneration is determined by the economic viability of cogeneration that is in turn depends many factors, the most important ones being electricity and heat prices, fuel prices, CO2 emissions prices, electricity and heat network access and tariffs and the discount rate for the capital investment needed. In addition, viability of cogeneration is affected by market regulation and market structures, the availability of skilled labour force and access to financial resources.

The EU total thermal energy demand consumes some 60% of the primary energy resources in the EU and counts for around 46%[147] of its final energy use. Out of the total heat demand, 42% can be found in the industrial sector, 35% in the households, 20% in services and 3% in agriculture[148]. Figure 10 illustrates the share of each sectors in total heat demand.

Figure 9. Break-down of total heat demand by sector, based on national reports from 15 Member States [Percent]

147 21.1% for electricity and 32.6% for transport. However, some electricity is used for heating and cooling (Statistical pocketbook 2010)..

148 JRC, Progress report on the implementation of the CHP Directive, 2011



The two main types of heat that can be satisfied with cogeneration are high quality, high temperature heat (140-500 °C) for industrial processes and low temperature heat for space heating in buildings and sanitary water (60-120 °C).[149] Very low temperature heat or cooling (6 °C to -40 °C) can also be satisfied by cogeneration, whereby the residual heat is used to produce cold by means of absorption systems.[150] High temperature heat can only be transported very short distance (some 30 m) and therefore usually requires direct connection with the heat consumer. Lower temperature heat, provided usually by district heating systems or smaller size distributed co-generation is well suited to the services and commercial sectors, for small industries and agriculture, and for the space heating and sanitary water needs of the residential sectors. The transport of low temperature heat (hot water) is economically viable over longer distances, up to 100-140 km.

The demand for heat is defined by the energy use trends in the industry, services and residential sectors.

While the benefits of cogeneration are well recognised in the industrial sector, its use is far from reaching the full potential. Industrial heat constitutes around 27.2% of the EU final energy use[151]. Industrial cogeneration fully matches the heat load characteristics of some industries, such as the refinery, chemical, pulp and paper and food and beverage processes. Out of the some 1505 installations belonging to the refinery, chemical, pulp and paper, food and beverage industries in the EU, only some 40% (626) use CHP units, while the majority (879) rely on conventional systems. These four industries represent a cogeneration potential of 54 GW electrical capacity and 72 MW thermal capacity, that if installed in replacement of the conventional systems would results in fuel savings (mainly natural gas, fuel and diesel oil, hard coal, LPG and refinery gas) in the order of 226 000 GWh/year (19.436 Mtoe/year) inferring 14.5% primary energy savings and 74[152] Mt CO_2 saving equivalent to 22.5% less emissions, in respect to separate heat and electricity production with conventional systems.

149 Cogeneration can satisfy the requirements of processes below 600 °C. Higher heat temperatures are not suitable for cogeneration (such cement, steel, ceramics and metallurgy demanding temperatures between 1100 and 1500 °C)

150 The efficiencies of the absorption machines are much lower than the traditional compression system used for refrigeration and these systems could only be envisaged in case of low quality waste heat without capacity to produce electricity.

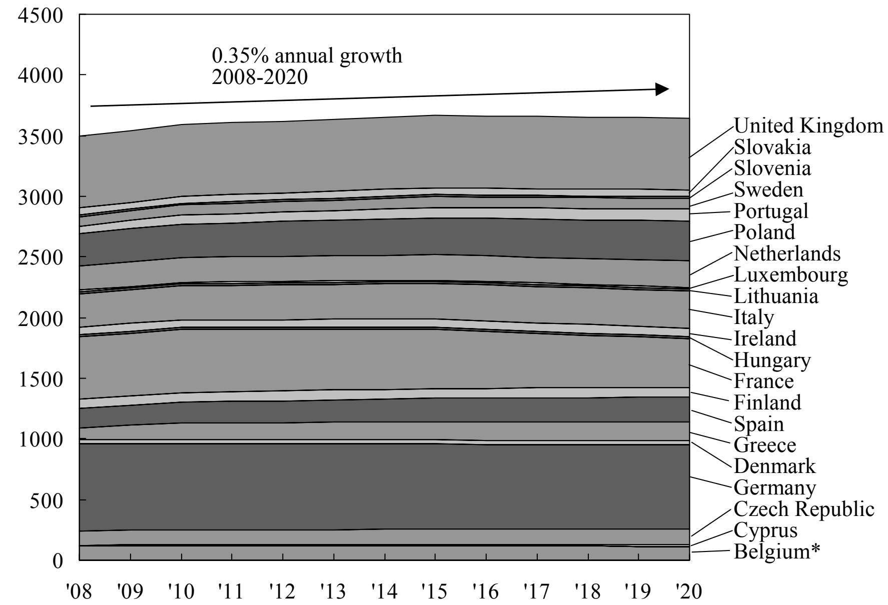
151 Eurostat 2008 energy statistics

152 The scenario assumed a future mix of fuels with dominant share of natural gas and biomass (60% natural gas, 15% diesel/fuel oil, 20% biomass, 5% coal). A 50% natural gas and a 30% biomass would result in 83 Mt CO_2 (+12% with respect of the main future scenario) saving, while a 70% natural gas and 10% biomass scenario would yield 64 Mt CO_2 saving (-13% compared to the main scenario).

Heating represents 70% of household energy consumption. Low temperature building heating consume close to half of the primary energy used in the EU. While the continuous upgrading of the EU housing stock to high energy performance levels will reduce heat demand on the long-term, demand for building heating and cooling is unlikely to diminish significantly even with conservative measures on the medium to longer term[153]. Cooling demand is forecasted to rise rapidly, by some 3.14% p.a. until 2030. An estimation by Member States of their heat demand is depicted in Figure 11.

[153] The forecast for heat is a 0.19% increase between 2000 and 2030

Figure 10. Forecasted heat demand 2008-2020, based on templates and/or national reports from 21 Member States [TWh thermal]



A significant part of the cogeneration potential is in the district heating sectors, but district heating is an energy saving solution even without cogeneration, since it enables turning low quality waste heat, no longer suited for electricity production, into useful energy to satisfy space and sanitary water heating in buildings or in industry and agriculture processes.

The benefits of district heating stem from its ability to use almost any kind of energy source, such as recovered heat from cogeneration and waste incineration, and renewable energy. Modern district heating systems are already largely based on recovered heat, i.e. cogenerated heat or heat from waste incineration, and they increasingly integrate renewable energy. In Germany 84% of the heat in the district heat systems comes from cogeneration and waste-to-energy plant. The proportion of recovered heat is some 60-70% combined with around 10-20% of renewable energy in such district heat vanguards as Austria, Finland, Denmark and Sweden.[154]

Economic impact and impact on energy savings

The economic impact and impact on energy saving are closely related in the case of CHP and DHC, therefore they will be analysed together.

By using cogeneration, other recovered heat and renewable energy district heat can substitute primary energy and reduce the need for procuring or importing fuels. It is not by accident that Denmark, who originally built its district heating network in response to the 70s oil crisis, is not dependent on exported fuels, quite the opposite is a net exporter of energy.[155] District heat introduces economy of scale in heat production and lead to cost savings; this in turn allows more investment in the latest technologies and is reflected back in heat prices to consumers. District heat and cooling can achieve efficiencies largely above isolated individual installations, which often perform significantly below their nameplate nominal efficiencies.[156] District heat is versatile and can be adapted or converted not only to different fuels, but also to new technologies, such as efficient and pollution reduction technologies. The network can

[154] http://ecoheat4.eu/en/District-Heating-Barometer/Sweden/Heat-sources-and-sustainability/

[155] http://www.energy.eu/#dependency

[156] Survey by Climespace, made available by Euroheat & Power

easily be made smart and interoperable with other smart grids and can be used to store and balance energy, thereby having a role in demand management as its complements smart electricity and other networks.

A best practice for a modern, recycled heat based heat and cooling system is Vienna. This case also proves that building of a modern, state-of-the art district heat and cooling systems is not reserved for new urban development, but can be used to convert old historical cities to efficient and green energy supply. In Vienna, the share of recycled heat in the heat supply reaches 96.5%. 71.1% of this comes from CHP and industrial plants and 23.8% from waste treatment plants. Due to supplying both heating and cooling the system is able to use waste heat all around the year and thus save primary energy. The primary energy factor [PEF][157] of the system is 0.21 and the city achieved a high level of security of supply. The heat is free of greenhouse gas emissions (as defined by the European standard EN 15316.) and comes with a reduction of 1.9 million tonnes of CO_2 emissions per year. The plan is to reach 50% market share in Vienna's heat supply and increase CO_2 emissions reduction to 2.7 million p.a. by 2020. This would help Vienna to reach its climate target by 2020.

District heating is one of the main tools to reduce the consumption of fossil fuels in cities. An example is the city of Lund in Sweden. The city connected its district heating grids to a waste heat source from a sugar factory by a 17 km district heating pipeline. This makes it possible to deliver supplies of waste heat during the sugar beet season. In addition, straw-fired and wood chip boilers were connected to the district heating pipeline. The overall environmental impact is 2,6 MWh/year energy savings and 7,430 tones CO2 equivalents reduction.[158]

District heating is a cheap, economic and environmentally friendly solution for densely populated urban areas where the density of building and heat demand is high; it is in addition the best placed solution for providing thermal comfort and increase quality of life for citizens.

The current penetration of district heating in Europe is uneven and overall low; far behind what would be optimal taken into account the unique economic and environmental benefits. In addition, a large portion of the EU existing district heating infrastructure is old and inefficient, in bad need of refurbishment. If these existing networks are not converted to modern systems they can lose competitiveness, market shares and consumers and are at risk of being replaced by stand-alone heating, thus loosing an opportunity to harness the unique benefits.

The examples of cities, where modern district heating and cooling systems were developed as part of strong urban policies on efficient, green and affordable energy supply show that the cost effective economic potential is 60% market share. Expert studies estimate that the average investment cost is 30 EUR per GJ of annual heat demand for reaching a DH market share of 60% in 83 cities in France, Germany, Belgium and the Netherlands. This cost will be 24 EUR/GJ in more heat-dense areas and 32-35 EUR/GJ in medium heat dense areas. District heat is less feasible in areas with one-family houses, where the average investment cost is about 90 EUR/GJ.

A best practice case is Sweden.

157 The primary energy factor (f_p)is used to determine the primary energy use of a district heating system. It is a ratio of primary energy (fuel input) excluding renewable energy and the final energy supplied to a e.g. a building calculated as $f_p = Q_p / Q_E$, where Q_p is the non renewable energy required for the building and Q_E is the final energy supplied to the building. The PEF is used to determine the primary energy use of a buildings under Directive 2010/31/EC on the energy performance of building. See Guidelines for assessing the efficiency of district heating and cooling systems, IEE project, Ecoheatcool, Work package 3, 2006.

158 http://www.eumayors.eu/benchmarks_of_excellence/benchmark_en.php?id=137

Over 50% of the total market for heat was provided through district heating in 2007 which is an increase from approximately 22% in 1978[159] as a result of a strong policy focus to make district heating a key element of Sweden energy efficiency, climate and security of supply policies. Currently district heat is serves 38% of Sweden's population of 9.4 million. The increased share for district heating has taken place primarily on the expense on the use of oil and, since the beginning of the 90s, also on the expense of the use of electrical heating displacing the use of electrical panels and the use of water based electrical heating.[160]

District heating is the most commonly used system in residential and public buildings in cities, where it makes up for around 90% of space heating. Experience with developing the district heating networks proved its cost-effectiveness.

The table below summarizes the current investment cost for district heating networks in Sweden. The range is wide, since conditions for district heating can vary. The table shows investment costs for distribution network in Sweden by GJ annually sold to customers, excluding substations. The cost level is of 2007.

