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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

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LIST OF ABBREVIATIONS

BAU	Business As Usual scenario
BAT	Best Available Techniques
CHP	Combined Heat and Power (generation)
DSM	Demand Side Management
DSO	Distribution System Operator
EE	Energy Efficiency
EEP	Energy Efficiency Plan 2011
EPBD	Energy Performance of Buildings Directive
ESCO	Energy Service Company
ESD	Energy Services Directive
EU	European Union
ETS	Emissions Trading Scheme
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IA	Impact Assessment
IAB	Impact Assessment Board
IED	Industrial Emissions Directive
JRC	Joint Research Centre of the European Commission
MS	Member States
NEEAP	National Energy Efficiency Action Plan
NRP	National Reform Programme
SME	Small and medium sized enterprise

1. INTRODUCTION AND POLICY CONTEXT

EU leaders, realizing the important benefits of energy efficiency and savings for the EU's social, economic and environmental agendas, have committed to reach the **objective of 20% primary energy savings in 2020** compared to a baseline[1]. This translates into a saving of 368 million tons of oil equivalent (Mtoe) of primary energy (gross inland consumption minus non-energy uses) by 2020 compared to projected consumption in that year of 1842 Mtoe.

The target is thus expressed in terms of **energy savings** (i.e. an absolute decrease of energy consumption). However, the majority of it can be reached through **energy efficiency** improvements (i.e. using less energy input for an equivalent level of economic activity or service). It is on the realisation of this potential that EU action is focussed. Realizing the 20% energy savings objective would in addition help to realize EU's 2050 vision of a resource efficient and low carbon economy as set out in the Low Carbon Roadmap 2050[2].

The Energy Efficiency Action Plan (EEAP) of 2006[3], endorsed at the Spring 2007 European Council, was an **important first step towards reaching** the 20% objective[4]. The Plan contained 85 policy measures, together forecast to permit about a 14% reduction by 2020. A good deal of work has been done to implement the plan, including via implementation of the Energy Services Directive of 2006 (the ESD) and the Co-generation Directive of 2004 (the CHP[5] Directive)[6]; revision of the Ecodesign Directive, the Energy Performance of Buildings Directive and the Energy Labelling Directive (adopted in 2009-2010)[7]; and the development of the Energy Efficiency Plan 2011 (adopted in 2011).

The **Energy Efficiency Plan (EEP)** includes measures that **need to be implemented through new legislative proposals**. These include the setting of clear political objectives; development of the energy services market; increasing the role of the public sector; improving consumers' awareness of their energy consumption; and increased efficiency in energy supply.

The measures needed to implement these policy initiatives are closely related to the scope of two existing legal instruments: the ESD and the CHP Directive. The two Directives already contain provisions that address the above mentioned issues: but their mid-term evaluation shows that in their current form these will not be sufficient to reach the policy objective of 20% savings. That is why their revision is required. The purpose of this impact assessment (IA) is to provide analytical input for the preparation of the Directives' revision.

The Energy Efficiency Plan also identifies policy initiatives that will be realized through other instruments including financial instruments, and implementation measures under the existing Ecodesign, Energy labelling and Energy performance of buildings Directives.

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1 7224/1/07, REV 1, the baseline is PRIMES 2007
2 COM(2011) 112 final
3 COM(2006)545
4 SEC (2006) 1174
5 The terms co-generation and CHP (combined heat and power) are used interchangeably in this IA.
6 Directive 2006/32/EC and Directive 2004/8/EC, respectively
7 Directives 20009/125/EC, 2010/30/EU and 2010/31/EU respectively

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Organization and timing

This impact assessment has been drafted by DG ENER with the support of an Interservice Steering Group[8]. The policy instrument that is the subject of this IA is strategic priority item 16 of the Commission Work Programme for 2011.

1.2. Stakeholder consultation

Broad ranging **stakeholder** consultation provided valuable input to the formation of the policy approach and development of concrete proposals for the new policy instrument(s). The process began with an online public consultation (8 June - 3 August 2009) for the revision of the 2006 Energy Efficiency Action Plan which contained questions on the policy measures discussed in this IA (Annex I). It received 207 replies. A majority of stakeholders were supportive of further binding measures and targets on energy efficiency. Additional information, especially on the readiness of people and companies to apply energy efficiency measures, was then extracted from the Commission's stakeholder consultation (27 October - 8 December 2010) in preparation of the Low Carbon Economy Roadmap 2050[9] to which almost 300 responses were submitted. A broad consultation exercise on the role of national energy efficiency action plans and on the role of energy companies was also launched in January 2011 by the working groups of the Bucharest forum on sustainable energy (which include Member State representatives and stakeholders)[10].

In parallel, **targeted meetings** with stakeholders were organised to discuss in detail what further measures on energy efficiency could be introduced at EU level and what their design should be. These included targeted meetings on financing, buildings and utilities (June 2009); on financing (December 2010); on energy saving companies (ESCOs) (January 2011); and with industries in the energy efficiency sector (February 2011). Finally, the EEP and the follow-up legal measures were discussed with more than 200 stakeholders at a dedicated conference at the EU Sustainable Energy Week on 13 April 2011 (See Annex II).

Member States' (MS) views were sought and obtained notably through discussion in the Council's Energy Working Group both before the adoption of the EEP and in the development of Council conclusions on the Plan. Detailed information on progress in implementation of the ESD by MS was gained through the ESD Concerted Action project (closed-door project for ESD implementing authorities) and on both Directives through questionnaires sent in November 2010 to the relevant Committees.

A detailed account of stakeholders' views is provided in Annex I. A short summary of the responses is included in Chapter 5 along with the discussion of the effectiveness, efficiency and coherence, and respect of subsidiarity of the options analysed.

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8 Composed of SG, LS, ECFIN, ENTR, CLIMA, INFSO, OIB, REGIO, TAXUD, ENV, MOVE, BUDG, EMPL, MARKT

9 SEC(2011) 287 final

10 The draft report on NEEAPs is available at http://ec.europa.eu/energy/efficiency/bucharest/bucharest_forum_telephone_interviews.pdf . It contains important insights on the importance of NEEAPs for MS and also on the scope and content of the second NEEAPs to be submitted by 30 June 2011.

1.3. Main analytical sources

This IA is based on a very broad range of studies and evaluations, e.g.:

- the IA for the EEP[11] (which included a review of more than 300 data sources)

- mid-term evaluations of the ESD and CHP Directives (Annexes III and IV) and external studies of various policy options (Annexes XII and XIII);

- three models (PRIMES market equilibrium model for energy supply and demand; Energy-Environment-Economy Model for Europe (E3ME); and Built Environment Analysis Model (BEAM));

- studies of the Commission's Joint Research Centre on energy savings obligations, metering and billing, energy efficiency in public procurement, and voluntary agreements[12], and examples of best practice from Intelligent Energy-Europe supported projects[13];

- the National Energy Efficiency Action Plans submitted in the framework of the ESD in 2007 and 2008, and national reports under the CHP Directive. Evaluations of these reports were prepared by the Commission[14];

- Member States' National Reform Programmes, reported to the Commission as part of the Europe 2020 Strategy process.[15]

1.4. Opinion of the IA Board

The IA was discussed at a meeting of the IA Board (IAB) on the 13th of April 2011. The IAB , in its first opinion, asked for a revision of the document along three main lines. Based on this the following modifications were made: (i) the analysis of the problem was strengthened (in Chapters 2 and 3); (ii) the intervention logic was presented better and the design of options was explained in more detail (in Chapter 4); and (iii) the assessment of impact was strengthened by adding more data from the modelling results for each option, where available, and for the overall package (including data on sectoral and geographical split) (in Chapters 5 and 6). The discussion of the administrative costs, based on existing experience in the Member States, has been strengthened for all relevant options.

Based on these improvements the IAB issued a second opinion on the 6th of May 2011 in which the improvements made to the text were acknowledged. A number of further clarifications were required. To this end the following issues were modified: (i) the way in which current policies were taken into the baseline was clarified (in Section 2.1); (ii) more information was added on the barriers to higher CHP market penetration (in Section 2.2), on the expected contribution of the 9% ESD target and the relationship between of the 20% energy efficiency target and the other energy and climate targets (in Sections 2.3 and 5.3.1); (iii) an explanation of why effective enforcement of the current provisions is not possible was added (in Section 2.3); (iv) additional data on impacts of the options related to energy audits

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[11] SEC(2011) 277
[12] The four studies are published online at: http://ec.europa.eu/energy/efficiency/end-use_en.htm
[13] http://ec.europa.eu/intelligentenergy
[14] SEC(2009)889, JRC, Synthesis report, 2009, and SEC(2011)276.
[15] COM(2011) 11 - A1/2, http://ec.europa.eu/europe2020/tools/monitoring/annual_growth_survey_2011/

and for the overall package were added (in Section 4.3.2. and Chapter 6); (v) the interaction between existing requirements and the new measures were better explained (in Sections 4.2.1 and 6.3); (vi) stakeholders' views were reflected throughout the discussion of the policy options (in Chapter 5). The executive summary was aligned with the main IA report.

The EU standard cost model could not be used to quantify administrative costs due to the high input data intensity it requires. Therefore, as explained above, the analysis is based on data from the existing experience. Further splitting of the benefits and costs for the overall package was not possible due to constraints of the modelling tools used.

2. PROBLEM DEFINITION

2.1. What is the problem?

The main problem identified in the EEP IA is that the EU's 20% policy objective for energy savings will not be met with present policies - and thus that the related environmental, social, security of supply and economic benefits will not be realised. That IA showed that this is not because of the lack of economic potential[16] but because of market and regulatory failures[17].

Table 1 below shows that the 20% target will not be reached in 2020 and the economic potential will not be fully used. Progress can be assessed through a comparison of the original projections made in 2007 (i.e. PRIMES 2007) and the most recent ones (i.e. PRIMES 2009 energy efficiency (EE) scenario). The PRIMES 2009 EE scenario includes EU and national policies and measures that had been adopted up to the end of 2009, including the implementation of the ESD and CHP Directives, plus the recast of the EPBD and the Ecodesign and Energy labelling measures that were adopted in 2010. The model does not allow the individual impact of each policy measure to be distinguished but establishes their overall impact on the demand and supply sectors (as presented in the table below). The impact of the economic crises is also included in the scenario. This forecast was the basis of the assessment used in the Energy Efficiency Plan.

[16] The Fraunhofer ISI *et al.* 2009 study uses the term "economic potential" to refer to measures that can be achieved with the application of the best available technologies that are economic for the consumer under today's usual market conditions reflecting consumer preferences and barriers – displayed by a discount rate of 8-15% or higher.

[17] Ibid 11

Table 1. Projected developments and energy savings potential in 2020

	2020 (PRIMES 2007) [Mtoe]	2020 (PRIMES 2009 EE) [Mtoe]	Expected progress in 2020 without further action [%]	2020 Economic potential [%]	2020 Technical potential [%]
	1	2	3 [=(2-1)/1*100]	4	5
Gross inland consumption minus final non-energy use	1842	1678	**-9%**	**-20% (EU target)**	n.a.
Final Energy Consumption, of which:	*1348*	*1214*	*-10%*	*-19%*	*-25%*
Industry	368	327	**-11%**	**-13%**	-16%
Transport	439	395	**-10%**	**-21%**	-28%
Residential	336	310	**-8%**	**-24%**	-32%
Tertiary	205	181	**-12%**	**-17%**	-25%
Energy transformation, transmission and distribution	494	464	**-6%**	**-35%***	n.a.

Sources: PRIMES for columns 1,2 and 3 and Fraunhofer Institute for columns 4 and 5.
*The data on the economic potential in the energy transformation sector are based on DG ENER calculations.

Therefore, the main problem that will be studied in this IA is how to close the gap towards the 20% objective by using the economic potential. Figure 1 below illustrates the remaining efforts that need to be realized for each of the final and supply side sectors to this end. The ESD already contains measures that address all final use sectors (excluding defence) and the CHP Directive partially covers energy generation (as presented in the figure below). It has been concluded that a revision of these Directives would be the most obvious mechanism to tackle the remaining potential in these sectors, subject to a detailed analysis.

Figure 1: Expected improvements in 2020 and need for additional effort per sector[18]

A new legislative instrument aimed at creating the right market conditions and legal environment so that **the 20% objective is fully realized in 2020 is therefore analysed**. To achieve the 20% saving, all end-use (residential, commercial and industry) and energy generation sectors will be covered with the exception of transport which is subject to a number of individual measures stemming from the White Paper on Transport[19]. As the ESD already contains measures that address all final use sectors (excluding defence) and the CHP Directive partially covers energy generation, the possibility of amending one or both of these is studied.

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18 Sources: PRIMES 2007, 2009 and Fraunhofer ISI *et al.* 2009
19 SEC(2011) 358

The energy sector is also covered to a certain degree by the ETS and the new IED. This will be taken into account when measures for the relevant sectors are analyzed and proposed.

2.2. What are the drivers for the problem?

The ESD and CHP Directives already address important barriers in these sectors, including:

- Insufficient political commitment, policy coordination and long-term political planning to reduce investment insecurity[20].
- Insufficient incentives for consumers to realize energy efficiency improvements and to tackle high upfront costs and the split incentives problem[21].
- Insufficiently developed markets for energy efficiency improvements[22].
- Low awareness of energy saving opportunities: poor knowledge of the benefits and costs makes people reluctant to make energy efficiency investments even though they are cost-effective[23].
- Insufficient price incentives for uptake of energy efficiency measures among energy suppliers[24].
- High transaction costs because of lengthy administrative procedures (e.g. for cogeneration) or a high number of separate units (e.g. energy efficiency improvements in households)[25].
- In particular for co-generation: this is more expensive than single generation (even though economically plausible) and is a complex technology which produces simultaneously electricity and heat (and sometimes cooling) and thus requires its operators to sell the output to two (or three) different and complex markets. This increases transaction costs and investment risk.
- Cultural barriers: mistrust of new technologies and lack of willingness to adopt energy savings measures (especially households), historic low penetration of district heating because of the prevalence of individual heating solutions.

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20 Jollands N. and Ellis M. 2009. Energy efficiency governance – an emerging priority. ECEEE 2009

21 For example, IEA. 2007. Mind the gap. Quantifying Principal-Agent problems in energy efficiency; Allcott, H. and Mullainathan. 2010. S. Behavior and energy policy. 1204-1205. Science, 327; Duerinck J. Electricity and fuel consumption in Europe: a panel error correction model for residential demand elasticities; and Boardman B. 2007. Home truths. University of Oxford

22 Marino A., Bertoldi P. and Rezessy S. Energy Service Companies Market in Europe. Status Report. JRC 2010

23 For example, see WBCSD. 2007. Energy efficiency in buildings, business realities and opportunities. Cited at: http://www.wbcsd.org/DocRoot/qUjY7w54vY1KncL32OVQ/EEB-Facts-and-trends.pdf; ECME Consortium 2009. The functioning of electricity retail markets for consumers in the European Union. Final Report; and See for e.g. a survey undertaken by chambers of commerce of 12 Member States in the framework of the IEE project CHANGE, Energy Efficiency in SMEs: Success Factors and Obstacles. 2009. Cited at: www.eurochambres.eu/change

24 Lovings A. 1997. Climate: Making Sense and Making Money

25 Survey results, Commission Progress Report on Implementing the Cogeneration Directive

2.3. Will existing policies do enough to address the problem?

Achievements and shortcomings of the ESD and CHP Directives

The ESD and CHP Directives were the first steps to tackle the barriers and from this perspective were milestones in energy efficiency policy development. They encouraged the introduction of a number of concrete policies at national level. However, their frequently 'soft' and open wording has not been sufficient to overcome the main barriers to energy efficiency.

The **mid-term evaluation**[26] **of the ESD shows that it has not succeeded in tapping the full energy saving potential of the sectors it covers.** Even if Member States continue their efforts on energy savings beyond the ESD's target year of 2016, primary energy savings from the implementation of the Directive will reach only 50-95 Mtoe in 2020, leaving a significant gap towards the 20% saving target (which requires savings of 368 Mtoe).

The analysis showed that Member States will achieve their 9% target in 2016 but that this does not guarantee the realization of the 20% target in 2020. This is because the present ESD target is based on proving 9% end use energy savings in 9 years against the average of a five year base period. These savings are relative and do not necessarily translate into consumption reduction. Therefore, there is no guarantee that the overall energy savings which would be needed to contribute to the 20% energy efficiency target for 2020 are realized. Furthermore, savings as early as 1991 can be counted and the realm of the ESD varies from one Member State to another[27]. For example, a government may be able to show that its policy in the sectors covered achieved proven savings of 9% whilst at the same time energy consumption is only stabilised or even growing due to high economic growth.

The Directive's main measures and the results of their evaluation are summarised below.

Measure and barrier that it addresses	Summary of the mid-term evaluation
Indicative 9% target (Art. 4): Each MS should demonstrate 9% improvement by 2016 in the quantity of "end use energy"[28] consumed, relative to the five year period preceding the implementation of the Directive Addresses barrier (1) (section 2.1.)	**Most MS are on track to achieve the 9% target, so that it can be expected that the target by 2016 will be met by all Member States**[29]. Assessment of progress uses a complex combination of bottom up and top down calculation methodologies which implies considerable administrative costs for MS. T**he 9% target is considerably less ambitious than the 20% overall objective.** No direct relation between the ESD target and the overall objective can be established.
National energy efficiency plans (NEEAP, Art. 14): measures to reach the 9% target have to be presented in NEEAPs which have to be updated every three years Addresses barrier (1) (section 2.1.)	NEEAPs **proved to be useful tools but the measurement of savings (mentioned above) is complicated**. For many MS the NEEAPs of 2007-2008 were the first time they made a comprehensive overview of EE possibilities and policies. This also helped MS build their institutional capacity[30]. However, the limited focus of the NEEAPs has sometimes led MS to over-focus on certain end-use sectors and overlook other energy saving potentials.

26 See Annex III

27 The realm of the ESD includes end use savings, defined as savings excluding ETS installations ("undertakings") and where deemed necessary military end uses. As Member States define both provisions differently, the basis for the saving calculations is not fully harmonised.

28 Defined as final energy consumption minus the consumption of the installations covered by ETS minus optional deduction of final energy use for military purposes

29 Responses from Member States to the questionnaires on horizontal ESD issues, November 2010

30 Maclagan L, Bruel R, Draft report on Bucharest Forum telephone interviews, March 2011

Measure and barrier that it addresses	Summary of the mid-term evaluation
Exemplary role of the public sector (Art. 5): MS have to select at least two from a list of measures to promote this role. Addresses barriers (1,3,4) (section 2.1.)	**Most MS have taken appropriate measures but the level of ambition varies between MS**. Where MS have set ambitious objectives, it seems that it is not the ESD that has driven this[31]. The provision has been superseded by later EU legislation requiring energy efficiency to be taken into account in the public procurement of vehicles and of office equipment[32]. This has created fragmented requirements.
Role of energy companies (Art. 6): MS have to ensure that energy companies[33] promote EE through provision of energy services, audits, contributing to funds, voluntary agreements or other market-orientated schemes. Addresses barriers (3,4) (section 2.1.)	**The impact has been moderate**. The level of ambition in implementation has been uneven, due to the vagueness of the provision's wording. In no case has implementation led to the energy services market becoming well developed in a Member State where this was not previously the case.
Information provision (Art. 7, 8, 12): MS have to disseminate information on financial and legal frameworks, to ensure the availability of energy audits and the availability of qualification, accreditation or certification schemes for providers of energy services and audits. Address barrier (4) (section 2.1.)	**Progress has been limited.** In most cases MS used non-legislative measures (e.g. awareness raising campaigns) to provide information especially to the general public, schools and industries. SMEs have been less frequently targeted. However, generally, the awareness of consumers on how energy use can be rationalised remains low[34]. There has been only limited progress as regards certification, mainly regarding energy performance of buildings. The availability of audits has improved only in some MS and mainly in relation to energy intensive industries.
Removal of barriers (Art. 9, 10): MS have to remove national regulations that impede energy savings and tariffs that create incentives for energy consumption; MS have to make available model EE contracts for financial instruments. Address barriers (2,6) (section 2.1.)	**Progress has been limited and uneven.** Legal, accounting and budgetary obstacles remain in many MS. For example, the accounting practices of some public authorities prevent them retaining in their budgets savings from reduced energy consumption. The effect of the provision on model contracts is also difficult to assess. By 2010 they were not yet available in half the MS.
Funds and funding mechanisms (Art. 11): MS are invited to establish these to subsidise energy efficiency improvements or promote energy services. Addresses barriers (2, 6) (section 2.1.)	**No direct link was established between developments at MS level regarding the funding of energy efficiency and the introduction of the ESD.** Most Member States applied funding schemes for energy efficiency before the ESD came into force. From 2007 onwards many new schemes were introduced (40% of all current schemes).
Metering and billing (Art. 13): MS have to ensure understandable and accurate information is provided for consumers via individual meters and energy bills on a frequent basis. Addresses barriers (2,4) (section 2.1.)	**Because of the vague wording the provisions did not lead to improvements** and the Commission received numerous complaints from citizens. For example, billing based on actual consumption is considered as "frequent enough" when provided monthly (e.g. Sweden) or every three years (e.g. Austria).