Table 41. Summary of current investment cost for district heating networks in Sweden

EUR/GJ	Heat-dense areas	City average heat density	Detached houses
Severe conditions	19	45	
Normal conditions	14	31	75
New buildings	9	19	36

* Severe conditions consider connection of existing buildings in typical narrow streets in downtown areas
Normal conditions consider connection of existing buildings in typical residential areas
New buildings consider situations when the network is built at the same time as the new buildings

These estimates can be translated into annual cost by multiplying with a a rate of 4, 6, 8 or 10%, depending on the interest rate and period.[161]

The realisation of the national economic potential for CHP reported by Member States – which is a conservative estimation - (see table under option D1) would require an average annual growth rate of 5.7% until 2020 to increase the CHP penetration rate from the current 11%[162] to 21% in 2020. This contrasts with the overall 0.5% increase in the period of 2004-2008 under the business as usual scenario.

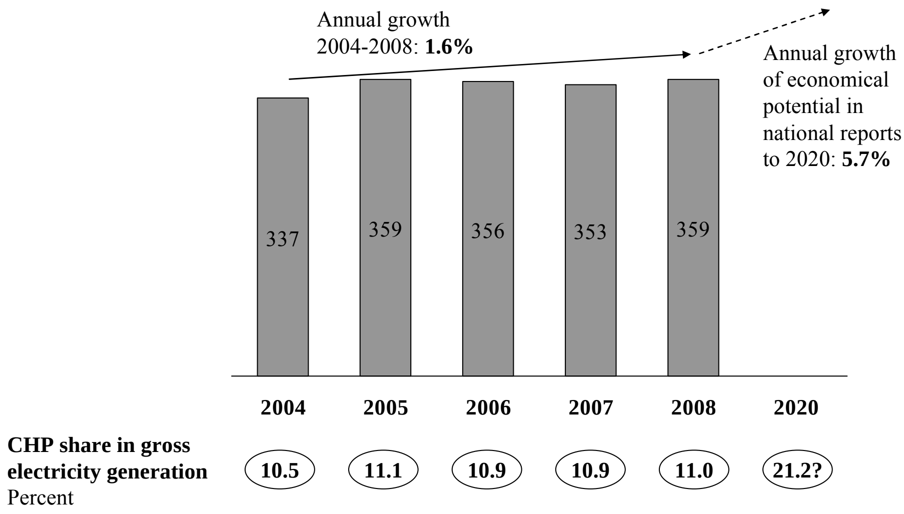
The measure would require additional investment in new and refurbished cogeneration units, and in district heat and cooling infrastructure.

159 Swedish Energy Agency
160 Andersson & Werner, 2003
161 Provided by Sven Werner; see also Urban Persson, Sven Werner, Heat distribution and the future competitiveness of district heating, Applied Energy 88 (2011) 568-575.
162 2008 data, Eurostat, Data in focus 7/2010

Figure 11. Illustration of increase in CHP growth rate required up to 2020

Electricity output from CHP in EU-27

TWh



Source: Eurostat.

Additional capital investment in CHP plant depends on the technology and the size of the capacity. It ranges from 7 000-1 000 EUR/kWh for a combined cycle gas turbine (CCGT) or gas turbines with heat recovery that suits the need of industry (large and medium) larger district heat systems (10s-100s MW and 1-100 MW sizes, respectively and 600-1 200 EUR/kWh for internal combustion engines (ICE), a technology that is well suited for industry, district heat and commercial buildings. Newer and least adopted technologies, such as based on Stirling engines, requires higher initial investment in the range of 2 500-10 000 EUR/kWh, but are compensated with much lower operating cost: i.e. 1-4 EUR/kWh as opposed to 7.4-12.9 EUR/kWh for CCGT and gas turbines and 9.7-15.5 EUR/kWh for ICE

In addition to the investment needed for the production unit, the costs of heat and/or cooling distribution infrastructure consists of four elements:

- Network mains – from the heat supply to the street-level.
- Connection to the building – from the street-level mains.
- Installation within the building.
- Meters and management systems.

The cost per units, i.e. length of the mains, is determined by the heat density, the design operating temperatures (higher temperature comes at a higher cost), the complexity of the existing infrastructure (city-centre locations more expensive than locations with little existing infrastructure and piping), the length of the heat mains (the costs increase with network length) and peak heat demand (larger peak demand requires pipes with a larger diameter, raising the costs). The magnitude of cost is different in case when the DH is built as part of a new urban development and when old historic cities convert to DH.

The impact of ETS on the development of cogeneration

From the start of the ETS's Phase I in 2005 until today, there has been great volatility of the prices of CO_2 emission allowances, i.e. ranging from €0.1/tonne to €30/tonne. As a consequence it has been difficult for investors to estimate the value of future CO_2 emission allowance savings from employing CHP. Since investors prefer security when making decisions, price swings have possibly had an inhibiting effect on investments in CHP. In addition, the price for CO_2 emission allowances has stayed below the level that would make the building of a new CHP plant attractive. This would require above 70 EUR/t of CO_2 price on a sustained bases. The price of CO_2 emission allowances reached the 30 EUR/tonne only briefly. In 2009 and 2010 it stayed in the 10-16 EUR/tonne range.

Moreover, in the course of the different phases the allocation for CHP has changed with time, which also created an additional risk. the result is overall that investors treat the ETS as a risk factor and do not include the carbon price in the financial analysis of a prospective investment.[163] Nevertheless, investors in CHP obviously have a longer time horizon for this type of decisions. As the EU ETS develops with time and the cap is reduced the performance of the scheme will probably stabilize. However, for some time a degree of uncertainty will remain.

High efficiency cogeneration plants are by definition expected to save at least 10% primary energy as compared to separate generation of electricity and heat. Simple comparisons for two examples how costs are reduced by using CHP are:

1. If double benchmarking with no free allocation is used, and when comparing the benefit of CHP on the same fuel basis, like for instance for natural gas, the reduction of CO_2 emissions per MWh is 203 kg *10% = 2.03 kg[164]. At a price of €20/tonne CO_2 this is a saving 0.406 euro / MWh compared to separate heat and electricity production.
2. If cogeneration is totally excluded from the EU ETS the savings would be 4.06 euro cent per MWh thermal input.

In the Member States the real advantage through EU ETS of CHP lies somewhere between the two examples made above. Today it is closer to the example with more free allocation, but this will reduce with time.
However, it is difficult to judge how large influence the EU ETS has had compared to the national support schemes. Given the large price swings of CO_2 emission allowances since their introduction this could indicate that the EU ETS was of less importance than the national support schemes until now. A higher price for emission allowances in the future would naturally increase the weight of the EU ETS.

In many countries the implementation of CHP in the EU ETS did not work perfectly as exemplified in the Section describing Phase I of EU ETS above. The rules of the EU ETS made CHP disadvantageous at times even though the intention was to the contrary. For example in Phase I some countries already used double benchmarking in order to compare cogeneration in a just way, e.g. in Germany. But also here problems had occurred when allocation of allowances was made based on benchmarking data in the sense that some plants received too few emission allowance rights. If the assumed load factor was lower than the normal operating hours of a CHP, the plant would not receive sufficient allowances. This way CHP was penalised.

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163 European Summary report on CHP support schemes, IEE, CODE project, December 2010; Case studies of CHP investments, IEE CODE project, Work package 3, 2011 (forthcoming)

164 DEFRA, Guidelines to DEFRA / DECC's GHG Conversion Factors for Company Reporting version 2, 2009

Another aspect is how CHP benefits from the higher electricity prices through the cost of CO_2. Today electricity prices are usually calculated on a long term basis. The power generation mix in many Member States includes renewables and nuclear power, which have no CO_2 cost to pass on. Therefore, in practise CHP cannot pass on 100% of the CO_2 cost savings to customers at all times in all Member States.

Size of installations impact on CHP

Trading of emission allowances is limited to installations of thermal capacity above 20 MW during Phase I and II. Small cogeneration plants, boilers and electricity generators therefore have an advantage since they do not need to buy additional certificates. In the past and present phases, the CHPs in the range of 20 to 40 MW thermal power have to compete with heat and electricity installations that fall outside of the EU ETS. New entrants with a heat demand just below 20 MW might be discouraged from replacing their boiler with CHP units.

In Phase III this will change though since focus shifts to the consumer of heat where possible. All units providing heat and electricity to a factory consuming more than 20 MW thermal power will fall within the EU ETS. The disadvantage for larger plants seems to have removed this way. Also for the former possible disadvantage for district heating appears to have been removed since free emission allowances can be given to residential units.
So, as mentioned in the paragraphs above in Phase I and II there was a problem with so-called “internal leakage”, i.e. smaller units were chosen instead of larger ones to avoid the emission allowances. In Phase III this seems to have been resolved since the focus is now on the heat consumers making the size limitation on the utility irrelevant.

Impact on corporate behaviour

Several studies show that EU ETS is impacting corporate behaviour. A survey covering 517 European companies, government bodies, industry associations, market intermediaries and NGOs showed that in 2005 about half of the studied companies already took into account the value of CO_2 allowances and more than 70% intend to do so in the future. Half of the companies say that ETS is one of the key issues in long-term decisions. They claim that the EU ETS has strong or medium impact on decisions to develop innovative technology. The industries where the ETS is one of the key issues in long-term decision making are steel, pulp & paper and power generation[165].

However, the same surveys say that companies seek clarity and long-term stability regarding rules over longer periods. This would ensure a stable climate of investments and the renewal of asset portfolios. The main reason is that asset lifetimes in capital-intensive industries are between 20-60 years with construction times spanning several years.

Lately the events in the financial markets have limited the availability of capital and increased risk aversion among investors. The power market has also suffered from this. In these circumstances investors might prefer the lowest capital cost investment options like an industrial boiler or an electricity generator instead of a CHP.

165 European Commission et al., Review of EU Emissions Trading Scheme - Survey Highlights, 2005

Future of ETS

As mentioned above in Phase III the_free allocation of emission allowances will be given to district heating as well as to high efficiency cogeneration, for economically justifiable demand, in respect of the production of heating or cooling. In 2013 80% of free allowances can be given. Thereafter, the total allocation to such installations in respect to the production of heat shall be reduced by a linear factor of 1.74% per year.

The new allocation methods in Phase III will in principle put CHP at an advantage compared too fossil fuelled electricity generators, since the latter have to pay for all their emission allowances. However, the advantage as compared to non-CHP heat generators, i.e. heat only boiler is not straightforward, since all heat will receive free allocation. Moreover, CHP plants that are not part of a heat consuming installations will not receive free allowances, since under the new implementation rules, allocation will go to heat consumers.

Conclusion on CHP in the ETS

During Phases I and II the EU ETS have been tested and improved. Initially the allocation of allowances for CHP was not explicitly foreseen but taken into account as New Entrants in the ETS. During Phase II improvements have been made for the EU ETS and for CHP as well. The allocation of allowances has been improved and in some Member States CHP is now explicitly mentioned. The disadvantage that CHP experienced during Phase I is less in Phase II. In Phase III, CHP installations will not receive free allocation unless they are part an installation which is a heat consumer. This can be detrimental to the development of independent CHP operators supplying heat to third parties on commercial bases. Under the new system heat consuming installations falling under the ETS will be allocated free allocation for the heat they import from CHP operators. However small heat consumers not falling under the ETS will not receive allocations for the heat bought form independent CHP operators. The issue of leakage towards the non ETS sector, by building small heat only boilers have not fully disappeared.

From the start of the EU ETS the price of emission allowances have fluctuated greatly. During Phase I the cap for allowances had been set too generously in many Member States, which when revealed made the price of emission allowances collapse. During Phase II the credit crisis and slow down in the economy have reduced emissions of CO_2 and hence its price. These instabilities have not provided the confidence and investment security in the EU ETS system that investors would prefer. On the other hand according to surveys a majority of companies already take the ETS into account when making investment decisions.