The efficiency and effectiveness of the **CHP Directive has also proved to be limited as revealed in the Directive's progress report[35]**. The share of electricity from high-efficiency CHP increased only from 10.5% in 2004 to 11.0% in 2008. This shows that the lack of concrete obligations regarding the real uptake of the CHP in the Directive and its soft wording have failed to create the investment security needed, to decrease the burden of the numerous

31 Background study "Horizontal Issues concerning energy efficiency", 2011 (Annex XII)
32 Directive 2009/33/EC and Regulation (EC) No 106/2008
33 Energy distributors, distribution system operators and retail energy sales companies.
34 E.g. less than half of EU consumers (47%) know how much electricity they consume - The functioning of the retail electricity markets for consumers in the European Union, SEC(2010) 1409 final
35 See Annex IV

administrative procedures and to create a playing level field for this technology and its operators.

The Directive's main measures and the results of their evaluation are summarised below.

Measure and barrier that it addresses	Summary of the mid-term evaluation
National potential (Art. 6): MS are obliged to evaluate their national potential for the application of high-efficiency cogeneration. Addresses barriers (1, 4) (section 2.1.)	**All MS have made an analysis.** But as the Directive does not define how this analysis of potential should be carried out, each national analysis **has different depth, length and quality**. The information given is not conducive for comparison and does not give the detail needed for a comprehensive evaluation of national potentials. There is no obligation on MS to realise this potential.
Guarantees of origin and support schemes (Art. 5 and 7): MS are required to create a system of guarantees of origin for CHP electricity and base support schemes on useful heat[36]. Addresses barriers (3, 5) (section 2.1.)	All Member States have established a system of guarantees of origin. However, **in close to half the system is still not fully operational.** Member States have established various types of support schemes (see Annex XIII) but there is no evidence that this has been driven by the Directive.
Connection rules (Art. 8): lays down rules to guarantee the connection and access of electricity from cogeneration to the grid. Addresses barriers (5, 6) (section 2.1.)	The wording of Art. 8 **does not provide** regulatory certainty and stability for access to the electricity and heat markets, nor does it guarantee sufficient political commitment by Member States. The requirement has **led to introduction of rules that vary across MS**. These were not sufficient to address the challenges; network connection and access still often constitute a barrier to the expansion of cogeneration.
Evaluation of administrative burden (Art. 9): MS are required to evaluate the case for addressing a range of administrative barriers Addresses barrier (6) (section 2.1.)	The evaluation of administrative procedures has been completed by all Member States. However there is **no evidence of any systematic implementation of the results of this evaluation.**

Experience has shown that better enforcement action is not possible from the Commission side because of the open wording of many of the two Directives' provisions and the lack of clarity concerning the minimum requirements that MS have to meet in order to implement them. This resulted in the fact that even though there were a number of observations and also complaints from citizens and companies for the Directives' poor implementation, the Commission was in most cases not able to launch infringement procedures.

Preliminary information on the forthcoming National Energy Efficiency Action Plans, which are due to be submitted in June 2011, shows that it is unlikely that their level of ambition will be significantly improved so that they make an important contribution towards the 20% target in 2020. These observations come from discussions with Member States and also from a study[37] carried out as a preparation for this IA. The main deficiencies that could be expected are in the Plans' coverage (potential and measures on the supply side will probably not be included) and the scope of the activities on end-use consumption (some further measures are expected but no major step up of effort).

Based on the evaluation of the ESD and CHP Directives, it can be concluded that they will not, in their present form, lead to the implementation of actions sufficient to tackle the problems described in section 2.2 and the new challenges described above.

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36 'Useful heat' is defined as the thermal energy needed to satisfy an economically justifiable demand for heat and cooling.

37 http://ec.europa.eu/energy/efficiency/bucharest/bucharest_forum_telephone_interviews.pdf

Other relevant policies and new challenges

In addition, since the adoption of the two Directives the following new challenges have emerged:

- **A new target for 20% energy efficiency was endorsed by the European Council in 2007:** this made the level of ambition of the ESD inadequate. In addition, the political climate has changed significantly since the two Directives were proposed (ESD: proposed Dec 2003, CHP: proposed July 2002) and adopted (in 2006 and 2004 respectively) and the EU Member States and the European Parliament have called upon the Commission to propose more and binding measures on energy efficiency.

- **The Renewable Energy Directive (Directive 2009/28/EC) was adopted in 2009**: it set a higher priority for technologies using renewable energy relative to CHP. This increases the risk perception for CHP and has further hampered the market uptake of this technology.

- **The third internal energy market package was published in 2009**: it sets obligations for the introduction of smart meters but does not spell out measures that will ensure that these meters are used for the benefit of final consumers and not only of energy utilities.

Relationship between the indicative energy efficiency target and the binding energy and climate targets

The relationship of the EU's energy efficiency policy objectives, in particular the 20% energy efficiency target for 2020, with the two binding targets on renewable energy and greenhouse gas emissions was assessed through a separate run of PRIMES, i.e. the "Reference scenario". This scenario assumes that these two binding targets are met. The result of the modelling shows that this alone would not have a significant effect on progress towards the achievement of the 20% savings objective (only increasing savings by an additional 0.8 percentage points or 14 Mtoe compared to baseline with efficiency policies). This is because there is a range of possible measures for the realization of GHG emissions reduction, in addition to energy efficiency. These, for example, include increased use of renewable energy, particularly favoured by the renewables target, fuel switching, reduction of non-CO_2 emissions and international offsets (CDM/JI). Thus, the objectives of energy efficiency policy would not be met by the achievement of the two other targets and additional measures to fully reap energy efficiency's benefits are required.

2.4. The Union's right to act, subsidiarity and proportionality

The EU's competence in the area of energy, and of energy efficiency in particular, is enshrined in the Treaty on the Functioning of the European Union, Article 194(1). The EU's role needs to respect the principles of subsidiarity and proportionality. Member States are essential for the realization of energy efficiency policy and EU intervention should be well targeted and supportive to their actions. The EU's role is in:

– Establishing a common framework which creates the basis for coherent and mutually reinforcing mechanisms while leaving in being the responsibility of Member States to set, in a transparent and comparable way, the concrete means and modalities to achieve the agreed objectives.

– Creating a platform for exchanging best practice and stimulating capacity building.

– Setting minimum requirements in areas where there is a risk of internal market distortions if Member States take individual measures.

– Using EU instruments to promote energy efficiency, e.g. through financing, and to mainstream it in other policy areas.

The appraisal section includes a measure-by-measure check of respect for the principle of subsidiarity and proportionality.

3. OBJECTIVES

3.1. General and specific policy objectives

Because progress towards the target of 20% is not satisfactory, the **main objective of this IA is to contribute to the closing of the gap by exploring measures in all sectors with potential for cost-effective savings.** To realize this general objective the following specific objectives need to be achieved:

- Stimulate higher political commitment to energy efficiency
- Trigger measures to reap the remaining cost-effective potential on the energy demand side, particularly in buildings and industry
- Support a functioning commercial market for delivering energy efficiency improvements
- Provide equal playing field rules for energy efficiency market actors
- Decrease the administrative burden and simplify the legislative framework
- Ensure that consumers are empowered with correct, understandable and regular information on their energy use
- Trigger measures on the energy supply side so that energy is transformed, transmitted and distributed in the most cost-effective way
- Support the establishment of 'smart grids' that encourage energy efficiency improvements.

3.2. Consistency of the objectives with other EU policies

The above general and specific policy objectives are in line with other EU policies. They:

- Enable the reduction of greenhouse gas (GHG) emissions up to 2020 and thus contribute in a cost-effective way to reaching the EU's climate objectives.
- Make possible further commitments on greenhouse gas emission reduction after 2020.
- Promote economic recovery and enhance the competitiveness of EU industries in line with the Europe 2020 Strategy, contributing to the Resource efficiency flagship initiative and the sustainability layer of Europe 2020.

- Increase security of energy supply as called for in the Energy 2020 Strategy: less energy used in Europe means less reliance on imports and a lower energy import bill.
- Create jobs and reduce energy poverty in support of the EU's social agenda.
- Reduce environmental and land-use impacts resulting from the extraction and treatment of energy resources and waste and from energy transmission and distribution.

The coherence of each individual policy option is assessed in Chapter 5.

4. POLICY OPTIONS

4.1. Overview of policy options

The first level of policy option relates to whether there should be legally binding energy efficiency targets on Member States. A second level of analysis relates to the nature and impact of legal measures - most of the options are based on the current instruments of the two Directives as it has been evaluated that the problems lie not with the instruments themselves but with their inconclusive wording. New policy measures that are added to the analysis are the energy savings obligation, and tools to enhance generation efficiency and grid efficiency. Finally the alternatives legislative approaches are reviewed.

Table 2. Overview of policy options

First-level policy options
A: National targets/objectives
Option A1: Retain the current approach
Option A2: Extend the indicative end use target of ESD to 2020
Option A3: Comprehensive indicative target for each Member State for 2020
Option A4: Binding target for each Member State for 2020
Second-level policy options
B: Energy Savings Obligation
Option B1: Retain the current approach (limited encouragement in the ESD)
Option B2: Repeal the current ESD provisions without replacement
Option B3: Require all Member States to introduce energy saving obligations while leaving their design for determination by Member States
Option B4: As B3 but with harmonisation of key design features
C: Further measures to realise potential at the end-use stage
Option C1: Retain the current approach
Option C2: Energy saving measures for renovation of public buildings
Option C2a: Introduce 3% binding target for renovation of public buildings to cost-optimal levels
Option C2b: Introduce 3% binding target for renovation of public buildings to nearly zero energy levels
Option C2c: Establish a national financing and technical assistance infrastructure for renovation of public buildings.
Option C3: Obligatory use of energy efficiency as a criterion in public procurement
Option C4: Voluntary measures to promote energy efficiency via public procurement
Option C5: Enhanced obligations for smart metering and billing by energy companies

Option C6: Voluntary measures on metering and billing
Option C7: Mandatory energy audits and energy management systems for industry
Option C8: Voluntary systems to promote energy audits and the use of energy management systems in industry
Option C9: Obligations for Member States to promote ESCOs
Option C10: Voluntary measures to promote ESCOs
D**: Measures to realise potential at the stage of energy transformation and distribution**
Option D1: Retain the current approach
Option D2: Removal of existing provisions
Option D3: Mandatory CHP and district heating/cooling requirement for new electricity and high-heat-demand industry installations
Option D4: Mandatory connection and priority access of high-efficiency cogeneration to the electricity grid
Option D5: Voluntary measures to promote CHP and district heating/cooling
Option D6: Minimum performance requirements for energy generation
Option D7: Energy efficiency obligation on energy network regulators
Option D8: Voluntary measures to increase the efficiency of energy transformation, transmission and distribution
E: National reporting
Option E1: Retain the current approach
Option E2: Require light form of reports
Option E3: Require detailed calculation of savings and evaluation of measures across the whole economy
Option E4: Reporting only in National Reform Programmes
Option E5: Combine reporting with other relevant instruments
Third-level policy options
Option 1: Retain the two current Directives (ESD and CHP) as they stand today
Option 2: Abolish the two current Directives without replacement
Option 3: Propose two separate revised Directives and extend their scope
Option 4: Merge the two Directives and extend the scope
Option 5: Use Regulation legal instrument instead of Directive

The options are described in more detail below.

4.2. First-level policy options

4.2.1. National targets and objectives

The targets set in the ESD are not comprehensive – they cover only a part of energy consumption - and are indicative. This approach can be contrasted with that adopted by the EU for renewable energy (where the Renewable Energy Directive[38] sets binding national targets for 2020) and for greenhouse gas emissions (where the EU Emissions Trading Scheme (ETS) creates binding targets for 2020 at firm level for the sectors it covers, and the effort-sharing decision[39] does the same at national level for those it does not). Both systems of

38 Directive 2009/28/EC

39 Decision 406/2009/EC

targets are comprehensive. In a step in that direction, the European Council has invited Member States to set indicative national energy efficiency targets for 2020 as part of a new system of National Reform Programmes (NRPs). The method for calculating savings was not specified; the European Council has subsequently asked the Commission to develop one. In this context, the following options are assessed:

Name	What EU obligation?	Flexibility for MS
A1: Retain the current approach	Indicative 9% target for end use savings in 2016, embodied in legislation (energy services Directive); overall indicative target in the framework of the Europe 2020 process (invitation from European Council to set targets for 2020, no common methodology, no set level of ambition).	The method of setting the target in the framework of the energy services Directive is fully harmonised. However, Member States are largely free to choose the measures to comply with the saving target. The request to set a target for overall national energy efficiency in the Europe 2020 process is political. Member States can choose not to set any targets here. The target formulation and the level of ambition for 2020 is fully in the hands of Member States. They can adopt targets that fit their national policies or even decide to set no targets at all.
A2: Extend the indicative end use target of ESD to 2020	In addition to the 9% ESD target for 2016 (see A1), additional target for end use savings in 2020. In addition, maintain the overall indicative target in the Europe 2020 framework.	See A1.
A3: Comprehensive indicative target for each Member State for 2020	Maintain ESD target for 2016 (see A1). Set a legislative requirement for Member States to adopt an overall indicative target for 2020.	See A1 for the ESD target. The 2020 target would still be indicative as in A1. In contrast to A1, all Member States would be legally required to set energy efficiency targets. In addition, they would lose the flexibility to determine how to formulate the target. However, they would retain full flexibility on the level of ambition they choose.
A4: Binding target for each Member State for 2020	As A1 plus binding targets for primary energy consumption in 2020. As for the renewable energy and GHG targets, the targets announced in the Europe 2020 process would be those embodied in legislation.	See A1 for the ESD target. For the 2020 target, Member States have no flexibility in terms of target formulation or level of ambition.

<u>Options not retained for assessment</u>

The option of repealing the current ESD target provisions without replacement was not retained because the purpose of targets in energy policy is to establish a confident climate for investment. A Commission proposal to repeal a provision concerning national targets that the EU had previously, on a Commission proposal, adopted would bring the credibility of targets in the energy sector into question. The option of setting binding targets for end-use efficiency rather than comprehensive targets was not retained because the EU's overall target (established after the ESD's adoption) is expressed in terms of primary energy savings. There would seem no reason to express binding targets – if they are to be set – in any other way.

4.3. Second-level policy options

4.3.1. Energy Savings Obligation

Denmark, France, Italy, the UK and the region of Flanders have introduced energy savings obligations, under which energy suppliers or distributors are required to achieve a given quantity of savings among energy end-users. These obligations vary widely in design features[40]. The ESD contains limited provisions to encourage the use of this tool.

The following options are assessed:

Name	What EU obligation?	Flexibility for MS
B1: Retain the current approach	Obligation to choose from various options to promote energy services given in Article 6 of the ESD.	Large flexibility concerning which provisions to adopt.
B2: Repeal the current ESD provisions without replacement	None	Member States would have full flexibility on how to develop the market for energy services.
B3: Require all MS to introduce energy saving obligations while leaving their design for determination by MS	Oblige energy suppliers/distributors to achieve energy savings among consumers.	Large flexibility as to the design of the scheme (level of ambition, sectors targeted, focus of savings achieved)
B4: As B3 but with harmonisation of key design features	Oblige energy suppliers/distributors to achieve a specified amount of energy savings and use harmonised procedures to prove these savings.	Still significant flexibility as to design of the scheme, however constrained by given level of ambition and accounting rules.

Options not retained for assessment

The option of harmonisation of all design features and introduction of a European system of tradable white certificates is discussed in Annex VII, where it is concluded that setting obligations at national level is preferable.

4.3.2. Further measures to realise potential at the end-use stage

The starting point for these options is:

Name	What EU obligation?	Flexibility for MS
C1: Retain the current approach	Vague obligations on the public sector (but strong for office equipment, i.e. Energy Star) and on metering and billing, energy audits and ESCO from ESD.	Large room for flexibility in implementation (except Energy Star).

This would mean retaining the provisions of the current ESD. For the **public sector**, **industry** and **ESCOs** these are largely non-normative. For **metering and billing** they are normative but have proved difficult to interpret. (For more detail see section 2.2).

Starting from this baseline, three options on increased **public sector** contribution are assessed:

[40] JRC. 2010. Energy Saving obligations and tradable white certificates. Cited at: http://ec.europa.eu/energy/efficiency/studies/efficiency_en.htm

C2: Energy saving measures for renovation of public buildings	EU level obligation on MS to achieve increase of the annual renovation rate to 3% for publicly owned and occupied buildings (excluding social housing). Three possibilities are considered: Option C2b: Introduce 3% binding target for renovation of public buildings to cost-optimal levels; Option C2b: Introduce 3% binding target for renovation of public buildings to nearly zero energy levels; Option C2c: Establishing a national financing and technical assistance infrastructure for renovation of public buildings.	For Options C2a and C2b MS have to ensure that the target is reached and properly monitored. MS have full flexibility on the way they reach it. Option C2c includes an obligation on MS to ensure sufficient financing and technical assistance for the renovation rate of relevant public buildings to be increased.
C3: Obligatory use of EE as a criterion in public procurement	EU level obligation that existing energy labels (the Energy Label or Energy Performance Certificate) and performance requirements (Energy Star) are used as a criteria in public spending for the purchase of energy using products and buildings, and for services as far as the service providers use products or buildings. MS would be obliged to eliminate constraints in legal, accounting and budgeting rules.	MS have to implement the requirements. They may set further measures (including on green public procurement)
C4: Voluntary measures to promote EE via public procurement	EU level encouragement to MS	MS can provide, if they consider it necessary, information and support to procuring authorities and take other steps to eliminate barriers to energy efficiency in procurement.

In order to improve consumers' ability to manage their energy consumption, two options to improve **metering and billing** are assessed:

C5: Enhanced obligations for smart metering and billing by energy companies	EU level harmonised common requirements on the provision of feedback to consumers by metering; common EU requirements for the frequency of billing based on actual consumption; provision of data on individual historical consumption by internet; possible EU harmonisation of guidelines on the clarity of billing	MS must ensure proper implementation and monitoring of the provisions. MS retain flexibility to introduce further requirements on clarity of billing and decide on technical aspects for the deployment of smart meters within the remit of other EU legislation[41].
C6: Voluntary measures on metering and billing	Common EU guidelines for energy companies to encourage use of in-home displays and bi-directional communication for advanced metering; Voluntary EU codes of conduct on clarity and minimum frequency of billing based on actual consumption	No legal obligations on MS.

In order to trigger additional energy savings in **industry**, two options are assessed:

[41] Measurement Instruments Directive (Directive 2004/22/EC)

C7: Mandatory energy audits and energy management systems for industry	A requirement that non-SME companies in industrial sectors implement regular (minimum every 5 years) energy audits relating to all energy aspects of their operations	MS have to ensure proper implementation. They have the flexibility to define quality requirements for the audits within the broad objective of a systemic screening of all energy related aspects of the company.
C8: Voluntary systems to promote energy audits and the use of energy management systems in industry	A requirement for Member States to introduce energy efficiency programmes, such as Voluntary Agreements with industry to commit to implementing regular energy audits or energy management systems. MS could provide incentives for companies to join by e.g. granting tax or financial benefits and support schemes	MS have broad flexibility to design their programmes, to tailor them to specific industry sectors, and to define implementation channels and offer incentives.

ESCOs have an important role to play in facilitating energy efficiency measures. Two options are assessed to promote the development of ESCOs:

C9: Obligations for Member States to promote ESCOs	Requirements for MS to ensure market monitoring, providing lists of energy service offers and standard contracts.	Large room for flexibility in implementation. Government support can be modelled closely on existing national policies.
C10: Voluntary measures to promote ESCOs	Encourage the setting up of voluntary agreements at national level through which large energy consumers commit to engage ESCOs to lower their consumption.	Large room for flexibility regarding level of ambition, content and design of the voluntary agreements.

<u>Options not retained for assessment</u>

The option of improving consumer information solely through methods such as personalised web pages and telephone services was not retained because research shows them to be ineffective if adopted on a freestanding basis rather than in combination with advanced metering/improved billing[42]. The option of promoting energy audits and energy management systems for households and SMEs was not retained because for audits this would overlap with options B3 and B4, while energy management systems are not suitable for these sectors.

4.3.3. Measures to realise potential in energy transformation and distribution

The starting point for these options is:

Name	What EU obligation?	Flexibility for MS
D1: Retain the current approach	Implementation of a guarantee of origin system; calculation of efficiency of CHP and primary energy savings using either a harmonised or an alternative methodology; 4-yearly reporting obligation on progress in raising the share of high efficiency CHP; annual submission of statistical information; guaranteeing of minimum grid access for high efficiency CHP	MS are free to decide whether and how to support high efficiency CHP and whether to take measures to increase its use. They must, however, use a common definition of the type of CHP that merits support.
D2: Removal of existing provisions	No obligation to apply the common definition of high efficiency CHP e.g. for state aid purposes or for guaranteeing access to the grid.	As D1; Member States are, in addition, free to define the type of CHP that merits support, subject to the application of EU state aid rules.

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

Option D1 means retaining the provisions of the current CHP Directive. These do not promote energy efficiency across the energy supply sector in general, but only in relation to co-generation. They contain binding measures regarding the gathering of information/reporting to the Commission and the provision of state aid for CHP, but not regarding the promotion of CHP. (For more detail see section 2.2). Option D2 means removing even these provisions. Starting from this baseline, three options to promote **CHP** in particular are assessed:

D3: Mandatory CHP and district heating/cooling requirement for new electricity and high-heat-demand industry installations	New thermal electricity generation capacity must be used for the generation of heat as well as power whenever there is an appropriate demand for heat nearby.	MS would have to ensure coordination of their administrative procedures related to CHP production units and related heat and cooling network connection and development. While the measure would ensure a common high ambition level for CHP, it would still be based on national economic conditions respecting the specificities of each country.
D4: Mandatory connection and priority access of high-efficiency cogeneration to the electricity grid	Requirement to provide priority or guaranteed access to the grid and priority dispatch for high efficiency CHP to ensure level playing field in electricity markets and help distributed CHP.	The requirement would ensure a common EU approach to grid access of high efficiency CHP, within the limits of ensuring the reliable operation of the national electricity network, that MS would have to implement correctly.
D5: Voluntary measures to promote CHP and district heating/cooling	National measures and programmes driven by level of ambition of MS, initiatives by local or regional authorities to include CHP into their programmes to build a sustainable energy system in their communities	MS would have full flexibility to decide whether they want CHP to play a role in building their future sustainable energy systems and what measures to take at what level.

Three options to promote efficiency across the **energy supply sector** in general are assessed:

D6: Minimum performance requirements for energy generation	MS would have to provide information on the energy efficiency parameters of their electricity and heat supply installations and how these relate to BAT	MS would be required to provide information while retaining flexibility as regards setting energy efficiency requirements for power and heat installations.
D7: Energy efficiency obligation on energy network regulators	A requirement for energy regulators to increase the priority given to energy efficiency when they design network tariffs and regulation, and to set the network tariffs a) allowing the provision of energy efficiency related energy services to consumers b) incentivising the reduction of network losses via better grid operation, management, demand response and the connection of distributed generators.	This measure would reduce the discretion of network regulators. It would not significantly limit MS's flexibility, since they already have obligation to ensure the independence of network regulators.
D8: Voluntary measures to increase the efficiency of energy transformation, transmission and distribution	This would leave scope for MS and network operators to implement best practice sharing, voluntary industrial initiatives and regional cooperation to introduce measures reducing network losses and developing network services needed for demand management, demand response and demand aggregation.	MS would have full flexibility to decide whether and how they want to drive network developments, including the development of electricity, gas and district heating/cooling smart grids within the limits of the existing requirement under the EU internal energy market to ensure the independence of network regulators.

<u>Options not retained for assessment</u>

In some Member States, pricing rules are not favourable to developing district heating. The option of regulating this at EU level was not retained because of concerns about subsidiarity.

4.3.4. National reporting

Under the ESD, Member States are required, every three years, to make detailed reports of progress in end-use energy savings, using a complex methodology, and to accompany these with detailed plans for future action. These documents are known as National Energy Efficiency Action Plans (NEEAPs). There is no agreed template for them. The next NEEAPs are due in June 2011. In their NRPs, Member States have typically chosen to include a paragraph or two describing highlights of their action on energy efficiency. Member States will be invited to report every year. There is as yet no set reporting method and again, no agreed template. In this context, the following options are assessed:

Name	What EU obligation?	Flexibility for MS
E1: Retain the current approach	Every three years, MS are obliged to submit national plans including planned and implemented EE measures as well as a calculation of the final energy savings delivered by each single measure; no common rules. Each year, Member States must report on the basic EE indicators on primary energy consumption and the progress with EE policy implementation in a previous year.	MS can use their own national methods to determine final energy savings; free choice of indicators within certain constraints set by ESD; no obligation to report on the achievement of the 9% target for final energy savings in 2016; no formal obligation to report on EE indicators on annual basis; no obligation to use a common template for reporting on national energy efficiency plans
E2: Require light form of reports	As E1 with a simplification of the requirements for three-yearly reports (no impacts of single measures) and common formats for each type of report	Fewer requirements than under E1, but less flexibility in how they are implemented by Member States.
E3: Require detailed calculation of savings and evaluation of measures across the whole economy	Extension of the methodologies for reporting on energy savings in E1 to additional sectors including energy generation and transmission/distribution	Methodology for the detailed calculation of primary energy savings needs to be developed and agreed in the comitology; obligation to set own national systems for the regular collection of statistical information from each energy generating installation
E4: Reporting only in National Reform Programmes	Existing provisions of ESD are repealed without replacement. Basic information on EE provided through NRPs only.	No formal obligation to report on EE indicators on annual basis, no obligation to use a common template for reporting on national energy efficiency plans. No obligation for the MS to continue collection of data on the impacts of EE measures.
E5: Combine reporting with other relevant instruments	As E2 but in the form of a common report also incorporating other existing reporting obligations covering renewable energy and greenhouse gas.	MS can combine reporting required by this Directive with other EU Directives on energy efficiency as well as renewables and reduction of emissions of GHG.

<u>Options not retained for assessment</u>

The option of simplifying the reporting obligations under the ESD (as in E2) while keeping the reporting interval at three years was not retained because this simplified procedure would be likely to end up duplicating much of what would then have to be put in place, in parallel, for the NRPs.

4.4. Third-level policy options

This section describes options concerning the purpose and scope of the legislative proposal and the choice of legal instrument. These can be defined according to four variables:

- **whether there is a need to adopt a new legislative proposal or not**

The answer to this question will come from the analysis of the first-level options.

- **whether the purpose and scope of the two existing Directives (ESD and CHP) should be extended**

As explained in chapter 2, the purpose of the ESD is to enhance the cost-effective improvement of energy end-use efficiency in the Member States. It is therefore focused exclusively on achieving savings in end-use sectors. The Directive does not include measures to promote energy savings directly in the energy supply sectors.

With the setting in 2007 of a 20% target, a qualitative step was made in the level of ambition of EU energy efficiency policy, which from then on has aimed at achieving energy consumption reductions irrespective of whether this is done in the energy supply or end-use sectors. The ESD in its current form is not able to achieve such a target. This raises the issue of whether it should be modified in view of achieving the 20% energy efficiency target, through extension to the supply sectors.

In addition, the ESD excludes some end-use sectors (e.g. undertakings covered by the Emissions Trading Directive[43], and armed forces to the extent that this application causes conflict with their nature or activities). In addition, Member States can exclude from the obligations in Articles 6 (obligations on energy utilities) and 13 (metering and billing) small distributors, small distribution system operators and small retail energy sales companies. This raises the issue of whether these exclusions should be retained.

The mid-term review of the CHP Directive did not identify any major issue concerning its purpose or scope.

- **whether the two Directives should remain as separate legal acts**

The CHP Directive deals with energy supply. If the decision is taken to modify the purpose of the ESD to include the supply side, it could make sense also to incorporate provisions that are currently dealt with in the CHP Directive. The new legislative proposal would in this way become the general EU legal framework for energy efficiency, encompassing energy saving instruments across all sectors.

- **whether in the light of the changes proposed for each Directive the form of the new legal instrument should be a Directive or a Regulation**

Directives and Regulations are both binding legal acts of the Union. Regulations are directly applicable in their entirety. Directives are binding upon each Member State as to the result to be achieved, leaving to the national authorities the choice of form and methods.

[43] Directive 2009/29/EC

The choice of legal instrument should be inspired by the principle of proportionality, according to which the content and form of Union action should not exceed what is necessary to achieve the intended objective[44]. A Directive should be the preferred option if, in the light of the content of the provisions of the new legislative proposal, the intended objectives can be fully achieved while providing some room for manoeuvre to Member States as to the choice of the means to achieve such objectives. The choice of legal instrument therefore depends on the content of the preferred second-level policy options as assessed in Chapters 5 and 6.

The following options have been retained for further analysis and comparison. They are intended to encapsulate the main policy choices.

Option 1: Retain the two current Directives as they stand today

This option implies the maintenance of the purpose and scope of the ESD and the CHP as they currently stand (the ESD would continue being exclusively focused on end-use sectors and the current exemptions to its the scope would continue in being). The Directives would remain as separate legal acts.

Option 2: Abolish the two current Directives without replacement

Do not propose any new legislative act(s) but abolish the two Directives.

Option 2: Propose two separate revised Directives and extend their scope

Under this option the CHP Directive and the ESD would remain as separate acts, but the purpose of the ESD would be extended to achieve the energy efficiency target of 20% and to cover energy efficiency measures in the supply sector. Its scope would also be broadened by removing existing exemptions to its coverage of end-use sectors.

Option 3: Merge the two Directives and extend the scope

As option 2, plus the merger of the ESD and CHP Directives into a single Directive.

Option 4: Use Regulation legal instrument instead of Directive

As option 3, but with a Regulation rather than a Directive as legal instrument.

5. ANALYSIS OF IMPACTS AND COMPARING THE OPTIONS

5.1. Analytical approach and modelling tools

To establish the baseline for each policy area the "PRIMES 2009 energy efficiency scenario" was used. This includes policies adopted up to December 2009.

To analyse the detailed economic, social and environmental impact of the policy options the E3ME model was used[45]. Results from the PRIMES 2009 energy efficiency scenario were used as an input for the energy projections. In cases where there was insufficient information

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44 Article 5(4) of the Treaty on European Union.

45 See Chewpreecha and Pollitt (2009).

to run the E3ME model, bottom-up assessments and individual studies were used to establish the impact of the options.

To evaluate the impact of the proposed options on the administrative burden for public authorities and businesses, results of various studies were used. Finally, to assess the impacts of the preferred policy options in combination, taking into account their overlaps, a further PRIMES run was performed[46].

5.2. Criteria used for comparison of the options

Based on the description of the impact, qualitative evaluation of how the options contribute to the policy objectives set in Chapter 3 is made using the following evaluation criteria:

- **respect of subsidiarity/proportionality**
- **effectiveness –** the extent to which options achieve the objectives of the proposal
- **efficiency –** the extent to which objectives can be achieved for a given level of resources (cost-effectiveness).
- **coherence –** the extent to which options are coherent with the overarching objectives of EU policy and to which they limit trade-offs.

For the evaluation of subsidiarity/proportionality the following symbols are used: **respected R**, **or not respected NR.**

The following symbols are used to describe the results of the evaluations of efficiency, effectiveness and overall assessment:

'=' **baseline or equivalent to the baseline**

'+' to '+++' **low to high improvement compared to the baseline**

'-' **worsening compared to the baseline**

For the evaluation of coherence with other policies the following symbols are used: **coherent C**, **or not coherent NC.**

5.3. Summary results for the first-level policy options

5.3.1. National targets and objectives

Option A1: Retain the current approach

Retaining the current approach would mean that no further targets are defined. The present ESD target of proving 9% end use energy savings in 9 years against a base period would expire at the end of 2016. The mid term evaluation[47] and feedback from the Member States through the ESD concerted action and evaluation questionnaires[48] have shown that this format

[46] SEC(2011) 277
[47] Annex III
[48] Annex XIII

of target setting is flawed. The achievement of the target cannot easily be monitored through official statistics and does not allow for any conclusion on whether the measures carried out have led to lower consumption. Moreover, due to the taking into account of "early action"[49] , the actual target in some Member States is considerably lower than the indicative 9%. The economic, social and environmental impacts of the present ESD, including the 9% target, are included in the base case.

Options A2-A4: Propose further targets

If the ESD were to be extended at the present saving pace (1% p.a.), **option A2** would imply an end use energy saving target of 13% in 2020. It is assumed that this would be achieved.

Option A3 would imply the setting of voluntary targets in the framework of the Europe 2020 strategy. The level of ambition of these targets would be up to Member States and could vary considerably. This is captured model-wise by assessing the impact of an optimistic hypothesis (80% of the savings necessary to reach the overall 20% target of the EU are achieved) and a pessimistic hypothesis (60% of savings achieved)[50]. Since the targets would not be binding, the level of fulfilment of the ambition could also vary. Two hypotheses are assessed. Under the first, more pessimistic hypothesis, this approach would lead to **energy savings of 15.4%** (283 Mtoe) relative to the projection used for the EU's overall 20% target. Under the second, more optimistic hypothesis it would lead to **energy savings of 19.3%** (355 Mtoe). This corresponds to a scenario in which new binding energy efficiency measures in EU legislation lead Member States to increase their combined ambition to a level equivalent to a 20% saving and in which they come rather close to achieving this.

Option A4 investigates the impact of binding national targets for primary energy consumption. In this case it is assumed that the 20% target is achieved.

- **Impact on energy consumption**

In the baseline, primary energy savings of 8.9% or 167 Mtoe are reached, compared to the saving of 368 Mtoe needed to achieve the 20% target. In the baseline, energy intensity is forecast to improve by 1.4% per year. Option A2, with its target for end-use energy savings of 1% per year, would therefore have no higher an impact than option A1. The overall 20% primary energy saving aim would not be reached. Depending on the hypothesis for the level of ambition, option A3 would lead to energy savings of either 283 or 355 Mtoe. The overall 20% target would not be reached in either case, but under the more optimistic hypothesis the gap would be small. Option A4 would lead to the 20% target being achieved in full.

- **Economic impact**

The economic impacts of options A1 and A2 are included in the baseline. The economic impact of options A3 and A4 were modelled using the E3ME model. As the table below shows, for both cases, the modelled impact on GDP is moderately positive.

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49 Savings since 1991/1995 count towards the target

50 The span given by these hypotheses matches the level of ambition witnessed so far with the indicative national targets set in the Europe 2020 framework.

Table 3. Overview of economic impacts of different target options, 2020

	Baseline (option A1)		Additional effects to baseline case							
			Extension of ESD target **(option A2)**		Indicative target (**option A3**, pessimistic hypothesis)		Indicative target (**option A3**, optimistic hypothesis)		Binding target **(option A4)**	
	2015	2020	2015	2020	2015	2020	2015	2020	2015	2020
GDP (bn € 2000)	11420	12537	0	0	19.5	30.0	21.5	32.4	23.7	33.8
Consumption (bn € 2000)	6627	7155	0	0	-6.5	1.4	-7.8	-5.8	-13.0	-14.7
Investment (bn € 2000)	2699	3177	0	0	23.0	26.6	27.0	35.5	33.8	46.6
Exports (bn € 2000)	4915	6147	0	0	-2.8	-6.6	-5.0	-10.8	-6.5	-16.2
Imports (bn € 2000)	4559	5744	0	0	-5.9	-8.6	-7.3	-13.6	-9.6	-18.2
Consumer prices (2000 = 1.0)	1.42	1.62	0	0	0.01	0.02	0.02	0.03	0.02	0.04

Source(s): E3ME, Cambridge Econometrics

It needs to be underlined that these modelling results in some senses represent a worst-case scenario. The modelling is based on fictive price increases (ranging from 2% to 4%), which reduce energy consumption. Whereas this approach is suitable to draw conclusions on economic, social and environmental impacts, the real world impacts are likely to be more positive. If price were in fact to increase as a consequence of energy efficiency policy, this would only tend to be in the short term. In the medium and longer term, these increases would be compensated by lower energy bills due to lower energy consumption. The modelled price increases lead to a decrease of consumption. The negative impacts displayed in the modelling for exports should in reality be lower or even positive as an increase in energy efficiency will permit the reaping of first mover advantages in selling energy efficiency technology to third countries.

- **Administrative burden**

National targets by themselves cause no administrative burden to private industry. However, as governments need to monitor the targets, this causes administrative costs. In the case of the targets proposed, the administrative costs for the ESD target (A1) or a possible extension thereof are already covered in the baseline. The administrative costs for additional overall targets for 2020 can be estimated to be low or even close to zero as these targets can be monitored through official statistics (primary energy consumption, final energy consumption, energy intensity) which are readily available at national level and from Eurostat.

- **Social impact**

As the table below shows, the effects on employment of options A3 and A4 are forecast to be positive.[51] Because energy efficiency solutions like building insulation or advanced heating systems demand skills, the increase of employment is likely to be in the medium to high quality segment. Efficiency programmes initiated by the public sector are likely to tackle social housing, favouring social inclusion. As discussed above, the modelling of energy

[51] Here again, it should be noted that these impacts represent a "worst case" result due to the modelling of energy saving by means of price increases. A more realistic assessment in the Energy Efficiency Plan estimated the employment potential at up to 2 million jobs based on data from the building sector.

efficiency through iteratively increased energy prices inevitably leads to a result that misleadingly depicts a permanent reduction in real household incomes.

Table 4. Overview of social impacts of different target options, 2020

	Baseline (option A1)		**Additional effects to baseline case**							
			Extension of ESD target **(option A2)**		Indicative target (**option A3**, pessimistic hypothesis)		Indicative target (**option A3**, optimistic hypothesis)		Binding target **(option A4)**	
	2015	2020	2015	2020	2015	2020	2015	2020	2015	2020
Consumer prices (2000 = 1.0)	1.42	1.62	0	0	0.01	0.02	0.02	0.03	0.02	0.04
Employment (000)	226824	226942	0	0	148.0	216.0	210.2	327.5	260	398
Real household incomes (bn € 2000)	7795	8672	0	0	-1.5	-2.0	1.7	-8.7	-1.9	-18.9

Source(s): E3ME, Cambridge Econometrics

As discussed above, the modelling makes the incorrect assumption that it will be energy prices alone, rather than more direct regulatory measures, that will be the trigger for an increased uptake of energy efficiency. In distributional terms, the model results show that these higher energy prices would hurt the more vulnerable income groups more than high income groups. However, as discussed above, the model results cannot be regarded as valid for energy efficiency in this respect. In reality, the energy and cost saving effects would strongly outbalance the direct income losses if indeed energy price increases were to occur. For comprehensiveness of this analysis, however, the distributional effects of the modelled price increases are shown in Annex V.

- **Environmental impact**

As the table below shows options A3 and (especially) A4 deliver a significant contribution to the reduction of greenhouse gas emissions. Reduced energy consumption will translate into further environmental benefits such as the reduction of local air pollutants and subsequent increase in air quality, in particular in densely populated areas. This was not modelled.

Table 5. Overview of environmental impacts of different target options, 2020

	Baseline (option A1)		**Additional effects to baseline case**							
			Extension of ESD target **(option A2)**		Indicative target (**option A3**, pessimistic hypothesis)		Indicative target (**option A3**, optimistic hypothesis)		Binding target **(option A4)**	
	2015	2020	2015	2020	2015	2020	2015	2020	2015	2020
CO_2 emissions (m tonnes carbon)	1096	1064	0	0	-40.5	-79.9	-53.9	-97.7	-69	-123
GHG emissions (m tonnes carbon)	1286	1250	0	0	-49.5	-92.1	-65.9	-113.2	-83	-142

Source(s): E3ME, Cambridge Econometrics

- **Interaction with the Emissions Trading Scheme**

The model projects that in reaching the 20% energy efficiency goal the ETS price will be put under some pressure. In this model the ETS price is set endogenously and is determined by the level of effort needed to meet the emission targets as a whole in the year 2020. The large reductions that occur in energy consumption are enough to meet these targets.

This result, while credible in principle, is liable to be overstated – in the model the specific ETS price becomes zero - because in the model, energy efficiency improvements are achieved by means of energy price increases. In reality, regulatory measures or instruments changing consumer behaviour which primarily target non-ETS sectors may put ETS prices under less strain. These interaction effects are not reflected in E3ME.

In order to test this argumentation, the impact of energy efficiency targets was also modelled using the PRIMES model. Several similar scenarios were modelled. These are known as the 'PRIMES 20% efficiency' scenarios. In these new scenarios, the ETS Directive is assumed to continue until 2050, with allowances continuing to decrease over time. PRIMES assumes foresight of actors over the full investment horizon. While unlimited banking is allowed from Phase 2 of the ETS until 2050, borrowing from the future is not permitted. These scenarios also assume full compliance with the renewable energy targets for 2020 – or even their overachievement, since incentives established for the purposes of the reference scenario are assumed to also remain in being in the 20% efficiency scenarios. The results of this additional modelling suggest that ETS prices will fall to a much lesser extent than predicted with the E3ME model. The ETS price, under these conditions, is forecast to be about 14.2 €/t CO_2 in 2020, compared to a price of about 16.5 €/t in 2020 in the PRIMES 2009 reference scenario which is taken for a comparison because in it the GHG and RES targets are reached[52].

Therefore, while both models project a further decrease in GHG emissions, they project different impacts on the ETS price. The much lower ETS price impact until 2020 in PRIMES is explained among other things by the different baselines used, a higher share of modelled measures with GHG reductions materialising in non-ETS sectors, the full market foresight assumed and an unlimited ETS banking flexibility until 2050 assumed.

Comparing the options on national targets and objectives

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

Evaluation criterion Policy options	Subsidiarity/ proportionality	Effectiveness	Efficiency	Coherence	OVERALL
Option A1: Retain the current approach	R	=	=	C	**=**
Option A2: Extend the indicative end use target of ESD to 2020	R	-	=/-	C	**-**
Option A3: Comprehensive indicative target for each Member State for 2020	R	+++	++	C	+++
Option A4: Binding target for each Member State for 2020	R	+++	++	C	+++

Options A1 and A2 are weak in terms of **effectiveness** because they do not come close to attaining the policy goal of a 20% energy saving. If the indicative targets in option A3 are accompanied by a strong set of binding measures, and if the introduction of these measures at European level leads Member States to revise upwards the current level of ambition of their indicative targets ("optimistic hypothesis") and to achieve these revised goals, then option A3

52 E3MLab National Technical University of Athens (2011), Modelling of Energy Efficiency scenarios.

will be effective; if not ("pessimistic hypothesis"), not.[53] Option A4, with binding targets, would certainly be effective.