The exclusion of plants below 20 MW thermal power during Phase I and II of the EU ETS have probably made some companies opt for the easier alternative to buy an industrial boiler and to purchase the electricity from the market instead of investing in CHP. As mentioned above, in Phase III this problem appears to have been resolved since focus has moved to the heat consumers, i.e. emission allowance rights are independent from which type of plant that produced the heat. Efficient CHP will receive substantial allocation of free allowances in Phase III, which should put it at an advantage.

When looking at the period 2002-2008 it is distinguishable that many Member States have experienced a growth of CHP. However, we cannot judge how much of that can be attributed to the EU ETS, since national support schemes in most cases contributed more total cost reductions in the short term.

ANNEX XI: Detailed explanation and analysis of certain options to promote energy efficiency at supply side (generation efficiency)

Efficiency of conventional power generation

Power and heat generation efficiency has been identified as one of the key elements to reduce primary energy consumptions and associated emissions for the EU to reach its energy and environmental objectives in 2020 and for a transition towards a sustainable energy system by 2050. Despite this importance, the EU does not have specific instruments to monitor and steer the energy performance of power and heat installations.

The EU Industrial Emissions Directive requires that permit conditions of installation should be based on best available technologies (BAT). The Commission established a consultation forum consisting of the representatives of EU Member States, the industries concerned and non-governmental organisation to define the BAT in reference documents. Currently there are 31 reference documents covering a number of sectors and BAT issues; for sectors not covered by BREF, the BAT should be established by the competent authority issues an permit. BAT is a broad concept encompassing both the technology and the environmental performance of a plant during its entire lifecycle. The focus of the IED is on emission performance. It established permitting, monitoring and reporting requirement for the implementation of set emission limit values. Energy efficiency is one of the elements of BAT that has to be taken into account; however this is not addressed with specific measurement, monitoring, control and enforcement mechanisms. Furthermore, the IED allows Member States not to apply the energy efficiency elements of BAT for combustion units covered by the EU Emissions Trading Scheme. This makes the BAT efficiency criteria under the IED considerably less relevant for large combustion plants that constitutes two third of all installations (73% in the case of the EU-10) and are responsible for close to 98% of the emissions under the ETS.

Energy efficiency improvements in heat and power generation plants are therefore driven by price signals in energy and carbon markets for which the framework conditions are established in the EU internal energy market legislation (IEM) and the EU Emissions trading scheme (EU ETS)[166] . It is expected that inefficient or more CO2 intensive units become less economically viable due to their higher fuel and carbon costs and therefore will be replaced by new, less emitting units. The main driver for power plant efficiency is the IEM. The EU ETS should exercise a pressure on both heat and power generation unit to emit less, which can they do by switching to carbon-free or low carbon fuels or more efficient units; the main focus of ETS is however on emission efficiency whereby it exercise and indirect impact on energy efficiency. The efficiency of market mechanisms for energy efficiency depends on long-term predictability and level of prices. Competitive energy and carbon markets have been showing large price volatility since they have been established. Electricity prices doubled from 2003 to 2008 and fall by more than 40% in the beginning of 2009 to recover in 2011. The carbon prices have shown price swings between 0.08 EUR to about 32 EUR since the ETS was established. Since 2008, prices have somewhat stabilised, but range of some 10-20 EUR is behind what was expected to bring about large structural changes. The revised ETS Directive corrected weaknesses by establishing EU-wide cap and harmonised rules for allowances allocation from 2013; price volatility and changes are however inherent to markets. Volatile prices in energy and carbon markets reduce effectiveness in driving investments, since higher price uncertainty makes firms more cautious by reducing the

166 The third IEM package will be applied from March 2011 while the revised ETS-scheme introducing a tighter emission cap and commending higher CO2 allowance prices will start operation in 2013.

responsiveness of investment to sale growths.[167] While market mechanisms are key to drive investments, their functioning and impact on energy efficiency needs monitoring and complementary measures to steer towards the desired outcome.

Improving efficiency in energy generation encounters a complex set of barriers. These include high up-front investment costs and high risks associated with long pay-back time, inefficient markets due to limited market integration and competition. Legacy infrastructures and technology lock-in make technology and market transformation difficult. In addition, as a result of the characteristics of the power market, notably the lack of direct substitute for electricity and its limited storability, and the lack of timely feedback on consumption to consumers, make demand less conducive to respond to prices under current technical conditions. The inelasticity of demand[168] means that higher prices alone will not lead to a significant decrease in demand and the long-term reduction due to price increases is relatively small.[169] Old and inefficient generation plants with fully depreciated capital investment therefore can still be economically viable, since the higher operation costs from higher fuel input and higher CO_2 emission are still lower than the needed investment cost combined with the lost operating income during refurbishment or the retiring of plant. Carbon prices alone therefore are not sufficient to remove market barriers, unless they result in very high energy prices on a sustained basis, which is not optimal from a societal view point.

A stronger focus on energy efficiency and effective mechanisms to steer technological development and investment decision is key if Europe is to bring down its energy and resource intensity to the levels in line with its 2020 objectives and 2050 strategies on a low-carbon, resource efficient energy system. While the share of renewable energy generation is rapidly increasing, Europe power production capacity is still 57.7% based on conventional thermal plants, followed by hydro (18%), nuclear (17.1%) and renewable capacity (7.2%).[170]

In terms of production, fossil fuel power plants dominate the European electricity generation fleet, providing 56 % of the total electricity demand, followed by nuclear energy (31 %) and renewable energy (13 %). In the EU, coal plants have a share of 29 % of electricity generation and natural gas combined cycle plants 19 %. In 2010 it is estimated that the fossil fuel power plant operating capacity is still close to two third of all generation capacity with coal and lignite accounting for 42% of the capacity and natural gas combined cycles for 26%.[171]

All energy forecasts show that fossil fuels will remain the main fuel for electricity generation in the medium and long term retaining a share in power generation of the order of at least 40 –

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167 Kyung Hwan Yoon, Ronald A. Ratti, Energy price uncertainty, energy intensity and firm investment, Energy Economocs 33 (2011) 67-78

168 Price elasticity of demand is also influenced by the degree to which consumers can find reasonable substitutes in the market for goods and services that are considered necessities to their health and well-being. For many applications, electricity has no close substitute.

169. Analysts estimate the short-term price-elasticity of demand as no more than -0.1 to -0.2. See,e.g., Sijm,. Hers, et al, *The impact of the EU ETS on electricity prices, Final report to DG Environment of the European Commission* (ECN-E-08-007, 2008, at p 104) at http://www.ecn.nl/docs/library/report/2008/e08007.pdf. The long-term price-elasticity for electricity is higher but also small, closer to -0.25 to -0.32. (To put this in perspective, electricity demand is even less responsive to price increases than demand for an addictive product such as tobacco, which has a price-elasticity rate of -0.34 to -0.37.) Results from a 2009 empirical analysis suggest that the price elasticity of residential demand is even lower (more on the order of -0.12 to -0.17) based on 2001 to 2008 data for both retail price deregulated and regulated states in the US. See Nakajima and S. Hamon, *Change in Consumer Sensitivity to Electricity Prices in Response to Retail Deregulation: A Panel Empirical Analysis of the Residential Demand for Electricity in the United State,* Energy Policy (2010) available at www.sciencedirect. com.

170 Eurostat, EU Energy and Transport in Figures, 2010

171 Primes 2009 baseline scenario, EU energy trends to 2030, DG ENER 2009.

50 % in 2030 both globally[172] and in the EU27[173].[174] In Europe in 2030 the share of solid fuels and gas would still be 38.9% (21.1% and 17.8%, respectively), while renewable would grow to 36.1%, the remaining 24.1% provided by nuclear in the EU power production.

The two major technologies for electricity production from fossil fuels in the EU are Pulverised Coal Combustion and Natural Gas Combined Cycle. The share of coal plants older than 20 years is 70% in Europe. The majority of pulverised coal plants operate with sub-optimal efficiencies between 32 - 40 %. The newer supercritical pulverisation technology developed in the 1990s has been in commercial operation for a number of years and has efficiencies in the range 40 – 45 %. However, if the best available technologies were to be used, as, for example, “advanced supercritical” plants, it should be possible to reach net efficiencies between 46 – 49 %.[175] Gas fired plants operate at an average efficiency of 52% compared to 58-59% of BAT. Europe’s gas and oil boiler plants operate at average 36% efficiency while BAT delivers 47%.

Increased focus on applying BAT in new generation capacities and upgrading low-efficiency fossil plants should be a high priority in the future. The higher uptake of BAT is not straightforwardly guaranteed without policies steering markets in the right direction. Without major refitting or replacement of old power plants, the possibility to improve efficiency in is limited by installed boiler design and the turbine. A systemic improvement in energy efficiency requires a stronger regulatory focus on energy efficiency to complement market signals from energy and carbon markets and to provide more stability and a targeted policy drive.

Option D6: Minimum performance requirements for energy generation

The two major technologies for electricity production from fossil fuels in the EU are Pulverised Coal Combustion and Natural Gas Combined Cycle.

The share of coal plants older than 20 years is 70% in Europe. The majority of pulverised coal plants operate with sub-optimal efficiencies in the range 32-40%. The newer supercritical pulverisation technology developed in the 1990s has been in commercial operation for a number of years and has efficiencies in the range 40–45%. If the best available technologies were to be used - for example, “advanced supercritical” plants - it should be possible to reach net efficiencies in the range 46–49%[176].

Gas fired plants operate at an average efficiency of 52% compared to 58-59% with best available technology (BAT).

Europe’s gas and oil boiler plants operate at average 36% efficiency while BAT delivers 47%.

Under BAU, average generation efficiency is forecast to evolve from 39.1% in 2010 to 41.2% in 2020[177].

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172 World Energy Outlook 2010, IEA

173 Overall thermal efficiency would increase from 39.1% in 2010 (estimated) to 40.3% in 2030

174 Primes 2009 reference scenario, EU energy trends to 2030, DG ENER, 2009

175 2009 Technology Map of the European Strategic Energy Technology Plan, (SET-Plan) Part – I: Technology Descriptions, JRC-SETIS Work Group, 2009.

176 2009 Technology Map of the European Strategic Energy Technology Plan, (SET-Plan) Part – I: Technology Descriptions, JRC-SETIS Work Group, 2009

177 Primes efficient scenario; under Primes reference scenario, which better reflects the current situation, the improvement would be from 39.1% in 2010 to 39.9% in 2020, see EU Energy Trends to 2030, DG ENER 2009, http://ec.europa.eu/energy/observatory/trends_2030/doc/trends_to_2030_update_2009.pdf. It is to be noted that these Primes figures are estimations

Under option D6, it is assumed that the efficiency of all new plants and the majority of existing plants would be raised, through the setting of authorisation and permit conditions, to BAT levels, and that as a result, average generation efficiency would reach 51.5% in 2020[178].

Impact on energy consumption

Compared to BAU, option D6 would reduce EU energy consumption by 77 Mtoe (if upper values for BAT were achieved – an optimistic hypothesis) or 62 Mtoe (if lower values were achieved – a pessimistic hypothesis).

Environmental Impacts

There would be significant positive environmental impacts under option E6. Under the pessimistic hypothesis, CO_2 savings would amount to an emissions reduction of 124 Mt CO_2[179].

Economic Impact

Administrative and compliance costs

The use of the energy efficiency BAT by operators under option D6 would result in compliance costs which can be, in certain cases, large. However, BAT is defined at a level that provides economically viable solutions with a balance between costs and benefits. Cost would be one-off investment costs offset by productivity gains and cost savings.

For national authorities there would be an additional administrative cost from developing expertise, measurement and monitoring and enforcement mechanisms for the application of energy efficiency criteria beyond current authorisation practices. Operators would also have small additional administrative costs due to the need to complement the current authorisation and permit applications with energy efficiency information.

Reduced cost and energy import

Option D6 would lead to a reduction in annual consumption of 15 billion m^3 of natural gas and 25 Mt of coal in 2020.