The criterion of **subsidiarity** aims at the attainment of a goal at the most local institutional level possible. Options A1 and A2 are compatible with this criterion, but fail in terms of effectiveness and efficiency because they do not achieve the goal and imply administrative burdens. Under the optimistic hypothesis for option A3, its voluntary approach will be sufficient for the goal to be achieved. This would then be the appropriate path to follow, while the more interventionist approach of binding targets (option A4) would go too far. However, under the pessimistic hypothesis for option A3, the voluntary approach would fail to attain the goal. Option A4 would then embody the approach that the subsidiarity criterion requires. The Energy Efficiency Plan 2011 states that the Commission will review this at the end of 2013.

Options A1 and A2 both fit **coherently** into the present energy and climate framework. Due to the technical complexity of the task of establishing and verify the target of end use savings, their cost-benefit ratio in terms of **efficiency** is neutral if not negative as many resources are required for verification and reporting on the attainment of the targets. Contrary to this, moving towards the overall primary energy saving targets in options A3 and A4 increases **efficiency** from the point of view of the target being easy to track with available statistics. They also increase **coherence** as they make the link of energy efficiency policies to other policies more understandable.

The result of the **stakeholders' consultation** showed that the majority of stakeholders (53%, 108 submissions) favoured a binding overall target, possibly supported by secondary ones (e.g. for CHP), 25% (50 submissions) were against while 22% (45 submissions) had no opinion in this regard. This call was also repeated by the European Parliament[54]. In strong contrast are, however, the views of the majority of MS who consider that the indicative approach to targets is to be kept, at least until its efficacy can be properly assessed.

Based on the analysis and taking into account the various views of stakeholders, it is proposed that Option A3 is retained. However, progress towards the 20% objective should be reviewed in 2013 (see chapter 7, "Monitoring and Evaluation"). If this review in 2013 shows that this does not deliver the results needed to reach the overall European 20% energy efficiency target, option A4 will then need to be further investigated.

Deciding to pursue this approach towards target setting, based on voluntary and indicative rather than binding national *targets*, would mean that the approach towards achieving the 20% objective would instead be based on binding *measures*. This is in line with the position taken by Member States, notably at the European Council meeting of 4th February 2011. Analysis of the various measures is provided in the text to follow.

5.4. Second-level policy options

5.4.1. Energy Savings Obligation

Details on the current situation and on design considerations are provided in Annex VII.

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53 The new binding measures will not on their own achieve the 20% target because they are designed to be accompanied by activities such as financing and consumer information at national level.

54 European Parliament resolution of 15 December 2010 on Revision of the Energy Efficiency Action Plan (2010/2107(INI))

- **Impact on energy consumption**

The present provisions on this topic in the ESD have had a limited impact on energy savings. Member States have found them difficult to implement[55] due to their broad and generic character. Options B1 and B2 are therefore assumed to have the same impact: that reflected in the baseline.

The impacts on energy savings of saving obligations depends on the level of ambition and the comprehensiveness of the scheme. Under option B3, Member States would be free to set the level of ambition. On average, existing schemes aim at 0.8% annual savings. It is assumed that if all Member States were required to use the instrument, they would on average choose a slightly lower level of ambition: 0.6%. This would save 50-56 Mtoe of primary energy consumption in 2020. For option B4, it is assumed that the requirement would be set at the more ambitious level of 1.5% savings per year, saving 108-118 Mtoe of primary energy consumption in 2020.[56]. It is assumed that the binding character of the obligations to be placed on energy suppliers/distributors will mean that in both cases these obligations are fully translated into energy savings.

- **Economic impact**

The economic impacts of options B1 and B2 are included in the baseline scenario. The introduction of saving obligations for energy suppliers/distributors (options B3 and B4) is estimated to have a positive economic impact. The E3ME model was used to assess the impact of financing the investment cost of energy saving obligations in three ways:

  - with **income tax increases** used to compensate energy suppliers/distributors;
  - with **energy price increases** to fund the investment costs[57]
  - with the costs being met from a **revolving fund** paid for by energy savings (this is equivalent to 100% price recoup by distributors/suppliers).

As shown in the table 6, saving obligations are estimated to lead to additional investment in energy efficiency of €100-198 bn in 2020. The impact on GDP is an increase of €247-1046m compared to the baseline.

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55 Questionnaires for mid-term evaluation of ESD, see Annex III

56 The rate chosen under option B4 represents an ambitious stance which is close to the maximum that is estimated to be achievable. Cf. Annex XIII; Thomas (2010), Success and failures of energy 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; Eyre, Pavan, Bodineau (2009), Energy company obligations to save energy in Italy, the UK and France: what have we learnt?; EuroWhiteCert (2007) White Certificate Trading Systems in the European Union, Intelligent Energy Europe project, available at www.eurowhitecert.org; Thomas (2007) Politische Rahmenbedingungen für Aktivitäten der Energiewirtschaft zur Förderung der Endenergieeffizienz, Zeitschrift für Energiewirtschaft 31(3).

57 It is assumed that competitive pressures in the market and/or optimal pricing strategies for entities with market power lead to suppliers/distributors only recouping 75% of the cost.

Table 6. Summary of overall economic impacts for EU27 (difference from baseline)

	Baseline (option B1)			**Additional effects to baseline case**																	
				Option B3									**Option B4**								
				Income tax increase			Energy price increase			Revolving fund			Income tax increase			Energy price increase			Revolving fund		
	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
GDP (bn € 2000)	10305	11415	12519	n/a	13.7	42.0	n/a	18.4	46.7	n/a	17.0	35.2	n/a	27.0	69.2	n/a	36.6	80.1	n/a	33.7	77.2
Consumption (bn € 2000)	6070	6628	7154	n/a	-1.5	11.9	n/a	3.4	18.2	n/a	2.0	13.6	n/a	-3.7	17.7	n/a	7.0	29.9	n/a	4.5	27.6
Investment (bn € 2000)	2285	2699	3176	n/a	9.7	5.6	n/a	9.3	5.7	n/a	9.3	5.9	n/a	19.1	15.3	n/a	18.0	15.9	n/a	18.2	15.4
Exports (bn € 2000)	3943	4913	6139	n/a	5.0	23.3	n/a	5.7	23.0	n/a	5.0	15.8	n/a	11.3	36.6	n/a	12.4	36.3	n/a	11.0	35.2
Imports (bn € 2000)	3638	4562	5751	n/a	-0.5	-1.0	n/a	0.04	0.2	n/a	-0.5	0.2	n/a	-0.3	0.4	n/a	0.7	2.1	n/a	-0.01	1.0
Consumer prices (2000 = 1.0)	1.24	1.42	1.6	n/a	0.00	0.0	n/a	0.00	0.0	n/a	0.00	0.0	n/a	0.00	0.0	n/a	0.00	0.0	n/a	0.00	0.0

Table 7. Summary of overall social impacts for EU-27 (difference from baseline)

	Baseline (option B1)			**Additional effects to baseline case**																	
				Option B3									**Option B4**								
				Income tax increase			Energy price increase			Revolving fund			Income tax increase			Energy price increase			Revolving fund		
	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
Consumption (bn € 2000)	6070	6628	7154	n/a	-1.5	11.9	n/a	3.4	18.2	n/a	2.0	13.6	n/a	-3.7	17.7	n/a	7.0	29.9	n/a	4.5	27.6
Employment (000)	218754	226816	226894	n/a	-37	235	n/a	174	430	n/a	159	386	n/a	-69	438	n/a	303	754	n/a	279	731
Real household incomes (bn € 2000)	6934	7797	8674	n/a	-0.4	14.0	n/a	3.6	19.2	n/a	1.7	12.9	n/a	-1.3	16.7	n/a	8.4	28.7	n/a	5.3	26.0

Table 8. Summary of overall environmental impacts for EU-27

	Baseline (option B1)			**Additional effects to baseline case**																	
				Option B3									**Option B4**								
				Income tax increase			Energy price increase			Revolving fund			Income tax increase			Energy price increase			Revolving fund		
	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
CO2 emissions (m tonnes carbon)	1094	1095	1063	n/a	-16	-34	n/a	-19	-37	n/a	-20	-38	n/a	-37	-71	n/a	-43	-76	n/a	-45	-77
GHG emissions (m tonnes carbon)	1286	1285	1249	n/a	-20	-43	n/a	-23	-46	n/a	-25	-47	n/a	-43	-86	n/a	-50	-90	n/a	-52	-92
ETS Price (2008 €/t CO2)	11.1	19.9	28.7	n/a	10.3	10.4	n/a	7.9	7.7	n/a	8.1	8.0	n/a	4.7	12.0	n/a	1.4	5.2	n/a	0.8	4.9

Source(s): E3ME, Cambridge Econometric

- **Administrative burden**

Existing energy saving obligation schemes create almost no extra costs for government. They are financed by energy prices or grid charges, or - if certificate trading is part of the scheme - by a charge per certificate issued[58]. The reported administrative costs are low: about €400,000 per year in the UK[59] and €700,000 in France.[60] Total administrative costs of around 0.002 Eurocent per kWh can be assumed[61]. This negligible effect on consumer prices is affirmed by the modelling results shown in the tables above.

Schemes with tradable certificates cost more to administer. The possibility to certify and trade energy savings (so called "energy savings certificates" or "white certificates") will lead to a larger increase in administrative costs, if the trade is not performed bilaterally between two obliged parties ("over the counter") but on a fully operational market. In this case, the savings need to be clearly certified, registered with a registration and clearance body and the trading in certificates monitored to avoid double counting of energy savings. These administrative costs are – at least in the starting phase of such a certificate scheme – outbalancing the overall economic gains of trading. However, these costs can be regarded as one-off installation costs similar to the set up of the relevant bodies for the European Emissions Trading Scheme. As full tradability is rarely used in the existing saving obligation schemes across Europe, an estimate of the administrative costs is difficult to estimate. 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 €1m per year[62]. However, it is decided that at this time, under both option B3 and option B4, this would not be required by EU legislation. Harmonisation at European level of standardised values for saving calculations (option B4) would further cut administrative costs.

Harmonising key parts of the saving obligations at European level (option B4) can contribute strongly to reducing the administrative costs for the Member States in comparison to purely national design (option B3). A considerable reduction in administrative costs and administrative burden can be achieved through focussing the saving obligation scheme on standardised actions with deemed ex ante saving calculations. By putting forward default values for the most common saving activities the Commission can contribute strongly to saving administrative costs.

- **Social impact**

The social impacts of options B1 and B2 are included in the base case. Table 7 shows that for all cases the impact on consumption is forecast to be positive compared to the reference case. All options show positive employment effects and in most cases real household income tends to increase due to lower energy bills. As discussed above, the modelling uses energy prices as the trigger for an increased uptake of energy efficiency. In distributional terms, the model results show that higher energy prices would have higher impact on the more vulnerable

58 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.

59 Based on administrative cost for the Energy Efficiency Commitment schemes.

60 See Annex XIII. An average of 10-15 staff work on the administration of the existing EU energy saving obligations schemes.

61 Harmelink et al., 2005

62 JRC. Energy savings obligation and white certificate schemes. 2009

income groups more than high income groups. All the same, as discussed above, the model results cannot be regarded as valid for energy efficiency, as the energy and cost saving effects would strongly outbalance the direct income losses if indeed energy price increases were to occur. For comprehensiveness of this analysis, however, the distributional effects of the modelled price increases is shown in Annex VII.

The majority of the jobs created will be in the higher quality segment. Member States would be able to further improve the social impact by targeting the energy efficiency improvement measures to 'fuel poor' households. In the UK[63], this has proved to be highly successful. Including this as a harmonisation element in the EU requirement could however have countervailing effects, for example if the refurbishment of social housing leads to higher rental prices, crowding out low income households. It is therefore appropriate to leave the correct appreciation of this factor to national circumstances.

- **Environmental impact**

Depending on the level of ambition of the obligation, 42-90 million tonnes of carbon equivalents can be saved (see Table 8). Further environmental benefits can be expected with the mitigation of local air pollutants through decreased energy production from conventional energy sources, especially in densely populated areas.

- **Interactions with the ETS**

The modelling of the options presented does not exclude ETS installations from the saving obligation scheme. This approach was chosen to take into account the impacts of already existing obligation systems that target primary energy (e.g. Flanders, Italy) or CO_2 (UK) and which are likely to serve as models to other Member States when setting up their national saving obligation schemes.

As the savings obligations thus directly and indirectly generate additional CO_2 savings, this has a direct repercussion on the ETS. In terms of the overall climate policy aim, the saving obligation scheme can strongly contribute to reaching the GHG emission targets, in particular in non-ETS sectors. However, there will also be savings in the ETS sectors and, according to the E3ME model, this also lowers ETS carbon prices. The extent of price decreases depends on the level of ambition chosen and the precise market condition (full or only partial rollover of the saving obligation costs to the consumer as depicted in table 7). In this respect, industries covered in ETS will face two cost components. The costs for emission certificates will fall on the one side. On the other side, they face additional costs for meeting the savings obligations, in case these costs cannot be rolled over to the consumers. The net additional burden depends very much on the detailed interaction which will vary from Member State to Member State. However, as the saving obligation scheme implements energy saving options also at these installations, it can be estimated that the total cost for industry will diminish, leading an increased competitiveness in global markets.

Comparing the options on energy savings obligation

[63] The UK's Energy Efficiency Commitment (EEC) schemes stipulated that at least 50% of the energy savings had to be targeted at customers that receive income/related benefits or tax credits. The present Carbon Emission Reduction Target (CERT) scheme has reduced this share to 40%. Bertoldi et al. (2010).

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

Evaluation criteria / Policy options	Subsidiarity/ proportionality	Effectiveness	Efficiency	Coherence	OVERALL
Option B1: Retain the current approach	R	=	=	=	**=**
Option B2: Repeal the current ESD provisions without replacement	R	=	=	C	**=**
Option B3: Require all Member States to introduce energy saving obligations while leaving their design for determination by Member States	R	++	++	C	**++**
Option B4: As B3 but with harmonisation of key design features (targeted sectors, level of ambition and counting methods)	R	+++	+++	C	**+++**

According to the mid-term analysis, **option B1** has limited effectiveness. An overall assessment of efficiency is difficult as the national implementation of Art. 6 of the ESD is too diverse to allow for precise evaluation. However, it can be estimated that with the market for energy services remaining well below its potential, a large numbers of barriers exist which hinder the effective uptake of savings. Due to the mainly passive approach, there are no coherence problems with other EU policy areas. However, the potential for mutually reinforcing policies can be expected to stay well below the possible potential. As **option B2** would in practice not deviate from option B1, the evaluation is the same.

Introducing saving obligations (**options B3 and B4**) will be highly effective in the sense that a clear amount of energy will be saved through energy efficiency measures. This adds reliability to energy efficiency policy. The higher level of ambition (B4, 1.5% annual savings) shows a stronger effectiveness than the lower level of ambition (B3) without negative economic, social or environmental impacts.

The efficiency of option B4 will be higher than B3 if harmonisation is used to reduce the administrative costs of the Member States[64]. Tradable quotas ("white certificates") have the potential to enhance cost effectiveness, but this needs to be balanced against the administrative costs of trading (installation of registers, certification bodies etc.) These costs depend on the national situation. Cases like Italy have shown however, that cost-effective trading systems can be put in place.

In general terms, the instrument is coherent with the overall aims of the Europe 2020 strategy (notably sustainability, employment and social inclusion), supports consumer policies, safeguards competitiveness and contributes to overall climate and environmental objectives.

The **public consultation** focused on the plausibility of the introduction of an <u>EU wide</u> trading scheme for energy efficiency improvements (i.e. of white certificates). There was no strong support for an EU wide scheme with 30% (60 submissions) of stakeholders positive, 32% (65 submissions) negative and 38% (78 submission) having no opinion. However, from the submissions it became clear that it was considered by many stakeholders that **individual**

64 See Annex VII for detailed discussion

national schemes could be a way forward. The proponents of national white certificate schemes believed that these schemes should be market driven and carefully designed in order not to overlap with other schemes and create further administrative burdens for MS.

Based on the analysis and taking into account the various views of the stakeholders, it is proposed that option B4 is retained.

5.4.2. Further measures to realise potential at the end-use stage

The analysis in this section addresses measures that aim to increase the role of the **public sector**, ensure that information on savings is provided for **consumers** and for **industry** and support the development of **energy service companies.** Their impacts are discussed in separate sub-sections. The assessment is mainly qualitative because of the difficulty of modelling these options. The final comparison based on the evaluation criteria is done for all the options together to allow for comparison of their impacts.

Retain the current approach - Option C1

Under this option the policies currently in place on the role of public sector (the ESD, and the green public procurement initiative[65]), metering and billing (the ESD and the internal electricity and gas market Directives[66]), energy audits (the ESD) and ESCOs (the ESD) would be retained and would be expected to continue to have limited impact, for the reasons explained in section 2.2 and in the mid-term analysis of the ESD[67]. These measures are taken into account in the baseline (PRIMES 2009 energy efficiency scenario).

Options related to the role of public spending in promoting energy efficiency (C2 to C4)

It makes sense under option C2 to focus on the refurbishment of public buildings, which represent a small but still considerable part (i.e. 12%) of the total building stock, because 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 data on energy consumption for other purposes (e.g. for equipment, public transport, heating of buildings).

Options C2a and C2b envisage that a target for each MS is established. As regards the scope of the target, it is suggested that it cover all buildings that are owned by the public sector, excluding social housing. The latter exclusion is because of the different ownership structure of social housing. In many countries a target could lead to significant a burden on social housing associations which do not have direct links with 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 business-as-usual because of the impact of the current policy mix (mainly the recast EPBD and national support schemes)[68].

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65 http://ec.europa.eu/environment/gpp/index_en.htm
66 Directives 2009/72/EC and 2009/73/EC
67 See Annex III
68 Ibid 70

Currently, the general refurbishment cycles are of 30-40 years but those which lead to energy efficiency improvements are at longer intervals (60-80 years). This signifies that approximately 3% of the building stock is renovated per year but in only half of the cases are energy efficiency improvements included (1.5% energy related renovation rate). Energy efficiency improvements are in most cases cost-effective when they are combined with ongoing maintenance and refurbishment work. Therefore, an upper limit of 3% can be identified for the cost-effective rate of energy-efficient renovation. This means that if all refurbishments are combined with a comprehensive package of measures to improve energy performance (which is presently not the case) the energy-related renovation rate would also be 3%.

To go beyond the 3% rate would force investors to carry out energy-related improvements to their buildings outside the refurbishment cycle, preventing the synergies obtainable from coupled renovation and thus leading to significantly lower cost effectiveness[69]. Furthermore, the construction sector would find it difficult to meet the increased demand and suboptimal renovations could be expected. Going below the 3%, by contrast, would not be ambitious enough to put on show the leading role of the public sector.

Energy-related retrofit rates beyond 3% are nevertheless 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.

An alternative method to achieve a significantly accelerated retrofit rate, as opposed to a target where MS have full flexibility, would be to require that certain financial and technical assistance instruments are established by MS in a form that would provide funding and technical assistance to national, regional and local public authorities to implement energy efficiency improvements of the building stock they own. This is examined as Option C2c. The establishment of such financial and technical assistance instruments could either result from a political commitment taken by all Member States or as a binding obligation resulting from EC legislation. There would be a need to achieve a maximum leverage ratio between public grants and final investment volume. These instruments would channel money from various sources to support investments in energy efficiency improvements of buildings. They can be set up at national, regional and local level and their design and objectives will vary according to the specific characteristics and needs. These instruments can provide support to preferential loans, or loans combined with performance linked grants, or guarantee/risk sharing facility.

Option C3 would entail inclusion of energy efficiency criteria in public spending. In order 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

[69] Ecofys, Cost-Effective Climate Protection in the EU Building Stock.

(e.g. Energy Labels), other major environmental impacts are also taken into account. Measures also include greater use of energy management systems by 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.

The impact of the individual options is estimated using the BEAM model of Ecofys[70] (for Options C2a and C2b). The impact of Option C2c depends on the level of ambition set by each Member State but is close to the impact of Options C2a and C2b. The impact of Option C3 was considered on an aggregate level and not as a sum of individual measures; the PROST study was used as a reference source for calculations[71]. Due to its voluntary character only qualification of the impact of Option 4 was possible. The E3ME modelling could not provide results for these options, as their impact was too small to affect model outputs. Details on the model/studies used and the assumptions made are in Annex VIII. Only the direct impacts of the options are estimated. However, all the options could be expected to lead to economies of scale and to develop the market for energy efficient products, buildings and services. This would lead to further energy savings.

Impact on energy consumption Based on the considerations above, the impact of the proposed options on energy consumption is presented in the table below.