Social Impact

Option D6 would lead over time to lower consumer prices for electricity and heat and to lower price volatility, higher security of supply and an increase in disposable income with a positive distributional effect especially for low income segments of the society.

Subsidiarity

Option D6 would not impinge on subsidiarity since it would build on existing EU competences as regards authorisation and permitting under EU energy efficiency, internal market and environmental protection regulation.

Effectiveness

In principle, option D6a would be effective because it would ensure a uniform application of BAT energy efficiency criteria across the EU, giving a significant performance improvement compared to BAU.

However, this does not take into account the fact that two other legislative measures, due to come into force soon, also have a potential impact on the efficiency of power generation.

178 Assuming 49% coal/lignite, 45% natural gas and 6% other fossil fuel generation.

179 Assuming a 0.385 conversion factor per MWh for coal and lignite and a 0.231 conversion factor for natural gas.

These are the third trading period of the EU ETS and the revised Industrial Emissions Directive (IED)[180].

In the past, the main effect of the ETS was to encourage fuel switching from fossil based generation towards renewable energy and also a switch from solid fuels (coal, lignite) to natural gas. Most new investment in generation therefore took place in building new renewable and natural gas plants, rather than improving the efficiency of the generation technology used[181]. However, it cannot be excluded that the next years will see a different pattern of implementation.

While the IED contains criteria for the use of BAT in new and existing generation plant, it also gives Member States an option to apply or not to apply these criteria. It follows that here too; it is uncertain whether this legislative measure will in fact start to deliver efficiency improvements.

If the ETS and/or IED are going to deliver significant improvements in the efficiency of generation plants in any case, introduction of the envisaged requirement in energy efficiency legislation would lead to less or no additional improvement and would thus be a less effective measure.

Given this uncertainty about the effectiveness of the measure, a preferable alternative approach could be to monitor trends in the efficiency of new and existing generating plants, reserving the option of stronger action for the case in which this monitoring shows an inadequate rate of progress.

Efficiency

Option D6 would potentially lead to significant compliance costs for the operators of energy facilities.

Coherence

Option D6 would be coherent with the EU energy and climate objectives and related strategies.

As stated above, there is a possible overlap between the effect of option D6 and the effect of the ETS/ IED Directives.

Option D7: Energy efficiency obligation on energy network regulators

Energy network operators play a decisive role in defining what type of energy efficiency improvement measures energy suppliers and energy services companies can offer, and what actions consumers can take to rationalise their energy consumption. They have a decisive role in integrating distributed energy resources[182] to the grid, such as distributed generation[183],

180 Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, as amended by 2009/29/EC (consolidated version of 25.6.2009); Directive 2010/75/EC on industrial emissions (integrated pollution prevention and control)

181 The share of coal-based power generation declined from 29.3% in 2005 when the ETS was introduced to 26.7% in 2008, the year for which the last statistical information is available from Eurostat. In the same period the share of renewable electricity grew from 14.1% to 16.8%. Natural gas capacity also increased as a cleaner alternative to coal and lignite; its share grew from 20.9% to 24.0%. See also Application of the Emissions Trading Directive by EU Member States, EEA, reporting year 2007.

182 Distributed energy resources (DER) is a common term for distributed generation, energy storages and flexible loads connected to the distribution or transmission network. Flexible loads are usually utilised through demand response activities.

demand bidding and energy storage[184] and in allowing demand response[185] to happen. Demand response requires that distribution system operators offer network system services to energy suppliers and energy service providers (such as ESCOs, demand aggregators, etc.) to develop and allow solutions for consumers to regulate their consumption. The tools for demand response are direct and indirect load control, via intelligence appliances with control functions. An essential element of demand response is dynamic pricing, where the energy price charged to the customers can vary significantly according to the time (e.g. time of use tariffs, peak pricing, real-time pricing) and location of the electricity consumed[186].

Demand response and the integration of distributed energy resources offer the prospect of large scale energy efficiency improvements. Significant energy savings can be achieved by supplying the same level of demand with locally available energy sources (distributed energy resources), thus reducing network losses from transport. Savings can also be achieved by avoid high load factors by making demand flexible in order to shift, eliminate or level out expensive peak load. The shifting of the load and peak shaving again need to be able to use active demand response solutions, storage[187] and distributed generation.

The development of flexible demand solutions (encompassing demand response and demand side management) for consumers, the integration of distributed generation and energy storage cannot happen without adapting network regulations to the more active distribution grid, i.e. smart grids. Since according to the EU internal energy market rules grids are regulated businesses, the design of network regulation and tariffs determines from what types of services they can collect their regulated income and return on investment. Network regulations adapted to smart grids are not only a pre-condition for network investments and smart grid deployment; they are also essential to ensure that the most energy efficient solutions in network operation, management and the dispatch of generation resources are available and systematically applied. Network regulations also have an impact on how benefits are shared among market actors participating in the process: DSOs, energy suppliers, energy service providers, ESCOs, demand aggregators, and consumers.

Network charges are an important cost element of the final energy supply price that end-energy consumers have to pay. They are the next largest component of the retail energy price after the wholesale price of energy. In the case of households and SMEs with low energy intensity, network charges can amount to more than 40% of the cost of supply.

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183 Distributed generation (below 50 MW) is low capacity generation connected to the distribution or transmission network, including renewable sources and combined heat and power.

184 Electricity storage is used to decouple the timing of generation and consumption of electrical energy. A typical application is load levelling, which involves the charging of storage when energy cost is low and utilisation as needed. This would also enable consumers to be grid independent for many hours. Heat storage can be used to decouple electricity generation from a CHP unit and its associated heat consumptions.

185 Demand response (DR) is a programme or activity designed to encourage customers to change their electricity usage patterns, including timing and level of electricity demand. DR includes time-of-use and dynamic rates or pricing, reliability programs such as direct load control of devices and interruptible load and other market options for demand changes (like demand side bidding).

186 IEA, Integration of demand side management, distributed generation, renewable energy sources and energy storages, state of the art report, vol. 1: main report

187 Electricity storage is used to decouple the timing of generation and consumption of electrical energy. A typical application is load levelling, which involves the charging of storage when energy cost is low and utilisation as needed. This would also enable consumers to be grid independent for many hours. Heat storage can be used to decouple electricity generation from a CHP unit and its associated heat consumptions.

Under Article 10 of the ESD, Member States have an obligation to ensure the removal of incentives in transmission and distribution tariffs that unnecessarily increase the volume of distributed or transmitted energy. The survey on the implementation of the Directive[188] has shown that few Member States have considered it necessary to require energy regulators and other competent authorities to modify network regulations and tariffs as a result of this provision. The broad formulation of the provision is one of the reasons that network regulations suitable for the large scale application of demand response and demand management solutions have not been in the focus of energy regulators.

The implementation of Article 10 ESD cannot be fully appraised without taking into account Article 13 of the ESD. This requires that consumers are provided with clear and understandable information via individual meters and bill on their actual energy consumption and time of use, and current energy costs frequently enough to enable their regulation of own consumption. Article 13 therefore also has implications for the regulation of network services and tariffs, since information provision and demand regulation criteria cannot be fulfilled without the grid operators enabling metering, consumption data handling and sharing and demand response services, such as time of use tariffs.

However the development of new smart grid enabling regulations that are also key to energy efficiency are generally not in place. As a result, network operators are still not offering system services and tariffs that would allow demand response by consumers or incentivise the participation of generators. This hampers the development of competitive retail markets based on decentralised systems and active participation of consumers; cheap and efficient and low carbon supply options are not used in the system to the extent needed in view of the EU's energy, climate, environment and internal market objectives.

To address these problems the option of placing energy efficiency obligations on network regulation is analysed (option D7).

Analysis of impacts.

Network regulation better reflecting energy efficiency performance criteria would allow three types of network services to be put in place:

1. savings from demand response: enabling consumers to actively manage energy use and price signals rewarding the shifting of load from peak to off-peak times when cheap and clean energy is available, better management of generation assets and displacing investment in peak load network and generation capacities
2. saving from integration of distributed generation: reducing network losses by reducing transport and voltage levels, enabling and utilising flexible generation and energy storage and the more optimal dispatching of generation sources
3. savings from reduced network losses. incentives for reducing malfunctioning and the improved use of the network assets

All three areas of network functions bring significant saving benefits.

The first group of services would allow existing demand response potential to be realised in the EU.

There is little experience of demand response (DR) in the EU[189]. This could be one of the major benefits smart grids and enabling smart grid regulation can bring. Methods of

188 See Annex V

189 Demand response is much more developed in the US, Australia and New Zealand; and a large body of literature exists on its potential and feasibility.

estimating DR potentials are not yet fully developed. According to a survey by the Nordic System Operators[190], DR potentials observed in Nordic countries vary between 0.3% and 3.9% and are for the whole market area about 2.4 % of peak load; the total DR potential ranges between 8% and 24 %, with an average of 17.7 %, for the whole market area. The exploitation of the potential is still low[191]. For the EU, the network operator of mainland Europe's electricity system, UCTE, has estimated the potential of demand response to be around 2.9% of peak load in 2008[192]. Other expert studies estimate potential savings in the range of 100 TWh from demand response by 2020 in the EU[193].

The second group of services also offers significant savings compared to centralised power systems. Grid losses on electricity transmission and distribution are in direct proportion to voltage levels and distance. The average loss in transmission is 15%. The CHP Directive recognizes this and allows the recognizing of primary energy savings from cogeneration achieved via reduced grid losses[194].

The third group of services concerns reducing the grids' own operating losses. This also has to be incentivized by grid regulation. Transmission and distribution losses differ widely by country and range from 1.5% for Luxembourg to 8.2% for Spain. Average losses for the EU-27 were 6% in 2005[195].

Developing incentive regulations adapted to smart grids that would reward demand response and distributed generation is key for suppliers and energy service providers to offer dynamic and time of use energy prices to consumers, for realising energy saving potential and for the development of competitive retail and energy services markets. Locational signals in network tariffs are also necessary to encourage and facilitate the higher uptake of distributed generation, such as medium, small scale and micro-CHP and renewable energy.

Analysis of impact

The cost of putting energy efficiency performance criteria for energy network regulations

Although the investment needs for developing smart grid technology to make networks "intelligent" and to deploy the infrastructure are estimated at 40 billion € by 2020[196], the imposition of criteria to enable energy efficiency services to be offered by energy grids would not entail additional costs. Quite the opposite, it would ensure that the investment in smart grid deployment brings benefits in terms of energy savings, cost reduction and the development of energy services markets, and that these benefits are shared among all participants, including an active demand responsive consumer (See also impact analysis of option C5 and C6).

190 Nordel, 2005. Power and Energy Balance, Forecast 2008. Prepared by Nordel's Balance Group, June 2005.

191 Empowering electricity consumers: Customer choice and demand response in competitive markets, IEA report (draft), 2011.

192 A study of The Union for the Co-ordination of Transmission of Electricity (UCTE) referred in an article in press: Torriti J, et al., Demand response experience in Europe: Policies, programmes and implementation, Energy (2009), doi:10.1016/j.energy.2009.05.021

193 Demand Response: a decisive breakthrough for Europe. How Europe could save Gigawatts, Billions of Euros and Millions of tons of CO2. Gapgemini in collaboration with VasaETT and Enerdata. 2008

194 Commission Decision 2007/74/EC.

195 Study to support the impact assessment of the EU energy saving action plan, Ecorys, 2010

196 Impact Assessment to Communication of the EU Infrastructure Priorities, SEC (2010) 1395

The third Internal Energy Market package[197] asks national regulators to provide appropriate tariff incentives, both short and long term, for network operators to increase efficiencies, foster market integration and security of supply and support the related research activities[198]. This option would go further and make energy efficiency a priority to be reflected in network regulations and tariffs. This is essential for the take-off of demand response and demand side management and the integration of distributed generation such as CHP and renewable energy.