Table 9. Impact on energy consumption[72]

	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 C2c (financial and technical assistance instruments)	4.0	7.5
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 on energy savings of Option C3 is the highest. The range presented depicts the range of possible measures to be covered and the different levels of ambition of the highest performance classes of labels and certificates. The potential is estimated to be 5% to 10% reduction in 2020 compared to the baseline (PRIMES 2009 EE scenario). Much of the savings will come from energy efficiency improvements in buildings.

The requirement that ambitious renovation levels are achieved upon renovation (Option C2b) would lead to higher savings than if only cost-optimal levels are required (C2a) and would limit the possibility of a 'lock-in' effect. This refers to the fact that, if sub-optimal renovation is been undertaken, subsequent, more comprehensive measures become less cost effective until the next major renovation (in 30-40 years). Regarding Option C2c it is assumed that if sufficient funding is provided this would encourage the public bodies to implement

70 Ecorys, Ecofys and BioIntelligence (2010): Study to Support the Impact Assessment for the EU Energy Saving Action Plan.
71 PROST SAVE supported study. 2003. Harnessing the Power of the Public Purse. Final report.
72 Based on Ibid 70, 71, see Annex VIII for more details

renovation projects and thus increase the energy related renovation rate to the optimal levels (as demonstrated above this would be approximately a 3% annual renovation rate). These renovations would be carried out to at least cost-optimal levels (as this is required by Directive 2010/31/EU) and for some countries to nearly zero energy levels. Therefore, it is considered that the impact of this option is the average of the impact of C2a and C2b.

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

- **Economic impact**

Energy efficiency improvements (e.g. adding of insulation during façade renovation) only account for part of the investment needed when renovation is carried out (alongside painting, scaffolding, renewal of roof tiles, renewal of bathrooms etc.). Energy related investments are usually 1.5 times lower than total investment needs. That is why energy efficiency measures should be carried out when general renovation is done.

Costs estimates for both types of investment are presented in the table below for Options C2a and C2b. Even the total investment needs are still a small fraction (0.03% for Option C2a and 0.01% for option C2b) of current EU GDP. The expected annual energy cost savings by 2020 exceed the total energy related investments for Option C2a, but are about 2.7 times lower for Option C2b (but would be equal for Option C2b over the whole lifetime of the measures).

Table 10. Investment needs and energy cost savings[73]

	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 (bn €)	4.32	1.92	8.16	3.72

With a requirement for very high performance (Option C2b), CO_2 savings would be one-third higher than with the current cost-optimal level (Option C2a), while investments would be 50% higher. The step from cost-optimum to nearly zero would therefore come with a higher lifecycle cost. However, it can be assumed that the cost optimum and nearly zero energy levels will converge up to 2020, due to better market penetration, higher energy prices, etc.

The financial requirements for Option C2c are estimated to be in the range of €2 to 4 bn per year which would cover the average annual total investment needs for the period 2010-2020. The funding could come from any source determined by the MS, such as Cohesion policy funds, national/regional/local sources, obligations related to energy savings obligations, revenues from trading with GHG emission reductions (e.g. the new PoAs under the Kyoto

[73] Based on Ibid 70, see Annex VIII for more details

Protocol[74]) and others. The burden on state budgets can be much lower than the total cost estimates because if properly designed the instruments can leverage private interments.

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 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. Conditionality on public spending would lead to higher investment needs, but would decrease overall costs for public organisations[75]. This is because the higher purchase prices of efficient goods and buildings are compensated by lower operating costs. Studies[76] show that the cost reduction is on average around 1% and CO_2 emissions are on average decreased by 25% when using green public procurement.

Energy performance contracting is also an important tool that could decrease the burden on public authorities. Under this performance-based form of purchasing, monetary savings from lower utility bills and maintenance costs that result from energy efficiency measures are used to cover part or all of the measures' investment costs. This model has been tried and proved cost-effective in a number of Member States[77]. Energy performance contracting is relevant for triggering renovation in public buildings and for upgrading the energy efficiency level of public infrastructure such as street lighting[78]. It is necessary for its uptake to be encouraged because in many Member States it is hampered by ambiguities in the legal framework and the lack of reliable energy consumption data to establish the baselines against which performance is measured[79].

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

- **Administrative costs**

The administrative costs – as opposed to the investment costs - of all options are not considered significant. Among the options analyzed, Option C2c would entail the highest administrative costs for the setting up of the financial and technical assistance instruments and for managing their operation. This cost would vary considerably in each MS depending on experience so far and the structure of the instruments chosen. Options C2a and C2b would require that MS collect data on publicly owned buildings and monitor the progress of their refurbishment. Such data are readily available to the public administration and will not be a burden for them to collect and monitor. MS will have to report their progress once a year to the Commission which can be as part of their NRP thus not adding an additional burden. Option C3 uses current labelling schemes and thus neither public authorities nor bidding companies would need to carry out additional calculations. The monitoring that the

[74] From 2007 new Programmes of Activities (PoAs) can be registered as CDM or JI projects. A PoA is a programme that can comprise multiple and combined emission reduction activities or projects. By aggregating the combined emission reductions of the different participants in the programme, it gives small and dispersed activities and projects that would be too small for the traditional stand-alone approach a chance to participate and profit from Certified Emission Reduction or Emission Reduction Unit revenues.

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

[76] Ibid 75

[77] Including Denmark, France and Germany

[78] In 2005, street lighting consumed 36 TWh of electricity. See http://ec.europa.eu/governance/impact/ia_carried_out/docs/ia_2009/sec_2009_0324_en.pdf

[79] COM(2011) 109 final

requirements are followed in the public tenders will be carried out by the market players themselves. Option C4 is voluntary in nature and would not lead to significant administrative burden.

- **Social impact**

Increased activity 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. The impact of Option C2c would be in the range of those of Options C2a and C2b. For Option C3 the employment impacts would be higher but of the same order of magnitude, because the main driver for more jobs would be measures applied for increased energy performance of public buildings. The impact of option C4 on employment would be insignificant.

Table 11. Job creation[80]

	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

Because of the need for dramatic reductions of emissions from the buildings sector if the 2050 greenhouse gas objective is to be met, and the consequent need for sustained high renovation rates, it can be expected that the employment impacts will be sustained over the long term.

Option C3 would also have a positive impact for people living in publicly owned social housing, because new investments would mean lower energy costs in the long run.

- **Environmental impact**

The CO_2 emission reductions forecast in 2020 are presented in the table below[81]. Like the impacts on energy consumption, the highest reductions will come from option C3, followed by C2(b, c and a), while the lowest would be C4.

Table 12. Impact on CO_2 emission reductions in 2020 (Mt)[82]

	CO_2 emission reductions in 2020 (Mt)
Option C2a (cost-optimal levels)	9.2
Option C2b (nearly zero energy levels)	20.0
Option C2c (financial and technical assistance instruments)	14.7
Option C3 (EE criteria in public spending)	12.8-25.7
Option C4 (voluntary provisions)	Higher than BAU but smaller than C2a

Options related to metering and billing (Options C5 and C6)

Metering and billing can enable 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

80 Based on Ibid 70, 71, see Annex VIII for more details
81 The conversion factor used for the residential and commercial sector is 1.35 Mt per 1 Mtoe
82 Based on Ibid 70, 71, see Annex VIII for more details

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[83].

The impact of the options is based on analysis of a number of literature sources.

- **Impact on energy consumption**

The measures in options C5 and C6 are expected to generate significant energy savings in generation, in transmission/distribution and in end-use consumption. The majority of the savings can be expected in end-use consumption of electricity, gas and centralised heat. However, the options will also enable savings in generation due to shifting peak demand to the base loads where more energy-efficient generation capacity can be used[84]. The peak shaving and better grid management enabled by bi-directional meters and better response from consumers will allow the reduction of distribution and transmission losses[85].

Summary of the estimated impacts on energy savings of options C5/C6

	Option C5			Option C6		
	Total	*Electricity and gas*	*Heat*	Total	*Electricity and gas*	*Heat*
Primary energy savings in generation (Mtoe)	1.5	0.5	1	0	0	0
Primary energy savings in transmission/distribution (Mtoe)	1-1.5	0.5-1	0.5	0	0	0
Primary energy savings in end-use consumption (Mtoe)	78-89	69	9-20	8-9	7	1 – 2
TOTAL (rounded)	**80-92**	**70**	**10-20**	**8-9**	**7**	**1 – 2**

Studies show that at EU level, improved **metering and billing of centralised heat** could lead to up to ca. **9-20 Mtoe** of primary energy savings[86]. Advanced electricity and/or gas meters could lead to a reduction of energy use of up to 10%[87], which would translate into ca. **69 Mtoe.** Some pilot projects suggest that the number could be even higher[88]. Further, in-home displays (IHD) have been reported (Darby 2010) to result in 5-15% final energy savings in pilot experiments. IHDs provide direct feedback to customers, who can directly observe the consequences of their behaviour. However, trials with smart meters equipped with in-home

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

84 E.g. combined heat and power with overall efficiency over 80-90% rather than simple open gas turbines with efficiency ca. 35%

85 In the USA it has been estimated that this could reach 1-2% (M.Jung, P.Yeung, Connecting Smart Grid and Climate Change, Silver Springs Networks http://www.silverspringnet.com/pdfs/SSN_WP_ConnectingSmartGrid-1109.pdf)

86 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)

87 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

88 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.

displays in the Netherlands show that consumers who returned their in-home displays after a few months tended to return to their original consumption levels[89]. It is therefore important that introduction of smart meters is supported by improved billing synchronised with the information provided by the meter. Experiments with monthly or bimonthly billing report savings in the range of 0-10%[90].

It is thus estimated that the introduction of stricter obligations on metering and billing would have the potential to lead to primary energy savings of the order of **80-92 Mtoe**. In the absence of widespread roll-out it is however difficult to make a firm prediction concerning the proportion of this potential that would in fact be realised. In Option C6, by contrast, the voluntary approach is likely to have a limited added value compared to the business-as-usual.

- **Economic impacts**

The roll-out of intelligent meters for electricity is already assumed by Directive 2009/72/EC. Where roll-out of smart meters is assessed positively by the Member States, at least 80 % of consumers are supposed to be equipped with intelligent metering systems by 2020, possibly reaching 100% in 2022. The roll-out of gas meters is assumed by Directive 2009/73/EC, according to which MS must ensure the implementation of intelligent metering systems that assist the active participation of consumers in the gas supply market. However, the time horizon for the roll-out of intelligent meters for natural gas has not been set by the EU legislation. As regards improved metering of individual consumption of heat and hot water, so far there has been no EU legislation that would set a time horizon.

In general, according to the existing EU legislation, the tempo of deployment of intelligent meters is up to MS. In principle, accelerated deployment of meters over a short period of time would increase the need for skilled installers and lead to a general increase of costs related to training installers. However, experience of some MS shows that deployment can be done in a short period of time if combined with a requirement for frequent billing for actual energy consumption[91]. The optimal speed of the roll-out will depend on the specific situation of a given MS (e.g. capability of energy companies to put in place upfront investments in the smart metering system). However, it is important that the critical conditions for empowering consumers to rationalise energy consumption using advanced metering and billing are introduced as soon as possible in order to ensure that the roll-out of intelligent meters does not lead to stranded investments.

As regards the requirement for frequent individual billing based on actual consumption, this needs replacement of individual meters. In a short term, the purpose of collecting accurate data on individual consumption could be solved through self-reading, provided that the meter is equipped with a suitable display.

In many countries, the individual consumption of centralised heat in multi-apartment buildings is often not accurately measured at all. Instead forecasts often with flat rates per m^2 of heated space are used. In such cases, setting early deadlines for the introduction of frequent

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89 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

90 Darby S, 2010, Literature review for the Energy Demand Research Project Environmental Change Institute, University of Oxford

91 E.g. in Sweden almost all meters have been replaced within 2 years when the requirement for monthly billing based on actual consumption was introduced

billing based on actual consumption will require quick deployment of individual heat meters and electronic heat cost allocators. Since local district heating companies have limited own resources for new investments and local residents may not always be financially capable of paying for such upfront investments, such a roll-out may require additional public support. In such a case, it would be reasonable that the deadline for the introduction of frequent (e.g. monthly) billing of individual consumption of centralised heat is 2-3 years longer than in case of billing of individual consumption of electricity or natural gas.

Under Option C5, ensuring that the new advanced **electricity/gas** meter is bi-directional electricity/gas rather than one-way black-box type (as the current legal provisions could be interpreted) 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 in an 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. Electronic **heat** allocators cost €10-25 for each radiator. More expensive models allow more accurate readings. The cost for heat allocators with evaporation agent is lower. Most accurate are individual heat meters (€120-300) with more expensive models ready for remote reading.

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

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

Direct financial benefits to consumers would come from a reduction in overall energy consumption.[92] The scale of saving would depend on the share of final energy consumption compared to fixed components of the energy bill. Other benefits would come from avoided costs of home visits for manual meter reading[93] and reduced costs related to handling complaints and requests from customers for the clarification of billing[94]. 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 photovoltaic power, etc).

Suppliers would benefit from lower costs for remote switching and disconnection, debt management, and theft of energy and it is also likely that they would sell new energy products and services as a result of smart meters [95]. Furthermore, the introduction of metering would result in cost savings due to reduced losses in transmission and distribution[96]. Electricity generators would benefit from reduced demand for peak generation. As a simple example,

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

93 Ibid 92. In the UK, it was assumed that on average reducing home visits would bring GBP 6 of saving annually per meter.

94 Ibid 92. In the UK annual savings due to reduced need for call centres were estimated to be ca. GBP 3 per meter.

95 Ibid 92. The benefit to suppliers in the UK was estimated to be ca. £100 million annually

96 Ibid 92. In the UK, this has been calculated as £0,5 per electricity meter and £0,1 per gas meter.

assuming that 7 GW working 9 peak hours per year at $10 000/MWh are replaced by power at $1 000/MWh, the annual savings for the system are €410 million[97].

Due to expected lower uptake of advanced meters and improved billing, the economic benefits of the measures in option C6 would be lower than in the case of option C5.

- **Administrative burden**

In general, introduction of advanced metering and improved billing of individual energy consumption will significantly reduce administrative burdens (substantial decrease of complaints related to inaccurate metering and billing, significant decrease of costs of billing due to electronic remote recording of consumption, decrease of postage costs due to introduction of electronic billing, etc). Also the administrative burden will be reduced for the public institutions dealing with complaints from citizens (national courts, ombudsman offices, consumers associations, European Commission, etc).

- **Environmental impact**

Reduction of final consumption of electricity/gas by 10% and heat by 20% would result in a significant reduction of emissions of greenhouses gases. Additional environmental benefits would come from enabling peak shaving in generation of 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 reduce the chemical waste and environmental pollution from the production of chemical agents used in such devices[98]. Increased frequency of billing would have no major environmental impact as the probably-resulting wider introduction of electronic billing of energy consumption would result in lower use of paper (for printing and posting the billing).

- **Social impacts**

A key social impact of improved metering and billing is that individual consumers will be effectively empowered to control their own energy consumption. Greater consumer awareness of the links between their behaviour, their energy consumption and the amount they pay will eventually strengthen consumers' position vis a vis energy suppliers.

The roll-out of advanced meters is already required by Directive 2009/72/EC and therefore installing better advanced meters would not lead to additional job effects. It can also be assumed that due to improved clarity of billing, the number of people employed by suppliers in call centres dealing with requests for information and complaints would be reduced. However, the need for telephone helplines to assist in the introduction of smart meters and the activation of services related to energy advice to consumers would probably compensate the reduction of employment in call centres dealing with complaints.

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97 Empowering electricity customers: Customers choice and demand response in competitive markets, IEA report (draft), 2011. Generation costs of an OCGT operating for only 9 hours per year, corresponding to a 0.1% capacity factor, is approximately $/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 $/MWh 1 000 and 10 000, the prospects for savings and making the electricity system more robust would improve considerably.

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

As regards metering and billing of centralised heating, it is estimated that 800 to 2600 people might be needed to read HCAs for every million flats. Billing service companies deal with this seasonal peak by employing temporary personnel and cooperating with external companies.[99]

Other impacts on consumers

Access to heat metering and controls and consumption-based billing is important for poorer consumers, since it gives them the opportunity to control the amount of money they spend for heating. Another important social impact is related to reduced intrusiveness of metering and billing. In particular metering of heat consumption can be troublesome as it requires readers to enter apartments and visit all rooms with radiators. From this point of view, advanced remote reading meters for heat consumption would pose no problems. The impact of introducing consumer-friendly metering will be positive as regards improving thermal comfort in housing.

Options related to energy audits and management in industry

Possibilities to save energy are difficult to assess for energy users. Assessment often requires specialized expertise. **Energy audits** provide an evaluation in the form of a study that identifies cost-effective saving potentials and measures to realise them. Audits raise awareness of savings potential and reduce the information gap that is one of the barriers to efficiency. Access to energy audits is thus the basis for realising cost-effective energy saving potentials. Audits are also the basis for the development of a market for energy services. Audits show saving possibilities without the proposed saving measures automatically being executed. **Energy management systems** (EMS) incorporate regular energy audits, the preparation and implementation of action plans and monitoring of impacts.

The impacts of options C7 and C8 were modelled using the E3ME model. It was assumed that energy audits were combined with energy management systems.

- **Impact on energy consumption**

Option C7 would introduce a policy driver for companies larger then SMEs, in the industrial and services sectors to use audits and energy management. Option C8 would be voluntary in nature.

Experience shows that all sizes of organisation require some form of focussed professional support with energy efficiency. Energy Audits programmes implemented in European countries [100] have shown that energy audits result in important energy saving possibilities being identified even in the energy intensive businesses which have the most experience and knowledge about energy. This particularly the case for businesses where energy is not a cost driver and energy efficiency is not considered core business.

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[99] Heat Metering and Billing, Technical Options, Policies and Regulations, World Bank, 2002 (www.worldbank.org.cn/english/content/heat.pdf)

[100] Energy audit program implemented under an EBRD performed industrial energy audits in, inter alia, Bulgaria, Romania. Audits resulted in financially viable measures, such the utilization of surplus heat from a nearby factory; switching from heavy fuel oil to natural gas, installation of cogeneration facility, utilization of geothermal energy, heat recovery from fluid gases and other measures. Audits identified energy efficiency improvement possibilities at such energy savvy companies as Stora Enso, a leading paper and pulp company in Sweden.

Audits generally identify the main uses of energy. It reviews energy bills and supply arrangements. It assesses the adequacy of monitoring and measurement of energy consumption and the supply of energy, including their accuracy. It includes an energy balance of the relevant aspects of the company's operations. It evaluates the extent to which the implementation of new energy sources (such as on-site co-generation) is appropriate. It also assesses performance in relation to current best practice in comparable businesses, followed by specific recommendations, where necessary, on how best practice can be achieved. Energy audits are a first step toward a sound energy management system and ensure that energy awareness occupies a prominent position among company managements and employees. If implemented properly, the returns from energy efficiency audits can be very high.

57% of the final energy consumption of the industrial sector will be attributable to energy-intensive industry in 2020, while the share of medium energy users will be 34%; SMEs will consume only 9% of the total. It is assumed that 95%, 90% and 80% of energy-intensive, medium energy user and SME companies, respectively, are suitable for applying energy audits. The scope for new savings from energy audits is further reduced by already implemented audits due to national policies that make audits a requirement as part of Voluntary Agreements, benchmarking and subsidy schemes.[101]

Given the deployment of audits or EMS and given amounts of saving potentials, the crucial factor for realizing savings is the follow-up of the audit, whether stand alone or part of EMS. Here it is assumed that there is either no supporting policy at all (min-case, 10-20% follow-up) or full support (max case, 80-90% follow-up). In the minimum case the audit has shown the possibilities for savings but all other factors and barriers, such as lack of capital or perceived risks, remain present. Therefore, it is assumed that only a small fraction of the audit suggestions is followed up. In case of support for the follow-up actions many more suggestions from the audit are assumed to be followed (as reported in the monitoring of the Finnish audit schemes, where subsidy is given for follow-up investments). For EMS the follow-up rate of the audit is assumed to be somewhat higher than for audits alone due to its structural character and organizational embedding.

Resulting savings

Under the assumptions set out above, extra savings in the range between about 0.4% and 5.0% of total industrial energy consumption are realised in 2020. The minimum and maximum turn out to be almost the same for both audits and EMS. The maximum applies in cases with a low present level of audits and full support for implementation of audit proposals. The minimum describes a situation with many audits already being done due to current policy and no support for implementation. A more balanced set of assumptions would result in about 3% savings in 2020; in the longer run the figures would be 50% higher. As shown in the tables below, option C7 would lead to from 8.8 to 19.4 Mtoe (if EMS is

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[101] Many companies have already done audits due to policies such as Voluntary Agreements, benchmarking and subsidy schemes. An audit is mandatory for enterprises with bills (UK) or use above a threshold (Bulgaria, Czech Republic), or for candidates applying for financing schemes (Austria, Germany, Czech Republic). In Finland and the Netherlands energy audits are part of VA. In the Swedish PFE program for electricity savings all industrial companies must have a certified EMS in 2 years after joining the program [Programme for improving energy efficiency in industry (PFE), SEA, 2007] It is assumed that they do not have to do an audit again or, if they have to do it anyway, it will not provide new information leading to extra saving measures. The fraction with already executed audits is uncertain but highly important, therefore it is varied. E-intensive companies will have the largest fraction (40-70%) and SME the smallest (10-20%).

implemented) final energy use reduction or 13.2 to 29.1 Mtoe primary energy reduction compared to BAU while Option C8 would have a lower impact on energy consumption.