The economic impact would be the development of energy services markets and innovative new products and services, the creation of new market and business opportunities for energy service providers, including ESCOs, the widening of choice for consumers and more competition in retail energy markets. A shift towards a more service oriented business to replace a volume driven commodity based business model would be begun. This would also be reflected in the transformation of energy markets towards a more locally based, sustainable and efficient energy system.

Impact on energy consumption and environment

Demand response and demand management could lead to significant savings depending on the starting efficiency of systems. Pilot projects report up to 40% savings in energy generation needs. If only a 7% reduction in generation capacity is assumed, the savings would amount to 22 Mtoe and 45 Mt of CO_2 reduction from the first of group of system services enabled by “smart” regulation of smart grids.

Savings from the second group of services cannot be estimated with current modelling tools and would require extensive assumptions as regards how much more distributed generation would be built and connected to the grid and how this would be dispatched. However, since this type of network regulation would effectively transform the structure of the market (from centralised to mainly decentralised), the impact would be proportionally transformational.

Savings from the third group of measures would be less compared to the large, innovative type of savings potentials from group 1 and 2 but could still be significant. Improving energy efficiency and reducing losses by one third, for example, would lead to 7.5 Mtoe primary energy savings and 15 Mt of CO2 reduction.

Option D8

<u>*Added value*</u>

EU forum to exchange best practice

Exchange of best practices is already happening through different scientific, research and academic programs organised at EU, national, regional and sectoral levels. One of the roles of sector trade associations is also to build networks of expertise. Standardisation organisations also play a role in the exchange and transfer of energy efficiency related knowledge. The Forum set up by the European Commission under the Industrial Emissions Directive already covers the energy efficiency of generators, e.g. large combustion plants above the 50 MW capacity threshold.

EU level forums to exchange best practice would however have added value. They would raise awareness and develop specialised expertise on the specific metrics of energy efficiency and energy savings in both the energy generation and network sectors. Such focussed forums could be more successful in developing and disseminating targeted tools and measures that

[197] Cf. 2009/72/EC and 2009/73/EC
[198] Cf. article 37 of Directive 2009/72/EC and article 41 of Directive 2009/73/EC

can be used not only in specific production and operational processes, but in other energy related aspects of industrial companies.

EU level forums for best practice exchange could encompass all interested stakeholders and would have to be organised for each major energy production and distribution sector. For example, distributed generation would require a different approach to energy efficiency than large fossil-based generation plants.

Voluntary Agreements

While agreements to implement energy efficiency programmes could be useful in other industrial and economic segments, their scope appears to be limited in the energy generation, transmission and distribution sector. Constraints on eligible activities would mainly arise from competition law, intellectual property rights and network regulation aspects of energy efficiency issues. In the case of generation, operational efficiencies and investment strategies form part of the competitive profile of a company, therefore information exchanges between companies or intervention in investment decisions are constrained by commercial confidentiality and intellectual property rights, such as trade secrets, industrial design, patents and trademarks. In the case of networks, the scope to act under Voluntary Agreements would be confined by biding technical regulations, network codes and the design of tariffs.

Annex XII: Results of the background study on horizontal and end-use options

The background study for horizontal issues concerning energy savings in the EU was carried out by:

Piet Boonekamp, Paul Vethman, Joost Gerdes, Jeffrey Sipma and Ynke Feenstra (ECN)
Hector Pollitt and Philip Summerton (CE)
Joseph Ordoqui (AETS)

The relevant reports are available at:
http://ec.europa.eu/energy/efficiency/eed/eed_en.htm

Annex XIII: Results of the background study on supply-side options

The background study for energy supply side efficiency framework was carried out by:

Monique Voogt (SQ Consult)
Jaap Jansen, Michiel Hekkenberg, Paul Vethman and Sytze Dijkstra (ECN)
Hector Pollitt and Philip Summerton (CE)

The relevant reports are available at:
http://ec.europa.eu/energy/efficiency/eed/eed_en.htm

Annex XIVa: PRIMES 20% efficiency scenario: EU 27 reference scenario with adopted and future energy efficiency measures (social discount rates)

Analytical Results Primes Ver. 4 Energy Model
E3M Lab, National Technical University of Athens
11/03/2011

EU27: Reference scenario with adopted and future energy efficiency measures (social discount rates)

SUMMARY ENERGY BALANCE AND INDICATORS (A)

ktoe	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
											Annual % Change		
Production	**936047**	**950181**	**941860**	**900326**	**821595**	**777943**	**705606**	**670611**	**644316**	**0,1**	**-1,4**	**-1,5**	**-0,9**
Solids	366477	277810	213423	196277	168295	152775	120508	111987	98727	-5,3	-2,3	-3,3	-2,0
Oil	129551	171052	173006	134290	102853	74042	49095	39909	36229	2,9	-5,1	-7,1	-3,0
Natural gas	162447	188965	207559	188677	164185	128673	108488	89913	73531	2,5	-2,3	-4,1	-3,8
Nuclear	202589	223028	243761	257360	238723	235681	183041	172717	162262	1,9	-0,2	-2,6	-1,2
Renewable energy sources	74984	89326	104111	123722	147540	186771	244474	256084	273568	3,3	3,5	5,2	1,1
Hydro	25101	28054	30374	26395	27808	28602	29309	30054	30615	1,9	-0,9	0,5	0,4
Biomass & Waste	46473	57201	67982	85129	96435	116281	142840	144836	146808	3,9	3,6	4,0	0,3
Wind	67	350	1913	6061	13850	26159	46320	52802	63255	39,8	21,9	12,8	3,2
Solar and others	153	274	421	807	3258	8937	17863	20094	24262	10,7	22,7	18,5	3,1
Geothermal	3190	3447	3421	5331	6188	6793	8141	8298	8628	0,7	6,1	2,8	0,6
Net Imports	**756079**	**738600**	**826299**	**986048**	**994178**	**1012173**	**937131**	**930133**	**909991**	**0,9**	**1,9**	**-0,6**	**-0,3**
Solids	81846	79338	98645	126639	119800	114021	97667	105092	97398	1,9	2,0	-2,0	0,0
Oil	535645	512185	533039	599851	578345	591698	561362	542667	521411	0,0	0,8	-0,3	-0,7
- Crude oil and Feedstocks	508460	494000	513725	581995	577468	598581	581337	567694	550688	0,1	1,2	0,1	-0,5
- Oil products	27185	18185	19314	17856	878	-6883	-19974	-25027	-29278	-3,4	-26,6		

Natural gas	135121	145288	192531	257366	292329	300347	263789	270326	277800	3,6	4,3	-1,0	0,5
Electricity	3323	1508	1686	971	264	-544	-1754	-1942	-2080	-6,6	-16,9		
Renewable energy forms	144	279	397	1222	3440	6652	16068	13991	15463	10,7	24,1	16,7	-0,4
Gross Inland Consumption	**1660159**	**1662517**	**1723099**	**1825989**	**1765722**	**1738246**	**1590285**	**1547218**	**1499473**	**0,4**	**0,2**	**-1,0**	**-0,6**
Solids	452940	364248	321007	319922	288095	266797	218175	217079	196125	-3,4	-1,1	-2,7	-1,1
Oil	631058	650858	658727	676859	631147	613870	558005	529051	502804	0,4	-0,4	-1,2	-1,0
Natural gas	294905	333268	393417	445998	456514	429020	372277	360239	351331	2,9	1,5	-2,0	-0,6
Nuclear	202589	223028	243761	257360	238723	235681	183041	172717	162262	1,9	-0,2	-2,6	-1,2
Electricity	3323	1508	1686	971	264	-544	-1754	-1942	-2080	-6,6	-16,9		
Renewable energy forms	75343	89606	104501	124880	150980	193423	260541	270074	289031	3,3	3,7	5,6	1,0
as % in Gross Inland Consumption													
Solids	27,3	21,9	18,6	17,5	16,3	15,3	13,7	14,0	13,1				
Oil	38,0	39,1	38,2	37,1	35,7	35,3	35,1	34,2	33,5				
Natural gas	17,8	20,0	22,8	24,4	25,9	24,7	23,4	23,3	23,4				
Nuclear	12,2	13,4	14,1	14,1	13,5	13,6	11,5	11,2	10,8				
Renewable energy forms	4,5	5,4	6,1	6,8	8,6	11,1	16,4	17,5	19,3				
Gross Electricity Generation in GWh$_e$	**2562823**	**2712209**	**2991720**	**3274121**	**3306416**	**3336908**	**3247437**	**3362721**	**3413331**	**1,6**	**1,0**	**-0,2**	**0,5**
Nuclear	794718	881662	944823	997519	925789	914641	713630	677255	645163	1,7	-0,2	-2,6	-1,0
Hydro & wind	292648	330306	375545	378836	501840	669910	942211	1046492	1210691	2,5	2,9	6,5	2,5
Thermal (incl. biomass)	1475456	1500241	1671352	1897765	1878787	1752358	1591596	1638975	1557477	1,3	1,2	-1,6	-0,2
Fuel Inputs for Thermal Power Generation	**383492**	**362334**	**382613**	**424208**	**412173**	**385316**	**347779**	**358043**	**344424**	**0,0**	**0,7**	**-1,7**	**-0,1**
Solids	263837	230040	223012	229245	218137	198200	157073	156875	138823	-1,7	-0,2	-3,2	-1,2
Oil (including refinery gas)	54404	51463	39294	29780	15730	10993	7328	10759	12461	-3,2	-8,7	-7,4	5,5
Gas	56754	67806	102408	134637	138559	123463	105320	106344	105948	6,1	3,1	-2,7	0,1
Biomass & Waste	5724	10033	14960	25901	34364	47217	72434	78009	80699	10,1	8,7	7,7	1,1
Geothermal heat	2774	2992	2939	4645	5383	5443	5623	6055	6494	0,6	6,2	0,4	1,5
Hydrogen - Methanol	0	0	0	0	0	0	0	0	0				
Fuel Input in other transformation proc.	**839073**	**814654**	**827098**	**842975**	**791727**	**791556**	**749191**	**725128**	**702813**	**-0,1**	**-0,4**	**-0,6**	**-0,6**