Table 13. Energy savings of Option C7

Final energy consumption by categories of industry (ktoe)*	2015		2020		2025		2030	
E-intensive	185237		186414		184557		183575	
Medium	106589		110625		113832		116458	
SME	29812		31136		32253		33207	
Total	321638		328175		330641		333239	
Potential scope audits/EMS (ktoe)	2015		2020		2025		2030	
Audits**	max	min	max	min	max	min	max	min
E-intensive	175976	52793	177094	53128	175329	52599	174396	52319
Medium	95930	57558	99563	59738	102449	61469	104812	62887
SME	23850	19080	24909	19927	25802	20642	26566	21252
Total	295755	129430	301565	132793	303580	134710	305773	136458
Fraction total energy	92%	44%	92%	44%	92%	44%	92%	45%
EMS (incl. audits)***	max	min	max	min	max	min	max	min
E-intensive	185237	55571	186414	55924	184557	55367	183575	55072
Medium	53294	31977	55313	33188	56916	34150	58229	34937
SME	0	0	0	0	0	0	0	0
Total	238532	87548	241727	89112	241473	89517	241803	90010
Fraction total energy	74%	37%	74%	37%	73%	37%	73%	37%

Notes:
*For 2020, E-intensive industry is 57%, Medium industry is 34% and SME is 9%. (Based on Primes EE)
**Eligible fraction audits: E-intensive industry 0.95, Medium 0.9, SMEs 0.8. E-intensive industry Already audited 70%, Medium VA, BM, ETS, subsidy schemes, etc. 40%, SMEs VA, subsidy schemes, etc. 20%; E-intensive industry Minimum case 40%, Medium VA, BM, ETS, subsidy schemes, etc. 20%, SMEs VA, subsidy schemes, etc. 10%.
***Eligible fraction EMS: E-intensive industry 1.0, Medium 0.5, SMEs 0.0; E-intensive industry Already audited 70%, Medium VA, BM, ETS, subsidy schemes, etc. 40%, SMEs VA, subsidy schemes, etc. 20%; E-intensive industry Minimum case 40%, Medium VA, BM, ETS, subsidy schemes, etc. 20%, SMEs VA, subsidy schemes, etc. 10%.**

Source: E3ME, Cambridge Econometrics.

Table 14. Energy savings of Option C7

Savings mandatory audits/EMS for given follow-up (ktoe)	2015	2020	2025	2030
Audits (incl. part good housekeeping)*				
E-intensive	2534	3825	5049	6278
Medium	3108	5018	7008	9056
SME	1272	1860	2477	2550
Total	6914	10703	14534	17884
Fraction total energy use	2.1%	3.26%	4.4%	5.4%
EMS (incl. good housekeeping)**				
E-intensive	3834	5201	6478	7765
Medium	2398	3485	4610	5765
Total	6233	8686	11088	13530
Fraction total energy use	1.9%	2.65%	3.4%	4.1%

Note: *Audits follow-up E-intensive 80%, Medium 80%, SMEs 80%; % (No support: E-intensive 10%, Medium 10%, SMEs 10%).**EMS follow-up E-intensive 90%, Medium 90%, SMEs 90% (No support: E-intensive 20%, Medium 20%, SMEs 20%);

Source: E3ME, Cambridge Econometrics.

- **Economic impact**

The cost of audits depends on the scale of energy use and the type of audits. The audits generally consist of an on-site visit by an energy auditor and the writing of a report identifying where energy can be saved. This type can be implemented regularly (survey and analysis) and as part of EMS.

For a mid-sized company (260 employees, annual turnover of 50 million EUR), e.g. a meat factory or a tool maker, this would mean a 4 days visit costing 500 EUR/day and preparing a report for an additional 2000 EUR for a total cost of 4000 EUR. An average company spends around 2-4% of its turnover on energy. A typical audit results in saving 20% of the energy bill. 10% of this savings can be achieved with good housekeeping without any real investment (changing lighting or behaviour), while 10% can be realised with an investment of 2-3 year pay-back time. If the company invests in energy efficiency measures with 5 year pay-back time, the saving achievable is generally 30%. As a result of this, a company that spends 2 million EUR on its energy bill could save 400000 EUR on energy bills for a cost of 4000 EUR for energy audit. The energy saving achieves an additional 10% in profits (sales would normally need to increase by around 40% to achieve this).This demonstrates that energy audits not only pay for themselves, but produce profits.

If the audits are of such quality that investment decisions can be based on them, the cost will be much larger for large complex projects (e.g. a chemical plant) then for a SME with a set of standard saving options (ventilation, compressed air, etc.). For investment grade audits the costs can run into hundreds of thousands of euro but the potential savings are also large. Therefore the costs should be related to total investments or total savings. Audit costs will increase in absolute terms with the scale of energy use in question, but will decrease in terms of cost per saved unit.

The costs of acting on the information can vary a great deal depending on the changes in behaviour which arise. These can vary from fairly costless actions, e.g. turning lights off, to expensive actions such as investment in buildings. Here we make the assumption that in the case of saving options that are not profitable enough to be done automatically, financial support is available. Therefore, the pay-back time is always acceptable and the extra costs of follow-up measures are zero.

The total costs for society for medium sized industry could be rather low (for example about 0.2 Euro/GJ (yearly saved) in case of the Finnish audit system)[102]. With usual gas prices a GJ saved delivers 5 Euro and the audit costs decrease the profits by about 4%. In energy intensive industries, the audit costs per GJ saved can be assumed to be a factor of 10 lower than for medium-sized companies. For a company using 20PJ this results, using the same reasoning, in audit costs of 60000 Euro. In this sector cost however will be very specific and project based.

A best practice case from a large scale energy efficiency programme in Sweden indicates savings achieved per EUR in the range of 86-195 kWh/EUR in industrial companies and 8-15 kWh/EUR for service sector companies.[103].

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[102] Based on results of the Finnish audit system evaluation (2006).

[103] P. Thollander, P. Rohdin Cost-Effectiveness of Energy Programs involving Energy Audits – Results from Sweden, IEPEC 2010, Paris

Regular energy audits can point to larger saving measures that need specific technical solutions and specific investment (process improvements, replacement of energy systems. The cots of these project specific audits are often defined as percentage (around 1-1.5%) of the total project cost[104]. This type of audits (investment grade audit) would be freely implemented based on the decision by the management, in line of the business strategy of the company.

Given the high audit costs for SME and there is a need for financial support in this sector, the option of mandatory audit for SME was not retained.

- **Administrative cost**

They would be the same in both C7 and C8 for companies implementing the measure. Companies already implementing the European Energy Management standard (EN 16001) would not incur additional administrative cost. Companies implementing other European or international standards on Environmental Management (ISO 14001), Quality Management (ISO 9001) or other systems would have a small adaption cost. There would be some additional costs for those companies that at present do not have a comparable system in place. The size of this human resource would depend on the size and complexity of the company. It can range from a part time post to several persons. The implementation of the measures recommended by audits would require investment, the scale of which would again depend on the size and complexity of the organisation’s systems. Since the aim of energy audit and management systems is to identify *cost-effective* saving measures, the administrative cost would be expected to be covered by the benefits from the energy savings.

- **Environmental and social impact**

The reductions in energy consumption achieved with option C7 are estimated to translate into 32-58 Mt of CO_2 emission reductions. Under option C8, only a fraction of this would be realised. It can be expected that Option C7 would have a positive, but small, impact on employment.

Options related to support for the ESCO market

Recent studies[105] suggest that even in well established ESCO markets, transaction costs are too high for potential customers to easily assess the available service offer[106]. A governmental body could act as market facilitator, increasing market transparency by listing available energy service offers, displaying quality labels, performing quality checks and providing model contracts and advice.

The analysis is based on a number of literature sources.

- **Economic impact, impact on energy consumption**

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[104] An example is a 765,000 EUR investment project with an audit could cost of 9,562 EUR (meat processing factory). The annual energy saving identified was 207,000 EUR resulting in a pay-back time of 3.7 year.

[105] JRC (2010), Prognos (2010), European Parliament's report "EU Energy Efficiency Policy – Achievements and Outlook, IP/A/ITRE/ST/2010-02 & 03, December 2010

[106] IEE project: ChangeBest, Fresh, ClearSupport

Feedback from the mid-term evaluation questionnaires[107], the summary documents for the Bucharest Forum's working group on the role of energy companies[108], projects on the markets for energy services undertaken in the framework of the Intelligent Energy Europe Programme[109] and relevant workshops[110] conclude that the high transaction costs of implementing energy services need to be lowered. Option C9 can cut transaction costs through government action to increase market transparency, increase credibility through quality checks and address legal barriers.

The full economic potential of the energy services market by 2020 is estimated at €25 billion [111]. Lowering transaction costs would increase the proportion of this potential that is reaped. It would give householders and firms the confidence to undertake investments with longer payback times. For the purposes of analysis it is assumed that the payback times judged acceptable would increase, under option C9, by two years. According to preliminary findings of the ChangeBest project[112], the potential yearly energy service volume in EU households could represent 194 M€/year when implementing contracts of 3 year payback times. With 8 year contracts, the market could increase to 1600 M€ per year. It follows that a two year increase in payback times would increase investment in energy efficiency by 500-600 M€ per year in the household sector. A similar calculation for the tertiary sector gives an increase in investment of 150-200 M€ per year.

Option C10 could be expected to have a significantly lower impact, because it does not address the main cause of low take-up of energy services: high transaction costs.

Both options can be expected to have a positive effect on SMEs. This effect under option C10 stays very general (overall demand pull for energy services, regardless who provides this). On the contrary, the visibility of often local small and medium sized energy providers will be increased. By this, they will have a level playing field and in some cases even a competitive advantage against big service providers or established utilities working on the energy services market. Currently, it is often the case that only the energy service offers from the utilities are known to the customers as these are marketed together with the electricity or gas bill. Increasing the visibility, increasing the trust in independent offers and highlighting the competitive advantages of other service providers will consequently strongly support smaller service providers. Experience gathered in Denmark, Germany and Italy, where initiatives were undertaken to increase small energy service providers' visibility support this argument.

- **Administrative costs**

For both options, additional administrative costs in comparison to the base scenario C1 will emerge. In order to turn voluntary agreements (D10) into a credible instrument, several rounds of coordination and independent monitoring needs to be foreseen. Turning to C9, the tasks attributed to the government body imply administrative burdens in terms of staff

107 See Annex XIII

108 eceee (2011) Briefing for DG Energy, EU Experience of Energy Efficiency Obligations/White Certificates & their Importance in Meeting Climate Change Challenges.

109 The IEE projects PROMETHEUS, http://www.prometheus-iee.eu; FRESH, http://www.fresh-project.eu; PERMANENT, http://www.permanent-project.eu; EESI, http://www.european-energy-service-initiative.net; CHANGEBEST, http://www.changebest.eu; MINUS 3%, http://www.minus3.org.

110 IEE contractors' meeting "Boosting the energy services market in Europe" 23 February 2011 Brussels

111 Bertoldi (2007)

112 http://www.changebest.eu

resources and additional costs. However, the additional costs can be minimised by using existing bodies to perform these tasks, for example the responsible authorities created at the demand of the present energy services Directive. The costs for creating and maintaining lists or registries of service providers can be minimised by choosing web based databases and random quality checks. In conclusion, it can be estimated that the additional administrative costs will be of a subordinate nature.

- **Social impact**

Energy services have tangible social impacts. Growing national markets will facilitate job creation. Some sources estimate that €100.000 of investment in third party finance of energy services translates into 1 man-year of employment[113]. This would imply that option C9 would create 6500-8000 jobs. As the provision of energy services demands comparatively high skills, the additional jobs are likely to be of high quality and create a demand for further training. In principle, both C9 and C10 should be able to trigger these impacts. However, as D10 will only be able to cover bigger actors, it can be estimated that its impact will be less.

- **Environmental impact**

The reduction of energy consumption has positive repercussions on CO_2 emissions. However, as with the overall energy saving impacts, no consolidated data exists. On project level, reduction achievements tend to be significant[114].

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

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

Evaluation criteria / Policy options	Subsidiarity/ proportionality	Effectiveness	Efficiency	Coherence	OVERALL
Option C1: Retain the current approach	R	=	=	=	**=**
Option C2: Energy saving measures for renovation of public buildings					
C2a Introduce 3% binding target for renovation of public buildings to cost-optimal levels	R	+	++	C	**++**
C2b Introduce 3% binding target for renovation of public buildings to nearly zero energy levels	R	++	+	C	**+**
C2c: Establish a national financing and technical assistance infrastructure for renovation of public buildings	NR	++	++	C	**++**
Option C3: Obligatory use of energy efficiency as a criterion in public procurement	R	+++	++	C	**++**

113 Vethman, Kroon (ECN) (2010), Lokaal energie- en klimaatbeleid, Aandachtspunten, valkuilen en oplossingsrichtingen uit lokale projecten in binnen- en buitenland.

114 The Berlin Energy Saving Partnership lead to a reduction of CO_2 emissions by 25% per annum (corresponding to 16200 t CO_2). eu.bac (2011) Energy Performance Contracting in the European Union

Option C4: Voluntary measures to promote energy efficiency via public procurement	R	+/=	++	C	**++**
Option C5: Enhanced obligations for smart metering and billing by energy companies	R	++	++	C	**++**
Option C6: Voluntary measures on metering and billing	R	+/=	+	C	**+**
C7. Mandatory energy audits and energy management systems for industry	R	++	++	C	**++**
C8. Voluntary systems to promote energy audits and the use of energy management systems in industry	R	+	++	C	**+**
Option C9: Obligations for promoting ESCOs	R	+++	+++	C	**+++**
Option C10: Voluntary measures to promote ESCOs	R	+	++	C	**++**

As regards consistency with the **principles of subsidiarity and proportionality,** Options C2a, C2b and C5 impose strong obligations on Member States in an area of national competence (C2a and C2b) or are strongly prescriptive (C5) and could be considered too 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. As regards Option C5, the number of complaints from citizens[115] on 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 is therefore compatible with the principle of subsidiarity, as is the less interventionist approach of in option C6.

The option on energy efficiency conditionality on the spending of public funds (Option C3) is in line with the principles of subsidiarity and proportionality, as it would counter the proliferation of national and local approaches that could present a barrier to competition.

At present, energy services markets across Europe work on the regional and local level. Concluding voluntary agreements (C10) or introducing lists of energy service providers and installing a governmental body to supervise ESCO markets at national level (C9) would therefore be consistent with the criterion of subsidiarity which asks for addressing a problem at the closest institutional level possible. Concerning option C9, in order to allow for cross border provision of energy service offers, national lists could be published on European level to be in line with the single market and allow for cross border exchanges of energy services.

Options C4, C8 and C10 are in line with the two principles as they are not prescriptive and give full flexibility to Member States.

Option C2c is considered not consistent with the two principles as it imposes direct spending requirement on national budgets. Therefore, even though beneficial in terms of its efficiency, effectiveness, and coherent with the current policy framework, the option is excluded from the preferred policy package.

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

As regards **effectiveness,** most of the options, with the notable exception of C1 (BAU), would help reach the objective of support of the development of energy efficiency markets and would emphasize the leading role of the public sector. Options C3 and C9 would have considerable direct (i.e. higher uptake of 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 than C3 and C9 and that is why its effectiveness is evaluated as medium (++). Options C5 and C7 would make important contributions to energy savings; however, as they function through provision of information and the implementation of savings possibilities is not mandatory their effectiveness is evaluated as medium (++). Because of the voluntary nature of Options C4, C8 and C10 and experience so far with current policies, it can be expected that they would lead to insignificant savings.

As regards **efficiency**, the highest scoring option is C9 as it would not require substantial investments but would lead to considerable savings. Options C2a and C3 are marked as medium efficient (++), as they would require increased purchase costs and a higher administrative burden, compensated by lower operating costs. Options C5 and C7 would impose costs on energy consumers and industries. These costs would be evenly distributed and low compared to the benefits and therefore the options are considered to have medium efficiency. C2b has low efficiency, as it is above the cost-effective level in the short and medium term. C4, C6 and C10 would not lead to significant costs or energy savings.

As regards **coherence 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 in line with the existing voluntary approach adopted in two Public Procurement Directives[116], the Commission's green public procurement initiative and the recast Energy Labelling Directive. However, there are already precedents of mandatory efficiency criteria in public procurement at EU level such as the Clean Vehicles Directive[117] and the Energy Star Agreement. Option C5 would supplement the current requirements on 'intelligent metering' in the internal energy market Directives.

The result of the **stakeholders' consultation** showed that regarding:

- **Obligations on the public sector:** there were many calls for an increased role of the public sector in awareness raising and promoting energy efficiency market development (i.e. 68% or 137 submissions were confirmative; 15% or 31 submissions were negative; and 15% or 31 submissions expressed no opinion). Some of the suggested mechanisms were increased renovation of public buildings, purchasing of efficient or green products and improved rules for public procurement. Some of the stakeholders wanted to make green public procurement mandatory but other raised concerns that when it is applied it seems to favour larger companies and not SMEs.

- **Awareness raising, metering, billing and audits:** the majority of stakeholders were in favour (70% or 141 submissions) of additional measures at the EU level for **raising awareness** particularly for consumers and SMEs while only 12% were against (24 submissions) and 19% (38 submissions) had no opinion in this regard. Concerning consumers and SMEs and their energy bills, **ICT solutions** were considered to be efficient.

[116] Directive 2004/18/EC and Directive 2004/17/EC permit certain environmental and social considerations to be taken into account in the procurement process but do not make them a mandatory element.

[117] Directive 2009/33/EC

There were suggestions that consumers should be able to access a website or digital indicator to be aware at any time of their energy consumption allowing them to take conscious decisions on energy saving. This information needed to be accompanied by advice on how to save energy. As regards **audits**, in the stakeholder consultation for the Low-carbon economy Roadmap 2050, 44% of stakeholders expressed readiness to do an energy audit for their house or company, 21% have already done this and 36% were reluctant about the idea.

- **Energy services companies (ESCOs):** there was no specific question on **ESCOs** but ESCOs were nevertheless mentioned in a number of replies as important market players. They were often mentioned as a way to encourage the uptake of energy efficiency by SMEs. It was also mentioned that EIB lending should be made available for ESCOs.

Based on the analysis and taking into account that various views of the stakeholders, it is suggested that Options C2b, C3, C5, C7 and C9 be retained.

5.4.3. Measures to realise potential at the stage of energy transformation and distribution

Option D1: Retain the current approach

As far as **CHP** is concerned, this would mean keeping the CHP Directive without remedying the shortcomings identified in section 2.2. The lack of clear policy drive and weak harmonisation would continue to lead to different levels of ambition in implementation and deployment among Member States. The CHP Directive has proved to be ineffective in stepping up the promotion of CHP and did not prevent the erosion of the existing installed base in the most vulnerable Member States. Overall, it has not provided a clear policy framework to achieve progress in realising the national potentials. Under these conditions, although according to the PRIMES model the share of CHP is expected to improve from 11% in 2010 to 19% in 2020, in reality a much lower level of improvement seems likely. As far as the **energy efficiency of energy transformation in general** is concerned, retaining the current approach is expected to mean that average efficiency would improve from 39.1% in 2010 to 41.2% in 2020[118]. Overall, energy consumption in energy transformation and distribution is expected, under this BAU scenario, to fall – at best - from 494 Mtoe in 2010 to 464 Mtoe in 2020. This improvement depends on the unlikely rate of progress in CHP use projected by PRIMES.

118 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.

Table 15. Summary of overall economic impacts for EU27 (difference from baseline); Note: the numbers are in million €

	Baseline (option D1)			Additional effects to baseline case											
				Option D3						Option D4					
				CHP Potential			25% CHP			DHC doubled			Grid rules		
	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
GDP (m € 2000)	10305	11415	12519	n/a	1161	1296	n/a	1717	2255	n/a	671	4150	n/a	940	64
Consumption (m € 2000)	6070	6628	7154	n/a	589	998	n/a	1034	1817	n/a	344	2774	n/a	428	114
Investment (m € 2000)	2285	2699	3176	n/a	50	-33	n/a	42	40	n/a	-91	94	n/a	26	-48
Exports (m € 2000)	3943	4913	6139	n/a	134	891	n/a	527	1813	n/a	370	2022	n/a	-31	-26
Imports (m € 2000)	3638	4562	5751	n/a	-388	560	n/a	-115	1414	n/a	-49	740	n/a	-517	-23
Consumer prices (2000 = 1.0)	1.24	1.42	1.6	n/a	0.0	0.0	n/a	0.0	0.0	n/a	0.00	0.0	n/a	0.0	0.0

Source: E3ME, Cambridge Econometrics.