Refineries	679426	705954	735244	758152	714898	707985	663362	639254	617055	0,8	-0,3	-0,7	-0,7
Biofuels and hydrogen production	2	202	610	3129	11918	18560	26993	28041	30558	79,6	34,6	8,5	1,2
District heating	32960	23240	19323	16212	16264	16028	14779	14758	13733	-5,2	-1,7	-1,0	-0,7
Others	126685	85258	71921	65482	48646	48984	44057	43074	41466	-5,5	-3,8	-1,0	-0,6
Energy Branch Consumption	**82379**	**88696**	**88176**	**96033**	**91539**	**87928**	**81357**	**77343**	**71754**	**0,7**	**0,4**	**-1,2**	**-1,2**
Non-Energy Uses	**97931**	**110541**	**112495**	**117477**	**111364**	**114790**	**114245**	**114623**	**115512**	**1,4**	**-0,1**	**0,3**	**0,1**
Final Energy Demand	**1068710**	**1069989**	**1112989**	**1173676**	**1168407**	**1172598**	**1101626**	**1068824**	**1044547**	**0,4**	**0,5**	**-0,6**	**-0,5**
by sector													
Industry	365650	328513	326949	326308	312714	318850	312388	311367	310707	-1,1	-0,4	0,0	-0,1
- energy intensive industries	234722	214526	213112	210991	193496	195083	187136	183945	181021	-1,0	-1,0	-0,3	-0,3
- other industrial sectors	130928	113987	113837	115317	119218	123767	125252	127423	129686	-1,4	0,5	0,5	0,3
Residential	264307	280418	286784	308104	309092	304969	273034	260573	256467	0,8	0,8	-1,2	-0,6
Tertiary	158484	160442	159866	176859	176246	171342	154938	149449	144246	0,1	1,0	-1,3	-0,7
Transport	280269	300617	339389	362405	370356	377437	361267	347434	333126	1,9	0,9	-0,2	-0,8
by fuel													
Solids	125031	84977	61454	54486	44180	44404	39178	38441	35771	-6,9	-3,2	-1,2	-0,9
Oil	444429	456959	478882	495857	474554	463505	419864	395041	371333	0,7	-0,1	-1,2	-1,2
Gas	227902	245996	265552	283524	288063	276527	236692	219325	210113	1,5	0,8	-1,9	-1,2
Electricity	184145	193367	216403	237537	240839	243970	236993	246052	251027	1,6	1,1	-0,2	0,6
Heat (from CHP and District Heating) [A]	48610	44616	40061	44441	57520	66182	72768	78364	81916	-1,9	3,7	2,4	1,2
Other	38592	44073	50640	57832	63253	78010	96131	91601	94386	2,8	2,2	4,3	-0,2
CO_2 Emissions (Mt of CO_2 - sec approach)	**4030,6**	**3800,1**	**3810,6**	**3946,6**	**3738,4**	**3530,5**	**3010,5**	**2890,9**	**2705,4**	**-0,6**	**-0,2**	**-2,1**	**-1,1**
Power generation/District heating	1484,3	1321,2	1320,8	1381,1	1294,4	1161,8	906,3	916,7	845,8	-1,2	-0,2	-3,5	-0,7
Energy Branch	152,2	171,0	170,2	181,6	158,8	142,6	125,0	113,0	103,2	1,1	-0,7	-2,4	-1,9
Industry	781,4	678,1	623,0	581,9	501,0	488,5	431,9	411,2	392,5	-2,2	-2,2	-1,5	-1,0
Residential	499,4	481,6	466,2	486,7	480,7	451,5	369,6	333,2	315,9	-0,7	0,3	-2,6	-1,6
Tertiary	300,5	275,3	242,0	262,2	253,2	234,8	201,3	186,2	171,8	-2,1	0,5	-2,3	-1,6
Transport	812,7	872,9	988,5	1053,1	1050,3	1051,2	976,4	930,6	876,1	2,0	0,6	-0,7	-1,1
CO_2 Emissions Index (1990=100)	**100,0**	**94,3**	**94,5**	**97,9**	**92,7**	**87,6**	**74,7**	**71,7**	**67,1**				

CO_2 Emissions (Mt of CO_2 - ref approach)	**4172,0**	**3950,7**	**3922,7**	**4087,6**	**3808,6**	**3596,9**	**3078,0**	**2955,0**	**2771,1**	**-0,6**	**-0,3**	**-2,1**	**-1,0**
CO_2 Emissions Index (1990=100)	**100,0**	**94,7**	**94,0**	**98,0**	**91,3**	**86,2**	**73,8**	**70,8**	**66,4**				
Source: PRIMES													

EU27: Reference scenario with adopted and future energy efficiency measures (social discount rates)

SUMMARY ENERGY BALANCE AND INDICATORS (B

	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
											Annual % Change		
Main Energy System Indicators													
Population (Million)	470,388	477,010	481,072	489,211	499,389	507,727	513,838	517,811	519,942	0,2	0,4	0,3	0,1
GDP (in 000 MEuro'05)	8142,7	8748,4	10107,2	11063,1	11385,6	12750,3	14164,0	15503,7	16824,7	2,2	1,2	2,2	1,7
Gross Inl. Cons./GDP (toe/MEuro'05)	203,9	190,0	170,5	165,1	155,1	136,3	112,3	99,8	89,1	-1,8	-0,9	-3,2	-2,3
Gross Inl. Cons./Capita (toe/inhabitant)	3,53	3,49	3,58	3,73	3,54	3,42	3,09	2,99	2,88	0,1	-0,1	-1,3	-0,7
Electricity Generated/Capita (kWh gross/inhabitant)	5448	5686	6219	6693	6621	6572	6320	6494	6565	1,3	0,6	-0,5	0,4
Carbon intensity (t of CO_2/toe of GIC)	2,43	2,29	2,21	2,16	2,12	2,03	1,89	1,87	1,80	-0,9	-0,4	-1,1	-0,5
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8,57	7,97	7,92	8,07	7,49	6,95	5,86	5,58	5,20	-0,8	-0,6	-2,4	-1,2
CO2 Emissions to GDP (t of CO2/MEuro'05)	495,0	434,4	377,0	356,7	328,3	276,9	212,5	186,5	160,8	-2,7	-1,4	-4,3	-2,8
Import Dependency %	44,6	43,5	46,8	52,5	54,8	56,5	57,0	58,1	58,5				
Energy intensity indicators (2000=100)													
Industry (Energy on Value added)	130,3	115,2	100,0	95,1	90,4	83,5	74,1	67,9	63,0	-2,6	-1,0	-2,0	-1,6
Residential (Energy on Private Income)	114,4	113,2	100,0	97,5	97,1	85,2	69,0	60,8	55,6	-1,3	-0,3	-3,4	-2,1
Tertiary (Energy on Value added)	126,5	117,0	100,0	99,4	95,3	82,0	66,5	58,3	51,6	-2,3	-0,5	-3,5	-2,5
Transport (Energy on GDP)	102,5	102,3	100,0	97,6	96,9	88,2	76,0	66,7	59,0	-0,2	-0,3	-2,4	-2,5
Carbon Intensity indicators													

Electricity and Steam production (t of CO_2/MWh)	0,46	0,40	0,37	0,35	0,31	0,27	0,21	0,20	0,19	-2,1	-1,8	-3,9	-1,3
Final energy demand (t of CO_2/toe)	2,24	2,16	2,08	2,03	1,96	1,90	1,80	1,74	1,68	-0,7	-0,6	-0,8	-0,7
Industry	2,14	2,06	1,91	1,78	1,60	1,53	1,38	1,32	1,26	-1,1	-1,7	-1,5	-0,9
Residential	1,89	1,72	1,63	1,58	1,56	1,48	1,35	1,28	1,23	-1,5	-0,4	-1,4	-0,9
Tertiary	1,90	1,72	1,51	1,48	1,44	1,37	1,30	1,25	1,19	-2,2	-0,5	-1,0	-0,9
Transport	2,90	2,90	2,91	2,91	2,84	2,79	2,70	2,68	2,63	0,0	-0,3	-0,5	-0,3
Electricity and steam generation													
Net Generation Capacity in MW_e			**654125**	**715732**	**815725**	**899559**	**973943**	**982361**	**1030158**		**2,2**	**1,8**	**0,6**
Nuclear energy			133923	134409	127038	126752	120959	102326	89016		-0,5	-0,5	-3,0
Renewable energy			112878	147262	209008	275448	385882	429825	497328		6,4	6,3	2,6
Hydro (pumping excluded)			99714	104505	107315	110748	114080	115249	117282		0,7	0,6	0,3
Wind			12793	40584	86137	136271	222284	250735	293375		21,0	9,9	2,8
Solar			371	2172	15307	27855	47854	61004	82557		45,1	12,1	5,6
Other renewables (tidal etc.)			0	1	249	575	1664	2837	4114			20,9	9,5
Thermal power			407324	434061	479680	497358	467101	450210	443814		1,6	-0,3	-0,5
of which cogeneration units			75917	85934	98317	106207	109442	116527	121486		2,6	1,1	1,0
of which CCS units			0	0	0	0	5394	5394	5394				0,0
Solids fired			194165	186620	182609	180154	155830	133833	117399		-0,6	-1,6	-2,8
Gas fired			129444	167173	216523	233690	222972	218244	225861		5,3	0,3	0,1
Oil fired			71058	62082	55709	42165	30741	32283	31251		-2,4	-5,8	0,2
Biomass-waste fired			12051	17502	24115	40622	56808	65043	68438		7,2	8,9	1,9
Fuel Cells			0	0	0	0	0	0	0				
Geothermal heat			605	684	724	727	751	808	866		1,8	0,4	1,4
Load factor for net electric capacities (%)			49,1	49,1	44,0	40,4	36,3	37,3	36,2				
Indicators for gross electricity production													
Efficiency for thermal electricity production (%)			37,6	38,5	39,2	39,1	39,4	39,4	38,9				
CHP indicator (% of electricity from CHP)			11,4	11,7	14,8	17,0	19,9	19,7	19,6				
CCS indicator (% of electricity from CCS)			0,0	0,0	0,0	0,0	1,6	1,5	1,5				
Non fossil fuels in electricity generation (%)			45,8	44,8	47,3	52,8	59,4	60,0	63,4				
- nuclear			31,6	30,5	28,0	27,4	22,0	20,1	18,9				
- renewable energy forms and industrial waste			14,2	14,3	19,3	25,4	37,4	39,9	44,5				

Indicators for renewables (excluding industrial waste) (%) [(B)]													
RES in gross final energy demand (%)			7,6	8,6	10,9	14,5	21,0	22,5	24,7				
RES in transport (%)			0,5	1,4	4,2	6,5	10,1	11,1	12,9				
Transport sector													
Passenger transport activity (Gpkm)	**4880,7**	**5307,7**	**5892,2**	**6240,3**	**6511,3**	**7077,6**	**7433,0**	**7856,8**	**8254,0**	**1,9**	**1,0**	**1,3**	**1,1**
Public road transport	544,0	504,0	517,6	526,0	545,0	588,3	631,6	678,1	723,0	-0,5	0,5	1,5	1,4
Private cars and motorcycles	3501,1	3986,3	4428,1	4686,5	4866,1	5227,1	5384,4	5593,1	5783,6	2,4	0,9	1,0	0,7
Rail	472,5	421,7	447,9	461,0	482,5	538,7	598,0	668,3	749,2	-0,5	0,7	2,2	2,3
Aviation	317,3	351,3	456,9	527,3	576,9	681,6	776,1	872,8	951,5	3,7	2,4	3,0	2,1
Inland navigation	45,8	44,4	41,7	39,5	40,8	42,0	42,9	44,5	46,8	-0,9	-0,2	0,5	0,9
Travel per person (km per capita)	10376	11127	12248	12756	13039	13940	14466	15173	15875	1,7	0,6	1,0	0,9
Freight transport activity (Gtkm)	**1848,4**	**1942,4**	**2195,7**	**2494,6**	**2662,6**	**2929,1**	**3053,6**	**3218,0**	**3362,4**	**1,7**	**1,9**	**1,4**	**1,0**
Trucks	1060,4	1288,7	1518,7	1800,3	1940,3	2120,8	2163,7	2258,7	2336,0	3,7	2,5	1,1	0,8
Rail	526,3	386,1	403,7	414,1	440,5	505,2	565,0	612,4	661,2	-2,6	0,9	2,5	1,6
Inland navigation	261,6	267,6	273,3	280,2	281,9	303,1	324,8	346,9	365,3	0,4	0,3	1,4	1,2
Freight activity per unit of GDP (tkm/000 Euro'05)	227	222	217	225	234	230	216	208	200	-0,4	0,7	-0,8	-0,8
Energy demand in transport (ktoe)	**280269**	**300617**	**339389**	**362405**	**370356**	**377437**	**361267**	**347434**	**333126**	**1,9**	**0,9**	**-0,2**	**-0,8**
Public road transport	5197	4732	4914	5039	5179	5381	5395	5369	5233	-0,6	0,5	0,4	-0,3
Private cars and motorcycles	154395	166321	182974	187736	186470	179531	161765	146873	139193	1,7	0,2	-1,4	-1,5
Trucks	74969	79037	90951	105104	111595	119219	117567	117691	113302	2,0	2,1	0,5	-0,4
Rail	9560	9452	9600	9436	9654	10752	10892	10737	9560	0,0	0,1	1,2	-1,3
Aviation	29038	34112	45395	49703	51992	56840	59647	60445	59226	4,6	1,4	1,4	-0,1
Inland navigation	7110	6963	5555	5386	5466	5715	6002	6319	6612	-2,4	-0,2	0,9	1,0
Efficiency indicator (activity related)													
Passenger transport (toe/Mpkm)	39,6	39,5	40,3	39,5	38,0	34,7	31,1	27,6	25,2	0,2	-0,6	-2,0	-2,1
Freight transport (toe/Mtkm)	47,1	46,8	46,3	46,5	46,1	44,9	42,7	40,6	37,2	-0,2	-0,1	-0,8	-1,4

Source: PRIMES

Annex XIVb: PRIMES 20% efficiency scenario: EU 27 reference scenario with sufficient measures to meet the 20% energy efficiency target

Analytical Results Primes Ver. 4 Energy Model
E3M Lab, National Technical University of Athens
11/03/2011

EU27: Reference scenario with sufficient measures to meet the 20% energy efficiency target

SUMMARY ENERGY BALANCE AND INDICATORS (A)

ktoe	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
											Annual % Change		
Production	**936047**	**950181**	**941860**	**900326**	**821613**	**777765**	**703030**	**668174**	**641035**	**0,1**	**-1,4**	**-1,5**	**-0,9**
Solids	366477	277810	213423	196277	168305	152440	119914	111091	98436	-5,3	-2,3	-3,3	-2,0
Oil	129551	171052	173006	134290	102853	74040	49044	39868	36181	2,9	-5,1	-7,1	-3,0
Natural gas	162447	188965	207559	188677	164185	128538	107639	89651	73273	2,5	-2,3	-4,1	-3,8
Nuclear	202589	223028	243761	257360	238718	235382	180961	170868	159336	1,9	-0,2	-2,7	-1,3
Renewable energy sources	74984	89326	104111	123722	147552	187366	245472	256696	273809	3,3	3,5	5,2	1,1
Hydro	25101	28054	30374	26395	27808	28602	29310	30054	30595	1,9	-0,9	0,5	0,4
Biomass & Waste	46473	57201	67982	85129	96446	116736	143468	145196	146865	3,9	3,6	4,1	0,2
Wind	67	350	1913	6061	13850	26158	46290	52733	63157	39,8	21,9	12,8	3,2
Solar and others	153	274	421	807	3260	9017	18076	20264	24433	10,7	22,7	18,7	3,1
Geothermal	3190	3447	3421	5331	6188	6853	8328	8450	8758	0,7	6,1	3,0	0,5
Net Imports	**756079**	**738600**	**826299**	**986048**	**994230**	**1005404**	**918363**	**913732**	**896431**	**0,9**	**1,9**	**-0,8**	**-0,2**
Solids	81846	79338	98645	126639	119886	113149	94679	101654	95258	1,9	2,0	-2,3	0,1
Oil	535645	512185	533039	599851	578335	589511	554981	537241	516715	0,0	0,8	-0,4	-0,7
- Crude oil and Feedstocks	508460	494000	513725	581995	577465	597021	576506	563462	547128	0,1	1,2	0,0	-0,5
- Oil products	27185	18185	19314	17856	870	-7510	-21525	-26220	-30414	-3,4	-		

											26,7		
Natural gas	135121	145288	192531	257366	292305	296605	254304	262757	271140	3,6	4,3	-1,4	0,6
Electricity	3323	1508	1686	971	264	-544	-1754	-1942	-2080	-6,6	-16,9		
Renewable energy forms	144	279	397	1222	3439	6683	16154	14022	15400	10,7	24,1	16,7	-0,5
Gross Inland Consumption	**1660159**	**1662517**	**1723099**	**1825989**	**1765791**	**1731634**	**1569654**	**1529024**	**1483259**	**0,4**	**0,2**	**-1,2**	**-0,6**
Solids	452940	364248	321007	319922	288192	265588	214592	212745	193693	-3,4	-1,1	-2,9	-1,0
Oil	631058	650858	658727	676859	631137	612016	552286	524228	498689	0,4	-0,4	-1,3	-1,0
Natural gas	294905	333268	393417	445998	456490	425144	361943	352408	344412	2,9	1,5	-2,3	-0,5
Nuclear	202589	223028	243761	257360	238718	235382	180961	170868	159336	1,9	-0,2	-2,7	-1,3
Electricity	3323	1508	1686	971	264	-544	-1754	-1942	-2080	-6,6	-16,9		
Renewable energy forms	75343	89606	104501	124880	150992	194048	261626	270718	289209	3,3	3,7	5,7	1,0
as % in Gross Inland Consumption													
Solids	27,3	21,9	18,6	17,5	16,3	15,3	13,7	13,9	13,1				
Oil	38,0	39,1	38,2	37,1	35,7	35,3	35,2	34,3	33,6				
Natural gas	17,8	20,0	22,8	24,4	25,9	24,6	23,1	23,0	23,2				
Nuclear	12,2	13,4	14,1	14,1	13,5	13,6	11,5	11,2	10,7				
Renewable energy forms	4,5	5,4	6,1	6,8	8,6	11,2	16,7	17,7	19,5				
Gross Electricity Generation in GWh$_e$	**2562823**	**2712209**	**2991720**	**3274121**	**3306648**	**3344486**	**3234695**	**3347549**	**3400449**	**1,6**	**1,0**	**-0,2**	**0,5**
Nuclear	794718	881662	944823	997519	925771	913459	705541	670004	633360	1,7	-0,2	-2,7	-1,1
Hydro & wind	292648	330306	375545	378836	501840	669901	941883	1045726	1209183	2,5	2,9	6,5	2,5
Thermal (incl. biomass)	1475456	1500241	1671352	1897765	1879037	1761126	1587270	1631818	1557906	1,3	1,2	-1,7	-0,2
Fuel Inputs for Thermal Power Generation	**383492**	**362334**	**382613**	**424208**	**412347**	**386618**	**347515**	**356711**	**344910**	**0,0**	**0,8**	**-1,7**	**-0,1**
Solids	263837	230040	223012	229245	218274	198976	157725	156298	139602	-1,7	-0,2	-3,2	-1,2
Oil (including refinery gas)	54404	51463	39294	29780	15716	11058	7355	10805	12511	-3,2	-8,8	-7,3	5,5
Gas	56754	67806	102408	134637	138568	123937	104295	105398	105796	6,1	3,1	-2,8	0,1
Biomass & Waste	5724	10033	14960	25901	34406	47203	72517	78154	80508	10,1	8,7	7,7	1,1
Geothermal heat	2774	2992	2939	4645	5383	5443	5623	6055	6494	0,6	6,2	0,4	1,5
Hydrogen - Methanol	0	0	0	0	0	0	0	0	0				

Fuel Input in other transformation proc.	**839073**	**814654**	**827098**	**842975**	**791681**	**788415**	**740501**	**717426**	**696412**	**-0,1**	**-0,4**	**-0,7**	**-0,6**
Refineries	679426	705954	735244	758152	714898	706432	658022	634661	613261	0,8	-0,3	-0,8	-0,7
Biofuels and hydrogen production	2	202	610	3129	11918	18490	26822	27855	30369	79,6	34,6	8,4	1,2
District heating	32960	23240	19323	16212	16262	16176	15288	15041	14043	-5,2	-1,7	-0,6	-0,8
Others	126685	85258	71921	65482	48602	47317	40369	39869	38739	-5,5	-3,8	-1,8	-0,4
Energy Branch Consumption	**82379**	**88696**	**88176**	**96033**	**91573**	**87566**	**80315**	**76424**	**71052**	**0,7**	**0,4**	**-1,3**	**-1,2**
Non-Energy Uses	**97931**	**110541**	**112495**	**117477**	**111373**	**114613**	**112538**	**113434**	**114518**	**1,4**	**-0,1**	**0,1**	**0,2**
Final Energy Demand	**1068710**	**1069989**	**1112989**	**1173676**	**1168408**	**1166283**	**1085184**	**1054819**	**1031707**	**0,4**	**0,5**	**-0,7**	**-0,5**
by sector													
Industry	365650	328513	326949	326308	312696	317256	307458	306926	306692	-1,1	-0,4	-0,2	0,0
- energy intensive industries	234722	214526	213112	210991	193469	193725	183009	180271	177694	-1,0	-1,0	-0,6	-0,3
- other industrial sectors	130928	113987	113837	115317	119226	123532	124449	126654	128998	-1,4	0,5	0,4	0,4
Residential	264307	280418	286784	308104	309119	303233	268389	257188	253425	0,8	0,8	-1,4	-0,6
Tertiary	158484	160442	159866	176859	176238	170003	151759	146642	141466	0,1	1,0	-1,5	-0,7
Transport	280269	300617	339389	362405	370355	375789	357578	344064	330123	1,9	0,9	-0,4	-0,8
by fuel													
Solids	125031	84977	61454	54486	44137	42970	35926	35473	33158	-6,9	-3,3	-2,0	-0,8
Oil	444429	456959	478882	495857	474582	461523	415201	390959	367720	0,7	-0,1	-1,3	-1,2
Gas	227902	245996	265552	283524	288013	272190	227604	212631	203557	1,5	0,8	-2,3	-1,1
Electricity	184145	193367	216403	237537	240867	244625	236239	245086	250204	1,6	1,1	-0,2	0,6
Heat (from CHP and District Heating) [(A)]	48610	44616	40061	44441	57577	66350	73075	78481	82190	-1,9	3,7	2,4	1,2
Other	38592	44073	50640	57832	63232	78624	97138	92190	94878	2,8	2,2	4,4	-0,2
CO_2 Emissions (Mt of CO_2 - sec approach)	**4030,6**	**3800,1**	**3810,6**	**3946,6**	**3738,6**	**3511,8**	**2960,5**	**2844,8**	**2670,4**	**-0,6**	**-0,2**	**-2,3**	**-1,0**
Power generation/District heating	1484,3	1321,2	1320,8	1381,1	1295,0	1166,3	907,4	912,7	849,4	-1,2	-0,2	-3,5	-0,7
Energy Branch	152,2	171,0	170,2	181,6	158,7	141,9	123,3	111,7	102,2	1,1	-0,7	-2,5	-1,9
Industry	781,4	678,1	623,0	581,9	500,4	482,2	415,3	397,1	379,5	-2,2	-2,2	-1,8	-0,9
Residential	499,4	481,6	466,2	486,7	481,0	443,8	354,1	321,2	304,9	-0,7	0,3	-3,0	-1,5
Tertiary	300,5	275,3	242,0	262,2	253,3	231,1	194,4	180,9	166,7	-2,1	0,5	-2,6	-1,5
Transport	812,7	872,9	988,5	1053,1	1050,3	1046,5	965,9	921,2	867,8	2,0	0,6	-0,8	-1,1

CO_2 Emissions Index (1990=100)	**100,0**	**94,3**	**94,5**	**97,9**	**92,8**	**87,1**	**73,4**	**70,6**	**66,3**				
CO_2 Emissions (Mt of CO_2 - ref approach)	**4172,0**	**3950,7**	**3922,7**	**4087,6**	**3808,8**	**3577,4**	**3026,4**	**2908,1**	**2735,2**	**-0,6**	**-0,3**	**-2,3**	**-1,0**
CO_2 Emissions Index (1990=100)	**100,0**	**94,7**	**94,0**	**98,0**	**91,3**	**85,7**	**72,5**	**69,7**	**65,6**				

Source: PRIMES

EU27: Reference scenario with sufficient measures to meet the 20% energy efficiency target