Table 16. Summary of overall social impacts for EU-27 (difference from baseline)

	Baseline (option D1)			Additional effects to baseline case											
				Option D3						Option D4					
				CHP Potential			25% CHP			DHC doubled			Grid rules		
	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020	2010	2015	2020
Consumption (m € 2000)	6070	6628	7154	n/a	589	998	n/a	1034	1817	n/a	344	2774	n/a	428	114
Employment (000)	218754	226816	226894	n/a	2	6	n/a	4	13	n/a	9	45	n/a	0	1
Real household incomes (m € 2000)	6934569	7797120	8674601	n/a	985	1363	n/a	1622	2549	n/a	351	3150	n/a	739	118

Source: E3ME, Cambridge Econometrics.

Option D2: Repealing the current CHP Directive without replacement

- **Energy, economic, environmental and social impact**

The Commission's assessment is that the CHP Directive has had a small impact on CHP growth. It is anticipated that this would continue to be the case under option B1. The impact of removing the current provisions on CHP production and capacity would be – under an optimistic hypothesis - the continuation of the current low growth rate or – under a pessimistic hypothesis - a decrease (see Annex XIII). The E3ME model was used to assess the impact of these two scenarios. The results are shown in tables above. To summarise the pessimistic scenario: by 2020 there is a fall in CHP heat consumption of 1.3% compared to baseline. This causes a 1% fall in total energy consumption, due to price effects, and a 1% increase in CO_2 emissions, due to switching to gas. The macroeconomic impacts would be small.

Under the pessimistic scenario primary energy consumption would be expected to grow by about 35 Mtoe. There would be no significant economic and social impact.

Option D3: Mandatory CHP and district heating/cooling requirement for new electricity and high-heat-demand industry installations in authorisation, permitting and planning

Cogeneration makes it possible to reach 85-90% efficiency of energy production compared to the 35-45% average efficiency of the EU power plant and industrial boiler fleet. Under option D3, the authorisation of new generation capacities and the permitting of existing capacities would be made conditional on equipping new and existing plants with cogeneration units and connection to district heating and cooling networks – in both cases, provided the conditions were appropriate. The measure would ensure that the economic potential for high efficiency cogeneration (see Annex XIII) is realised in the EU. It would overcome the market barriers present on the energy market and not overcome by the EU Emissions Trading Scheme[119]. It would provide mechanisms to match heat demand with supply from waste heat produced in electricity generation, other industrial processes and waste incineration.

- **Energy and environmental impact**

It is estimated that this option would lead to the realisation of the untapped economic potential for high-efficiency CHP, yielding an additional 15-25 Mtoe[120] of primary energy savings per year in 2020 and 35-55 Mt of avoided CO_2 emissions.

Option D4: Mandatory connection and priority access of high efficiency cogeneration to the electricity grid

Under the CHP Directive, Member States must ensure that transmission and distribution of electricity from high-efficiency CHP is guaranteed. They may also give it priority access to the grid. In addition, they must ensure that TSOs give priority dispatch to electricity from

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[119] The lack of effectiveness of ETS in overcoming CHP barriers stems from low and volatile price signals and the complexity of CHP requiring a competitive presence on both heat and electricity markets. It has been estimated that CO_2 prices of around €74 per tonne would be needed to trigger investment in new large CHP generation. The cost of carbon would need to be even higher for small distributed CHP. An analysis of this issue is provided in Annex X.

[120] Some of this potential is already included in PRIMES 2009 energy efficiency scenario. The mid-term evaluation of the CHP Directive showed, however, that this scenario would not in reality be fully realized as regards CHP under existing policies and measures, and thus it is included in the analysis.

high-efficiency CHP. These rights are all conditional on the reliability and safety of the grid being maintained. Member States are also required to put in place transparent, objective and non-discriminatory rules for the sharing and bearing of various grid investment costs as well as to ensure that the charging of transmission and distribution fees does not discriminate against electricity from high-efficiency CHP. The evidence[121] is that even with these provisions, substantial problems remain. Network connection rules, procedures and charging cause delays and have a constraining effect on the deployment of cogeneration. These administrative procedures and charges have been identified by stakeholders and studies as hampering the growth of cogeneration. Option D4 aims to address these problems by strengthening network connection and access rules, providing for mandatory connection to the network and priority access for high-efficiency CHP.

- **Energy, economic, environmental and social impact**

The measure would remove barriers and limitations to CHP expansion. The E3ME model was used to translate this into an increase in the supply of heat from CHP. The overall increase at EU level is small, reflecting the share of the sector in the EU economy (see Annex XIII). In the light of this, it is not surprising that the expected macroeconomic impacts are too small to discern (see table 20). CO_2 emissions are expected to fall – though again, only by a small amount. The measure would contribute to the realisation of the economic potential of CHP, and most of the savings are therefore already accounted for under option E3.

Option D5: Voluntary measures to promote CHP and district heating and cooling

Dedicated forums to exchange best practice could be a useful tool for promoting CHP and District Heating and Cooling (DHC). Both CHP and DHC are complex solutions that require specialised expertise in technology, energy and environmental regulations, project management and financial planning, spatial planning and building regulations, trading and industrial processes. These aspects could be addressed in dedicated forums, taking into account the different economics and requirements of the different CHP and DHC sectors, such as industrial CHP, micro-CHP, District Heating and District Cooling , etc.

- **Energy, economic, environmental and social impact**

An EU forum would raise the profile of CHP and DHC, raise awareness of the benefits, send signals and attract investors to the sectors. It would therefore positively affect the development of CHP and DHC. However, given that the Covenant of Mayor already organises those actors, i.e. cities, that can do the most for DHC, the niche an EU forum could cover is already partially occupied. In addition, the persistent and complex barriers to CHP and DHC make a voluntary approach less effective in ensuring that the significant energy saving and efficiency improvement potentials of DHC and CHP are developed. Therefore the positive impact of this option appears to be limited in comparison with Option D3.

Option D6: Minimum performance requirements for energy generation

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

121 JRC, progress report, 2011; ECN-CN background study, 2011

BAT levels, and that as a result, average generation efficiency would reach 51.5% in 2020[122]. For more details refer to Annex XI.

- **Energy, economic, environmental and social impact**

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). This would lead to a reduction in annual consumption of 15 billion m^3 of natural gas and 25 Mt of coal in 2020. There would be positive environmental impacts: under the pessimistic hypothesis, an emissions reduction of 124 Mt CO_2[123].

The use of the energy efficiency BAT by operators 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. Therefore, this would not pose a significant administrative burden in addition to that of the ETS.

Option D6 would lead over time to lower consumer prices for electricity and heat and to lower price volatility and higher security of supply.

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[124] to the grid, such as distributed generation[125], demand bidding and energy storage[126] and in allowing demand response[127]. Demand response requires that DSOs offer network system services to energy suppliers and energy service providers (such as ESCOs) to allow 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

122 Assuming a fossil fuel generation mix of 49% coal/lignite, 45% natural gas and 6% other fossil fuel.

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

124 Distributed energy resources (DER) is a common term for distributed generation, energy storage and flexible loads connected to the distribution or transmission network.

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

126 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 use 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.

127 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).

tariffs, peak pricing, real-time pricing) and location of the electricity consumed[128]. For more details refer to Annex XI.

- **Energy, economic, environmental and social impact**

Network regulation better reflecting energy efficiency performance criteria would allow three categories of network service 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) savings 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

Pilot projects report up to 40% savings in energy generation capacity from demand response and demand management. If a 7% reduction in generation capacity is assumed, the savings would amount to 22 Mtoe and 45 Mt of CO_2 reduction from category (1).

Savings from category (2) cannot be estimated with current modelling tools. Since this type of network regulation would transform the structure of the market (from centralised to mainly decentralised), the impact would be proportionally transformational.

Savings from category (3) would be less than the large savings potentials of categories 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: Voluntary measures to increase energy efficiency of energy transformation, transmission and distribution

Energy efficiency could be promoted through exchange of best practices in dedicated Energy Efficiency Forums or through Voluntary Agreements coordinated at EU level. The EU could also encourage Member States to set up Voluntary Agreements with energy companies to address energy efficiency improvement possibilities in operational practices.

- **Economic, Environmental and Social Impact**

The impact would be indirect and stem from the better dissemination of energy efficiency related expertise and solutions, as well as from peer pressure. In terms of energy savings and CO_2 emissions the impact would be likely to be small compared to Options D6 and D7. The setting up of an Energy Efficiency Forum on Energy Generation could however still be useful, especially if the implementation of option D6 is deferred while the need for it is assessed through monitoring. For more information on the EU value added of the options see Annex XI.

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

Table 17. Summary: estimated energy savings and CO_2 reductions from supply side options D1-D8

Options		Primary energy savings compared to BAU	CO_2 reduction compared to BAU
D1	Retain the current approach	-	-
D2	Repeal the CHP Directive	+35 Mtoe	+70 Mt
D3	Mandatory CHP and DHC requirements for new electricity and high-heat demand industry installations	-15-25 Mtoe	-35-55 Mt
D4	Mandatory connection and priority access of high-efficiency CHP to the electricity grid	Same as D3	Same as D3
D5	Voluntary measures to promote CHP and DHC	-	-
D6	Minimum performance requirements for energy generation	-62 Mtoe	-124 Mt
D7	Energy efficiency obligations for network regulators	-30 Mtoe	-60 Mt
D8	Voluntary measures to increase the efficiency of energy transformation, transmission and distribution	-	-

COMPARING THE OPTIONS

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

Evaluation criteria / Policy options	Subsidiarity/ proportionality	Effectiveness	Efficiency	Coherence	OVERALL
Option D1: Retain the current approach	R	=	=	C	**=**
Option D2: Removal of existing provisions	R	=	=	C	**=**
Option D3: Mandatory CHP and district heating/cooling requirements for new electricity and high heat demand industry installations	R	+++	++	C	**+++**
Option D4: Mandatory connection and priority access of high efficiency cogeneration	R	+++	+++	C	**+++**
Option D5: Voluntary measures to promote CHP and district heating/cooling	R	+	+++	C	**+**
Option D6: Minimum performance requirements for energy generation	R	++	+	NC	**+**
Option D6a: Monitoring to assess need for performance requirements for energy generation[129]	R	+++	+	C	**++**
Option D7: Energy efficiency obligation on energy network regulators	R	+++	+++	C	**+++**
Option D8: Voluntary measures to increase energy efficiency of energy transformation	R	+	+	C	**+**

As regards **subsidiarity,** Option D1 would not alter the current situation. D2 would transfer competence back to Member States. Neither would therefore raise subsidiarity concerns. The

[129] This alternative option reflects the uncertainties identified by the impact assessment concerning the value added by option 6, in the light of uncertainties about the extent to which other legislative measures already in place but not yet implemented will achieve the same efficient.

same is true for Options D5 and D8, since these would not impose any obligation on Member States. Options D3, D4, D6 and D7 would build on existing EU competences. A common feature of these options is that they would significantly contribute to creating a level playing field for generators and network operators. Option D3 would require that local authorities take a more active role in energy policies to contribute to achieving the objectives set at EU-level, in particular the 20% energy saving target. Options D4 and D7 would not alter the balance of shared competences between the Union and the Member States. Options D5 and D8 would leave it to Member States to decide their level of involvement.

As regards **effectiveness,** Options D1 and D2 would not achieve the general, specific and operational objectives. Options D3, D4, D6 and D7 would be effective tools to stimulate political commitment for energy efficiency and trigger energy efficiencies on the supply side. In the case of D6 it is as yet difficult to ascertain whether the imposition of stringent obligations on the energy performance of generators is the best way to achieve the objective. A softer measure, putting energy generation efficiency in focus and thus exercising peer pressure and public scrutiny may be more effective to ensure realisable results. A less stringent variant, D6a has therefore been developed and is considered conducive to ensure the greatest possible effectiveness at this stage. Option D3 would provide appropriate tools to overcome persisting barriers that the CHP Directive and other EU instruments have proved ineffective in tackling. Option D4 would be effective in tackling administrative barriers and achieve transparency, streamlining and swiftness of treatment in network connection and access procedures that are necessary to ensure the market take-up of CHP in line with the existing economic potential. In the case of medium and small scale CHP operators, option D4 would bring the simplification needed to ensure a level playing field with big, established market players. Option D7 would concern a regulated sector and takes into account the need for regulators and regulated businesses to operate on a clearly defined legal basis.

Option D1 would not be **efficient**, since the current level of ambition would not be implemented. Option D2 would abandon current EU policies and leave attainment entirely to Member States. This would be the least efficient solution since the nature of the objective, namely a common saving target, requires EU level mobilisation and coordination of efforts. D6 would bring results but at a relatively high cost; its softer variant D6a would be more appropriate at this stage to establish a balance between the desired objective and the cost to achieve it. D3 would unlock significant untapped saving potentials. At the same time it would offer a systemic and innovative solution to harness the benefits of integrated and coordinated approaches. Given the potential benefits, the level of effort is justified. D4 would be an efficient solution to support distributed CHP generation in particular. It would provide an essential building block for a more efficient, locally anchored and sustainable energy system. The attainment of objectives would be ensured by building and improving on existing national systems. Option D7 would put focus on energy efficiency and provide the necessary competences for energy regulators and competent authorities to reorientate priorities towards energy efficiency in all aspects of network operation. The costs would be in line with the achievable results. Options D5 and D8 would be less demanding in terms of effort and costs. They would lead to results in proportion to the level of adhesion of market actors.

Option D1 is **coherent** with existing EU legislation, but falls short of helping to achieve the EU strategic objectives, notably on energy efficiency and climate change. Option D2 would not be coherent with a number of EU legislative instruments that depend on the application of a harmonised definition of high-efficiency cogeneration. Option D6 would be difficult to achieve given the current level of resources and since other EU policies are already partially addressing the objective. This option therefore should preferably be modified from direct obligations partially overlapping with other EU policies towards capacity building awareness and monitoring that would fill current information gaps hindering the effectiveness of EU energy efficiency policies. The lighter version of D6 (D6a) would require at a first stage limited additional resources, would build on existing measures and would the more efficient use of national and EU resources. It would thus contribute achieving the objective at least cost. D6a is coherent with existing EU policies and legislation. Options D3, D4, D5, D7 and D8 would be coherent with energy and climate change objectives and EU legislation.

The majority of the **stakeholders** were in favour of further measures for energy utilities. 55% (111 submissions) answered confirmatively, 17% (34 submissions) responded negatively and 29% (58 submissions) had no opinion in this regard. It was proposed that these measures take the form of stricter requirements or encouragements for energy utilities to provide energy efficiency services or use Best Available Techniques (BAT). Some stakeholders also stated that there was a particular need for enhanced investments in **CHP and district heating**. Furthermore, investment in smart grids and smart metering was also emphasised.

Based on the analysis and taking into account the various views of stakeholders, it is proposed that Options D3, D4 and D7 be retained and D6 be retained as modified (i.e. Option D6a).

5.4.4. National reporting

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

(1) To encourage the setting of a clear comprehensive plan and the monitoring of progress at national level;

(2) To present 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;

(3) To permit the Commission to provide feedback, enabling weaknesses in planning to be identified and corrected in a timely way;

(4) To serve as the basis for remedial action when progress towards binding targets is insufficient.

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

(5) 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”.

- **Encouragement of MS to set clear and comprehensive plans**

The available evidence suggests that the NEEAPs have been reasonably successful in playing this role. In the light of this, Options E2 and E5 would be the most effective because they would extend these benefits to the whole energy sector. Option E1 would be less effective because it would continue to limit the scope to non-ETS end-use sectors. Option E4 would be less effective still because it would remove the formal framework for planning and reporting that exists at present. Option E3 would be the worst option. Theoretically it could cover all sectors in a comprehensive way but in practice it would focus the monitoring on verification of savings generated by single policy measures.

- **Comparability of presented information**

The best options to fulfil this aim would again be E2 and E5. The use of complicated verification methods under ESD (option E1) has been observed to create difficulties in comparability of information[130], as has the voluntary reporting that has so far taken place under NRPs (option E4). Option E3 would be sub-optimal as it would require arbitrary expert judgements[131], leading to incomparability of results.

- **Allowing the Commission to provide useful feedback to the Member States**

The best options in this respect are E2 and E5. With simpler indicators than E3 and a focus on impacts on sectors rather than impacts of single measures, these options would make it easier to identify strengths and weaknesses of the sets of policy measures, which, in combination with annual reporting under NRPs, would enable the Commission to react more quickly than in any other option. Option E4 with little information from Member States would make it difficult to draw reliable conclusions.

Ensuring the basis for remedial action if progress towards binding targets is insufficient This would best be realized through options are E2, E3 and E5, which would all allow the Commission to get clarity about strategic planning as well as progress with the implementation of measures. Option E1 covers only part of the 2020 target and as such is less effective. Option E4 with basic indicators would provide too little information.

- **Administrative burden**

The continuation of the current ESD approach (option E1) has been identified by a number of Member States as burdensome in administrative terms. According to the data available to the Commission, the first NEEAP required between 0,3-5 person-years to prepare[132]. More time was usually required in countries that were preparing a comprehensive energy efficiency plan for the first time. More time was also required in federal countries (Germany, Spain, Austria) where regional authorities had to be involved. In financial terms, Member States reported costs varying from €10,000 (Estonia) to €1,000,000 (Germany). A number of Member States complained about the 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.). In the second NEEAPs due by 30 June 2011, Member States will also need to report on achieved savings. This will make them more expensive. The full cost for the preparation has been forecast by several Member States to be in the range of €50,000-€2,000,000.

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130 SEC(2009)889

131 Other ways of determining the impact of certain measures (e.g. related to energy audits) which normally work in synergy with others would be too costly

132 See Annex III

Option E2 would significantly reduce this administrative burden by eliminating the most expensive tasks: ex-ante and ex-post evaluation of the impact of single policy measures. It is estimated that it would reduce costs to about half their present level. Option E3 would significantly increase the burden by extending ex-ante and ex-post evaluation to sectors not presently covered by the ESD (especially energy supply). It is estimated that it would lead to an approximate doubling of the present level of administrative costs. Option E4 would reduce administrative costs virtually to zero. Option E5 would have a burden a little heavier than that of option E2 because it would require some effort to be devoted to formal aligning of the reporting required for energy efficiency, renewable energy and greenhouse gas emissions.

Comparing the options on national reporting

It can be assumed that the stronger and the more comprehensive national plans and their implementation are, the greater the energy savings. The following table summarizes the outcomes of the analysis for each policy option.

Evaluation criteria / Policy options	Subsidiarity/ proportionality	Effectiveness	Efficiency	Coherence	OVERALL
Option E1: Retain the current approach	R	=	=	=	=
Option E2: Require light form of reports	R	++	+++	C	+++
Option E3: Require 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	+

All options respect the **principles of subsidiarity and proportionality.** Reporting is necessary to ensure that comparable information is available to check progress towards achieving the overall EU energy efficiency objective. Strategic planning of measures and monitoring of the main energy efficiency indicators is important for Member States to properly manage implementation. None of the options prescribes how national strategies and plans for energy efficiency should be designed.

As regards **effectiveness,** in relation to an overarching need to check progress towards EU 2020 targets it is important that Member States, possibly on an annual basis, should report on basic indicators (e.g. primary and final energy consumption and energy intensities in the main sectors) and inform about important changes in their national portfolios of policy measures. As the overall EU target is linked to primary energy consumption, the reporting should cover all sectors. As such, from the effectiveness point of view, only options E2, E3 and E5 qualify.

As regards **efficiency,** option E2 would impose the optimal administrative burden. Option E4 would be the cheapest but has to be disqualified as it would not ensure a stimulus for Member States to further strengthen their overall energy efficiency policies.

As regards **coherence**, the obligation for regular reporting may encourage energy efficiency measures to be designed to contribute to broader objectives (environmental, job creation, etc).

The result of the **stakeholders' consultation** showed that there is a general consensus on the need for enhanced **reporting obligations** and ways **to monitor and verify** the progress of individual MS (and also sectors). 70% (143 submissions) of the stakeholders responded confirmatively, 11% (22 submissions) answered negatively, while 19% (38 submissions) had no opinion in this regard.

Based on the analysis and taking into account the various views of the stakeholders, it is proposed that Option E2 be retained.

5.5. Results for the third-level policy options

The **effectiveness** of the options can be assessed by looking at how well they contribute to meeting the general objective of achieving the 20% target and realising further energy savings beyond 2020. Options 2, 3 and 4 have in common the widening of the purpose of the ESD (extending it to energy supply) and its scope (removal of exceptions). This can be justified on the grounds of effectiveness as the increase of the level of ambition of the EU energy efficiency objective has made more acute the need to look at all sectors to reap energy saving potential.

ETS is expected to have a positive impact on energy efficiency but will not in itself guarantee a decrease in energy consumption in 2020.

The Commission is not aware of any case where there has been conflict between the ESD and the nature and activities of the armed forces. The likelihood of such a case is so small that it might not be necessary to maintain an explicit exclusion in the new legislative proposal.

It would also make sense to withdraw the exemption of small energy utilities, at least in part. While there might be reasons to introduce a "*de minimis*" exception as regards energy savings obligations, it is more difficult to argue that small energy utilities should be exempt from the obligation to provide accurate information and billing to their customers.

Setting aside option 1 and 2, all the retained options would introduce comparable requirements delivering additional savings and would thus have comparable effectiveness.