SUMMARY ENERGY BALANCE AND INDICATORS (B)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
											Annual % Change		
Main Energy System Indicators													
Population (Million)	470,388	477,010	481,072	489,211	499,389	507,727	513,838	517,811	519,942	0,2	0,4	0,3	0,1
GDP (in 000 MEuro'05)	8142,7	8748,4	10107,2	11063,1	11385,6	12750,3	14164,0	15503,7	16824,7	2,2	1,2	2,2	1,7
Gross Inl. Cons./GDP (toe/MEuro'05)	203,9	190,0	170,5	165,1	155,1	135,8	110,8	98,6	88,2	-1,8	-0,9	-3,3	-2,3
Gross Inl. Cons./Capita (toe/inhabitant)	3,53	3,49	3,58	3,73	3,54	3,41	3,05	2,95	2,85	0,1	-0,1	-1,5	-0,7
Electricity Generated/Capita (kWh gross/inhabitant)	5448	5686	6219	6693	6621	6587	6295	6465	6540	1,3	0,6	-0,5	0,4
Carbon intensity (t of CO_2/toe of GIC)	2,43	2,29	2,21	2,16	2,12	2,03	1,89	1,86	1,80	-0,9	-0,4	-1,1	-0,5
CO_2 Emissions/Capita (t of CO_2/inhabitant)	8,57	7,97	7,92	8,07	7,49	6,92	5,76	5,49	5,14	-0,8	-0,6	-2,6	-1,1
CO2 Emissions to GDP (t of CO2/MEuro'05)	495,0	434,4	377,0	356,7	328,4	275,4	209,0	183,5	158,7	-2,7	-1,4	-4,4	-2,7
Import Dependency %	44,6	43,5	46,8	52,5	54,8	56,4	56,6	57,8	58,3				
Energy intensity indicators (2000=100)													
Industry (Energy on Value added)	130,3	115,2	100,0	95,1	90,4	83,1	72,9	66,9	62,2	-2,6	-1,0	-2,1	-1,6
Residential (Energy on Private Income)	114,4	113,2	100,0	97,5	97,1	84,7	67,8	60,0	54,9	-1,3	-0,3	-3,5	-2,1
Tertiary (Energy on Value added)	126,5	117,0	100,0	99,4	95,3	81,4	65,1	57,2	50,7	-2,3	-0,5	-3,7	-2,5
Transport (Energy on GDP)	102,5	102,3	100,0	97,6	96,9	87,8	75,2	66,1	58,4	-0,2	-0,3	-2,5	-2,5

Carbon Intensity indicators													
Electricity and Steam production (t of CO_2/MWh)	0,46	0,40	0,37	0,35	0,31	0,27	0,21	0,20	0,19	-2,1	-1,8	-3,8	-1,2
Final energy demand (t of CO_2/toe)	2,24	2,16	2,08	2,03	1,96	1,89	1,78	1,73	1,67	-0,7	-0,6	-0,9	-0,6
Industry	2,14	2,06	1,91	1,78	1,60	1,52	1,35	1,29	1,24	-1,1	-1,7	-1,7	-0,9
Residential	1,89	1,72	1,63	1,58	1,56	1,46	1,32	1,25	1,20	-1,5	-0,4	-1,6	-0,9
Tertiary	1,90	1,72	1,51	1,48	1,44	1,36	1,28	1,23	1,18	-2,2	-0,5	-1,1	-0,8
Transport	2,90	2,90	2,91	2,91	2,84	2,78	2,70	2,68	2,63	0,0	-0,3	-0,5	-0,3
Electricity and steam generation													
Net Generation Capacity in MW_e			**654125**	**715732**	**815661**	**899633**	**973738**	**981818**	**1027875**		**2,2**	**1,8**	**0,5**
Nuclear energy			133923	134409	127038	126752	120959	102327	87737		-0,5	-0,5	-3,2
Renewable energy			112878	147262	209008	275446	385755	429502	496501		6,4	6,3	2,6
Hydro (pumping excluded)			99714	104505	107315	110748	114086	115254	116912		0,7	0,6	0,2
Wind			12793	40584	86137	136268	222152	250407	292920		21,0	9,9	2,8
Solar			371	2172	15307	27855	47854	61004	82557		45,1	12,1	5,6
Other renewables (tidal etc.)			0	1	249	575	1664	2837	4112			20,9	9,5
Thermal power			407324	434061	479616	497435	467024	449989	443636		1,6	-0,3	-0,5
of which cogeneration units			75917	85934	98223	107350	109250	116538	121409		2,6	1,1	1,1
of which CCS units			0	0	0	0	5394	5394	5394				0,0
Solids fired			194165	186620	182609	180260	155730	133883	117578		-0,6	-1,6	-2,8
Gas fired			129444	167173	216469	233595	222739	217947	225578		5,3	0,3	0,1
Oil fired			71058	62082	55699	42255	30940	32270	31324		-2,4	-5,7	0,1
Biomass-waste fired			12051	17502	24115	40598	56864	65081	68290		7,2	9,0	1,8
Fuel Cells			0	0	0	0	0	0	0				
Geothermal heat			605	684	724	727	751	808	866		1,8	0,4	1,4
Load factor for net electric capacities (%)			49,1	49,1	44,0	40,5	36,2	37,2	36,2				
Indicators for gross electricity production													
Efficiency for thermal electricity production (%)			37,6	38,5	39,2	39,2	39,3	39,3	38,8				
CHP indicator (% of electricity from CHP)			11,4	11,7	14,8	17,2	19,8	19,8	19,6				
CCS indicator (% of electricity from CCS)			0,0	0,0	0,0	0,0	1,6	1,5	1,6				
Non fossil fuels in electricity generation (%)			45,8	44,8	47,3	52,7	59,4	60,1	63,2				

- nuclear			31,6	30,5	28,0	27,3	21,8	20,0	18,6				
- renewable energy forms and industrial waste			14,2	14,3	19,3	25,4	37,6	40,1	44,5				
Indicators for renewables (excluding industrial waste) (%) [(B)]													
RES in gross final energy demand (%)			7,6	8,6	10,9	14,6	21,4	22,8	25,0				
RES in transport (%)			0,5	1,4	4,2	6,5	10,1	11,1	12,9				
Transport sector													
Passenger transport activity (Gpkm)	**4880,7**	**5307,7**	**5892,2**	**6240,3**	**6511,3**	**7053,1**	**7385,4**	**7810,0**	**8206,9**	**1,9**	**1,0**	**1,3**	**1,1**
Public road transport	544,0	504,0	517,6	526,0	545,0	587,1	630,0	676,6	721,6	-0,5	0,5	1,5	1,4
Private cars and motorcycles	3501,1	3986,3	4428,1	4686,5	4866,1	5209,0	5346,5	5556,7	5747,0	2,4	0,9	0,9	0,7
Rail	472,5	421,7	447,9	461,0	482,5	537,6	595,8	665,9	747,1	-0,5	0,7	2,1	2,3
Aviation	317,3	351,3	456,9	527,3	576,9	677,5	770,2	866,4	944,6	3,7	2,4	2,9	2,1
Inland navigation	45,8	44,4	41,7	39,5	40,8	41,9	42,8	44,4	46,6	-0,9	-0,2	0,5	0,9
Travel per person (km per capita)	10376	11127	12248	12756	13039	13891	14373	15083	15784	1,7	0,6	1,0	0,9
Freight transport activity (Gtkm)	**1848,4**	**1942,4**	**2195,7**	**2494,6**	**2662,6**	**2917,6**	**3030,6**	**3195,9**	**3340,5**	**1,7**	**1,9**	**1,3**	**1,0**
Trucks	1060,4	1288,7	1518,7	1800,3	1940,3	2110,4	2142,8	2238,5	2315,7	3,7	2,5	1,0	0,8
Rail	526,3	386,1	403,7	414,1	440,5	504,6	563,8	611,3	660,2	-2,6	0,9	2,5	1,6
Inland navigation	261,6	267,6	273,3	280,2	281,9	302,6	324,1	346,2	364,5	0,4	0,3	1,4	1,2
Freight activity per unit of GDP (tkm/000 Euro'05)	227	222	217	225	234	229	214	206	199	-0,4	0,7	-0,9	-0,7
Energy demand in transport (ktoe)	**280269**	**300617**	**339389**	**362405**	**370355**	**375789**	**357578**	**344064**	**330123**	**1,9**	**0,9**	**-0,4**	**-0,8**
Public road transport	5197	4732	4914	5039	5179	5371	5382	5359	5227	-0,6	0,5	0,4	-0,3
Private cars and motorcycles	154395	166321	182974	187736	186470	178945	161010	146016	138412	1,7	0,2	-1,5	-1,5
Trucks	74969	79037	90951	105104	111595	118659	116498	116743	112474	2,0	2,1	0,4	-0,4
Rail	9560	9452	9600	9436	9653	10716	10828	10683	9538	0,0	0,1	1,2	-1,3
Aviation	29038	34112	45395	49703	51992	56396	57878	58963	57877	4,6	1,4	1,1	0,0
Inland navigation	7110	6963	5555	5386	5466	5702	5983	6300	6594	-2,4	-0,2	0,9	1,0
Efficiency indicator (activity related)													
Passenger transport (toe/Mpkm)	39,6	39,5	40,3	39,5	38,0	34,7	30,9	27,5	25,1	0,2	-0,6	-2,1	-2,1

Freight transport (toe/Mtkm)	47,1	46,8	46,3	46,5	46,1	44,9	42,6	40,5	37,2	-0,2	-0,1	-0,8	-1,4

Source: PRIMES

Explanations:
(A) Regarding heat from CHP, there is a break in the series between 2005 and 2010. This is related to the practice of Eurostat to report the fuel consumption of on site CHP under the final demand categories of the individual fuels, even if the fuel is in reality used in industrial CHP. In order to keep comparability with Eurostat statistics, the fuel consumption data for the statistical years are presented in a Eurostat compatible format. For the projection period from 2010 onwards the modeling allocates the fuel consumption for new CHP plants to the CHP part of the power generation sector while the corresponding heat and steam is shown under industrial energy demand. Comparisons concerning steam in industry should therefore start only from 2010 onwards. Except for the knock-on effect on total steam, this break in the heat series does not affect other comparisons in PRIMES that can start from 2005 or earlier years.

(B) PRIMES does not report separately on industrial waste. In order to ensure a consistent breakdown of supply and demand quanties, industrial waste is shown as part of total waste and of renewables. Given that only biodegradable waste counts towards the renewables targets, the indicators on the share of RES in gross final energy demand have been adjusted to exclude industrial waste. RES indicators have been calculated on the basis of the methodology developed by EUROSTAT, i.e. taking into account normalised hydro and wind production, increased weight for renewable electricity in road transport and aviation cap for gross final energy demand.

Disclaimer: Energy and transport statistics reported in this publication and used for the modelling are taken mainly from EUROSTAT and from the publication "EU Energy and Transport in Figures" of the Directorate General for Energy and Transport. Energy and transport statistical concepts have developed differently in the past according to their individual purposes. Energy demand in transport reflects usually sales of fuels at the point of refuelling, which can differ from the region of consumption. This is particularly relevant for airplanes and trucks. Transport statistics deal with the transport activity within a country but may not always fully include transit shipments. These differences should be borne in mind when comparing energy and transport figures. This applies in particular to transport activity ratios, such as energy efficiency in freight transport, which is measured in tonnes of oil equivalent per million tonne-km.

Abbreviations

GIC: Gross Inland Consumption
CHP: combined heat and power

Geographical regions
EU27: EU15 Member States + NM12 Member States
EU15: EU15 Member States (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, United Kingdom)
NM12: New Member States (Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia)

Units
toe: tonne of oil equivalent, or 107 kilocalories, or 41.86 GJ (Gigajoule)
Mtoe: million toe
GW: Gigawatt or 109 watt
kWh: kilowatt-hour or 103 watt-hour
MWh: megawatt-hour or 106 watt-hour
TWh: Terawatt-hour or 1012 watt-hour
t: metric tonnes, or 1000 kilogrammes
Mt: Million metric tonnes
km: kilometre
pkm: passenger-kilometre (one passenger transported a distance of one kilometre)
tkm: tonne-kilometre (one tonne transported a distance of one kilometre)
Gpkm: Giga passenger-kilometre, or 109 passenger-kilometre
Gtkm: Giga tonne-kilometre, or 109 tonne-kilometre