In order to assess the **coherence** of each policy option it is appropriate to look in particular at their consistency with EU energy and climate policies. Options 1 and 2 are not coherent with the 20% energy efficiency objective for 2020 nor with the post-2020 objective of limiting climate change to 2°C. The remaining options contribute to those objectives. This is particularly true of options 4 and 5 as they involve merging the ESD and the CHP Directives in a single legal act. Such an approach is more coherent with EU energy efficiency policy objectives and the Energy Efficiency Plan.

The policy options implying a broadening of the scope of the ESD to currently excluded final users subject to ETS do not raise any problem of coherence with the ETS or the EU Climate policy. The legislative proposal and the ETS Directive are complementary measures that reinforce each other in the realisation of their respective objectives.

The **efficiency** of the policy options can be measured in terms of the administrative costs associated with them. Option 5 would have the most positive effects in this regard since the direct applicability of the legislative proposal would avoid the need for national transposition measures and facilitate the monitoring of implementation. In this sense, recourse to a

Regulation would be a form of legislative simplification. It might in addition result in a lightening of reporting obligations.

Simplification of reporting needs would also result to some extent from Option 4, as a result of the merger of the two Directives (each presently with its own reporting requirements). Member States would still have to transpose the new Directive, but this would probably be less time consuming and burdensome that transposing two Directives in parallel.

Options 1, 2 and 3 would not trigger the streamlining effects of options 4 and 5 as the Directives would remain separate legal acts. Efficiency under options 1 and 2 would be the lowest lower since this option does not properly address the problems.

In terms of **respect of subsidiarity/proportionality**, most retained options do not fundamentally deviate from the current situation even when they imply a modification of the purpose and scope of the ESD. Such modification is justified in subsidiarity terms by the need to ensure that the 20% energy efficiency target is achieved and by the assessment that the current legal framework will not achieve this.

The table below summarises the evaluation of the first-level options:

Evaluation criteria / **Policy options**	**Subsidiarity/ proportionality**	**Effectiveness**	**Efficiency**	**Coherence**	**OVERALL**
Option 1: Retain the two current Directives as they stand today	R	=	=	=	**=**
Option 2: Abolish the two current Directives without replacement	R	-	-	-	**-**
Option 3: Propose two separate revised Directives and extend their scope	R	++	+	+	**+**
Option 4: Merge the two Directives and extend the scope	R	++	++	++	**++**
Option 5: Use Regulation legal instrument instead of Directive	**NR**	++	+++	++	**++**

6. PREFERRED OPTIONS AND THEIR INTERACTIONS

6.1. Preferred Options

Three levels of policy options were considered in the analysis in chapter 5.

The **first-level policy options** analyse various ways to improve the current policy framework.

The analysis concluded that there is **no need to propose binding national targets at the present moment**. Even though such targets could signify the importance of energy efficiency and raise it high on political agendas, individual measures like those analysed in the sections of chapter 5 that follow are in any case needed to make a real difference. The current policy framework and the measures to be proposed on the basis of this IA should be sufficient to reach the EU's 20% target in 2020. Therefore, only **indicative targets**, set by Member States, are recommended (Option A3). However, progress needs to be monitored and evaluated. If an evaluation in 2013 shows that this approach endangers reaching the overall European 20% energy efficiency target, a move towards binding national targets needs to be made.

To replace the need for a binding target but ensure the same results, the MS have asked the Commission to propose a package of binding measures. These were discussed as a **second-level policy options** and included measures to tackle the remaining economic potential on the demand and supply side.

The **energy savings obligation (Option B4)** is a key part of this package. To increase the uptake of energy efficiency measures and support the development of energy services market, it is suggested that **national energy saving obligation schemes are introduced which will aim at an annual final energy reduction of 1.5%** (Option B4). It is appropriate for the obligation to be placed by MS on their energy utilities (suppliers or distributors), since these are the entities best placed todispose of appropriate information about the energy consumption of their clients. Certain key features of the obligation schemes should be harmonized at EU level (targeted sectors, level of ambition and counting methods), but MS should have the possibility to adjust them to their national circumstances. This will, *inter alia*, permit the schemes already in being in several Member States to continue with their main design features unchanged. This requirement will put a financial value on energy savings and link the profits of utilities to energy efficiency rather than solely to the volume of energy delivered. The expected savings are considerable (108-118 Mtoe of primary energy consumption in 2020) while the costs per individual are negligible and evenly distributed amongst final energy consumers.

The **public sector could be an important actor** in stimulating market transformation towards more efficient products, buildings and services. Due to the high volume of public spending it could be a strong driver for higher market uptake and the development of the skills that are required to implement energy efficiency measures, notably in the building sector. To this end, two measures are proposed. First, 3% of the buildings owned by public bodies should be renovated annually to cost-optimal levels (Option C2a). This would not lead to especially high energy savings (approx. 9 Mtoe) but is taken forward as they have high visibility in public life and because an acceleration of the renovation rate of this type will play an even more important role in achieving energy savings after 2020. Even in cash terms, the benefits of this option will outweigh the costs: additional energy related investments of €1.6 bn per year between 2010 and 2020 will be offset by savings on energy bills of €1.92 bn. Second, public bodies purchasing high energy performance products and buildings based on the available energy labels and certificates (Option C3) will drive the market forward. This would lead to a direct impact of 9-18 Mtoe saved in 2020. It would require an initial investment increase but would decrease the overall costs for public organizations.

Information on actual energy consumption provided to households and companies on a frequent basis through their energy bills (Option C5) and **on the savings possibilities** for large companies through energy audits (Option C7) are both important for reducing the information gap that is one of the barriers to efficiency. The analysis has shown that in both options the burden for final consumers would be relatively low compared to the benefits they will gain. The introduction of bi-directional smart meters with in-home displays and electronic billing may decrease the administrative burden of the energy utilities even with a high frequency of billing. The possible savings of the two options are also considerable and could reach up to some 80 Mtoe for Option C5 and up to 30 Mtoe for Option C7. However, the scale of savings would depend on individual reactions of consumers and the interaction between these measures and other national measures that would incentivise the consumers to make use of the information that will be made available to them.

ESCOs are an important player that could take some of the burden of the initial required investments in energy efficiency measures. However, even in well established ESCO markets, transaction costs are too high for potential customers to easily assess the available service offer. Therefore, it is suggested that MS establish structures to carry out market monitoring, providing lists of energy service offers and standard contracts (Option C9). This would not pose a significant administrative burden - as Member States could use the agencies already established to follow energy efficiency policies - but would present an important support for the ESCOs market.

To support **more efficient energy generation, transmission and distribution** it is proposed that a number of regulatory measures be brought forward. These include measures to ensure that surplus heat from power generation and industrial processes and other waste-to-energy sources are used first to satisfy heat demand in buildings and businesses and that primary energy fuel is used more efficiently. This would be achieved by requirements to equip new generation capacity and high-heat-demand industry installations with heat recovery (CHP) units and to ensure their connection to consumers via district heating/cooling networks (Option D3). This would bring an estimated 62-79 Mtoe of savings depending on the level of potential realised by 2020. Second, to reduce the administrative burden and create a level playing field, it is essential to establish clear connection rules and priority access to the electricity grid for high efficiency cogeneration (Option D4). This would put CHP on equal footing with renewable energy technologies.

In addition, energy network regulators should be required to design tariffs and network regulations that would enable energy efficient solutions and technologies to be offered to consumers (Option D7). Since this would not bring additional tasks for regulators, but would instead put a clear mandate to prioritise energy efficiency *among* their tasks, the additional administrative burden would not be significant. Finally, it is also proposed that the Commission monitor progress as regards energy efficiency of electricity and heat generation. If current measures are not sufficient, further measures should be proposed, based on further analysis (Option D6 bis). Since this measure would build on already existing information provision requirements, no additional administrative burden would appear. This approach would allow substantiation of whether existing EU market mechanisms, in particular the ETS and the new Industrial Emissions Directive, deliver the necessary investment in BAT.

To limit the administrative burden whilst ensuring that proper monitoring of progress is carried out, **a light form of reporting is suggested** (Option E2). This would include brief statements of plans and progress, simple quantitative reporting with a common format, and a report annually feeding into NRPs. This approach would reduce the administrative burden by eliminating the most expensive tasks: ex-ante and ex-post evaluation of the impact of single policy measures. It is estimated that it would reduce costs to about half their present level.

In the analysis of the more general **third-level policy options** the conclusion has been drawn that in order to reach the level of ambition of the EU 20% energy efficiency objective as set in 2007, EU policies need to look at every sector to reap energy saving potential, including potential in sectors excluded from the scope of application of the ESD. That is why **extending the scope of the two existing Directives – ESD and CHP Directive - would be beneficial**. **Merging them into one legislative text would provide for simplification and better coherenc**e. The analysis was not so conclusive as regards the legal form.

6.2. Interactions between the options

All the options proposed are interlinked and mutually reinforcing. Only if combined in one package can they bring the energy consumption reductions required at a socially acceptable cost.

The energy service obligation (Option C9) will bring forward financing for the realization of energy savings and also create favourable market conditions for the uptake of energy services and, in general, energy efficiency improvements. It could, together with ESCOs (Option C9), ease the burden on public bodies of the financing of energy efficiency improvements (Options C2a and C3). It would be the most important tool for MS to reach their indicative targets (Option A3).

Improved awareness about of actual energy consumption through metering and billing (Option C5) and the audits for large companies (Option B7) will support the uptake of ESCOs (Option C9), ease the implementation of the energy saving obligations (Option B4), and to some extent the uptake of cogeneration (Option D3). While audits will provide the basic information on the possibilities for energy savings, ESCOs take over the financial risk of the investments needed to realise these possibilities. In this sense energy audits support the establishment of ESCOs (as they create demand for the services they offer). Furthermore, audits can be offered by ESCOs and thus the requirement for audits further supports the uptake of ESCOs.

In principle, energy saving obligations (Options B4) and ESCOs (Options C9) both address the market for energy services. However, ESCO projects usually relate to larger projects in the industry sector whereas the main target of the saving obligations is the small consumers segment, which is not directly tackled by ESCO services. In this respect, both instruments are complementary and lead to the provision of energy services to all consumer segments. Additionally, some saving obligation schemes (e.g. Italy) actively involve ESCOs to implement savings, which makes both instruments mutually reinforcing.

Options D3 and D4 on the promotion of district heating and cogeneration will be enhanced by the real-time and historic data on consumption that will be available from better heat metering (heat/hot water suppliers will be able to better optimise their energy generation and distribution) (Option C5).

6.3. Overall impact

The instrument mix put forward will contain a number of overlaps and interactions.

In terms of overlaps with existing policies, especially in the frameworks of the ESD and CHP Directive, the instrument mix takes up instruments already in place in some Member States (e.g. the saving obligation schemes which are in place in France, Denmark, Italy, Flanders and the UK, CHP priority access rules practices in Germany), brings them to all Member States and sharpens their stringency. It can be estimated that the instrument mix will enlarge and reinforce the impact of the existing national energy efficiency instruments.

In terms of interactions within the proposed package of measures, the largest overlap exists between overall energy saving targets (option A3) and all the other measures put forward. The net impacts need to be verified to come to valid conclusions on the viability of this policy mix. In order to evaluate this net impact and have a consistency check with the results of the

E3ME model, an additional set of model runs were performed with the PRIMES energy model (called the 'PRIMES 20% efficiency scenarios', see Annex XIV for the output data). These model runs include the preferred policy options outlined in the analysis. It is important to note that in the scenarios the underlying assumption is that sufficient financing is available to cover the energy efficiency investments. Therefore, it is essential that sufficient financing is triggered. Furthermore, one of the PRIMES 20% efficiency scenarios assumes that the measures are successful in changing consumer behaviour with respect to the uptake of energy efficient solutions[133]. The model results show that for the EU27 the net effect of the proposed measures, in combination and including the impact of assumed changed consumer behaviour, reaches the 20% objective.

Primary energy demand in 2020 falls, in fact, by between 19.7% and 20.9% in the new package scenarios compared to the PRIMES 2007 baseline projection. Compared to the PRIMES 2009 energy efficiency scenario, the reductions in 2020 are between 12% and 13.1%. Final demand also decreases by 15.6% to 19.5% in 2020 in the 20% efficiency scenarios compared to the PRIMES 2007 baseline projection. Compared to the 2009 energy efficiency scenario, the reductions in 2020 are between 6.4% and 10.7%.

The majority of the measures target the end-use sectors. This is confirmed by the fact that 55-58% of the energy consumption reductions in 2020 are projected to come from these sectors. The sectors reducing demand the most are the residential and tertiary sectors. Increased realization of energy efficiency measures throughout the whole economy also stimulates significant savings in the transport sector. Lower final energy demand leads to lower electricity production. There are also significant improvements of efficiency in the energy generation sector which projected to account for 42-45% of the energy consumption reductions in 2020 (including reductions due to lower electricity consumption by end-use consumers). However, this number has to be treated with care as the PRIMES model is rather sensitive to changes in CHP and thus the decrease is possibly overestimated. Also as the incentives for renewables are kept at the same level their relative share increases.

To reveal the geographical spread of the impact of the proposed package of measures, the PRIMES model was used for energy use and CO_2 emissions and the E3ME model for costs and benefits (as embodied, in combination, in changes in GDP). As the detailed modelling results for Member States may include effects particular to the special country, they are clustered according to regional impacts, as these are likely to be closer to reality and more reliable than a disaggregated split up per Member State.

In the table below the forecast reduction of primary energy (minus non-energy use) and CO_2 emissions per group of MS are presented. The results show that economic convergence, e.g. higher rates of GDP increase, among the former Communist economies still has significant relevance for their energy consumption which is projected to decline at a slower pace than in the Nordic, Western European and Mediterranean countries.

[133] This is modelled through setting the subjective discount rate for consumers at the same level as for capital budgeting decisions, that is around 9-10%.

Table 18. Energy savings (gross inland consumption minus non-energy use) and CO_2 emission reductions of the proposed package per group of countries compared to the baseline

	GIC-NEU			CO_2 emissions		
	Baseline	Change (new PRIMES - baseline 2009)		Baseline	Change (new PRIMES - baseline 2009)	
	2010	2015	2020	2010	2015	2020
Baltics (Latvia, Lithuania and Estonia)	1%	-2%	-8%	3%	-2%	-10%
Central and Eastern Europe (Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovak Republic and Slovenia)	0%	-2%	-8%	0%	-3%	-14%
Mediterranean (Cyprus, Greece, Italy, Malta, Portugal and Spain)	0%	-5%	-13%	-1%	-8%	-21%
Nordic (Denmark, Finland and Sweden)	0%	-7%	-19%	0%	-6%	-18%
Western Europe (Austria, Belgium, France, Germany, Ireland, Luxembourg, Netherlands, and United Kingdom)	0%	-3%	-14%	0%	-6%	-18%

Source(s): PRIMES

Data on the GDP impacts is available from the E3ME model and can be displayed for the same groups of MS (see the table below) [134].

Table 19. Costs and benefits of the proposed package per groups of countries compared to the baseline

	GDP (m euro 2000)		
	Baseline	Change	
	2010	2015	2020
Baltic states	37714	377	123
Central and Eastern Europe	551169	2319	4568
Mediterranean	2309051	5376	4206
Nordic	646374	975	2039
Western Europe	6762677	14738	22904

Source(s): E3ME, Cambridge Econometrics

The impact per economic sector is presented in the table below. For most sectors there are only positive impacts with the notable exception of the sectors that are related to fuel extraction and electricity and heat generation and distribution (see the table below). As expected, the proposed instrument mix will strongly affect the energy supply sectors, lowering output from coal, mining, manufacturing fuels and gas supply considerably. Increasing efficiency leads to lower input fuel needs for the other sectors which explain why employment rates and wages are not affected negatively.

[134] Here only the benefits in terms of GDP are highlighted. Non-monetarised secondary benefits such as improved living conditions etc. will occur in addition. For the clarity of the analysis, these have been left out.

Table 20. Impact of the proposed package on different economic sectors for EU 27 in 2020 in percentage difference from base)

SECTOR	Output			Employment			Wages		
	2010	2015	2020	2010	2015	2020	2010	2015	2020
1 Agriculture etc	0	0.15	0.41	0	0.05	0.46	0	0.77	0.85
2 Coal	0	-0.93	-1.39	0	0	0	0	0	0
3 Oil & Gas etc	0	-0.15	0	0	0	0	0	0	0
4 Other Mining	0	-0.23	-0.36	0	-0.49	-1.4	0	0.88	1.7
5 Food, Drink & Tob.	0	0.71	1.74	0	0.06	0.39	0	0.6	1.22
6 Text., Cloth. & Leath	0	0.29	0.82	0	-0.02	0.07	0	0.85	1.19
7 Wood & Paper	0	0.07	0.31	0	0.63	1.12	0	0.33	0.81
8 Printing & Publishing	0	0.46	0.7	0	0.14	0.61	0	0.66	0.58
9 Manuf. Fuels	0	-2.49	-4.06	0	-0.84	-1	0	0.88	1.75
10 Pharmaceuticals	0	0.44	0.14	0	-0.22	0.49	0	0.32	0.45
11 Chemicals nes	0	0.31	0.58	0	0.73	1.34	0	0.03	0.23
12 Rubber & Plastics	0	0.75	1.18	0	0.93	1.52	0	0.42	0.52
13 Non-Met. Min. Prods.	0	0.06	-0.28	0	0.54	1.28	0	0.46	0.31
14 Basic Metals	0	0.24	0.15	0	0.56	1.32	0	0.33	0.61
15 Metal Goods	0	0.71	0.93	0	0.29	0.58	0	0.53	0.8
16 Mech. Engineering	0	0.76	0.95	0	0.2	0.44	0	0.19	0.52
17 Electronics	0	2.27	3.14	0	1.06	0.93	0	0.73	1.07
18 Elec. Eng. & Instrum.	0	-0.01	-0.15	0	0.16	0.21	0	0.22	0.8
19 Motor Vehicles	0	0.25	0.11	0	0.25	0.46	0	0.41	0.76
20 Oth. Transp. Equip.	0	-0.08	-0.19	0	0.05	0.05	0	0.78	1.63
21 Manuf. nes	0	0.43	0.58	0	0.17	0.45	0	0.24	0.83
22 Electricity	0	0.75	0.5	0	0	0	0	1.49	2.89
23 Gas Supply	0	-4.29	-6.05	0	0	0	0	1.55	2.86
24 Water Supply	0	0.07	0.28	0	0	0	0	1.67	3.08
25 Construction	0	1.42	1.81	0	0.58	0.2	0	1.64	3.08
26 Distribution	0	-0.03	-0.08	0	-0.1	-0.08	0	0.37	0.73
27 Retailing	0	0.5	0.98	0	0.05	0.34	0	0.26	0.79
28 Hotels & Catering	0	0.58	0.75	0	-0.02	0.04	0	0.95	2.03
29 Land Transport etc	0	-0.11	-0.27	0	0.42	0.55	0	1.17	1.85
30 Water Transport	0	-0.01	0.33	0	0.32	1.6	0	1.18	2.12
31 Air Transport	0	-0.73	-1.42	0	0.74	0.04	0	0.76	0.69
32 Communications	0	0.25	0.5	0	2.28	2.69	0	-1.23	-0.98
33 Banking & Finance	0	0.45	0.7	0	-0.01	0.06	0	0.24	0.49
34 Insurance	0	0.66	1.52	0	0.06	0.29	0	0.18	1.15
35 Computing Services	0	0.58	0.84	0	0.39	0.28	0	0.28	1.12
36 Prof. Services	0	0.2	0.3	0	-0.03	0.1	0	0.25	1.2
37 Other Bus. Services	0	0.31	0.43	0	0.09	0.17	0	-0.03	0.63
38 Public Admin. & Def.	0	0.02	0.01	0	0	0	0	1.47	2.83
39 Education	0	-0.03	-0.06	0	0	0	0	1.51	2.86
40 Health & Social Work	0	0.07	0.08	0	0	0	0	1.34	2.64
41 Misc. Services	0	0.4	0.57	0	-0.42	-0.79	0	1.16	2.34
Total	**0**	**0.29**	**0.42**	**0**	**0.11**	**0.18**	**0**	**n/a**	**n/a**

Source(s): E3ME, Cambridge Econometrics

The impact on household income is insignificant. Nevertheless, in distributional terms, the model results show that higher energy prices would affect vulnerable income groups more than high income groups. This is partially due to a shortcoming in the E3ME model which presents energy efficiency improvements through increase of energy prices but does not take full account of the decrease of energy bills due to the saving measures. It is expected that the energy and cost saving effects would strongly outbalance the direct income losses if indeed energy price increases were to occur. Also the measures proposed (energy savings obligation, promotion of ESCOs) could be implemented in ways that enable them to serve as tools to decrease the burden for the socially disadvantaged group of population. Member States could also use other tools (e.g. financing mechanisms) that particularly support this group.

Relation with the GHG emission reduction and renewables targets for 2020 and the ETS

Measures to achieve the 20% energy saving target in 2020 will support the greenhouse gas reduction target, in particular in non-ETS sectors. According to the Low Carbon Economy Roadmap 2050 the achievement of the 20% EE and RES targets enables a 25% greenhouse gas emission reduction. (As stated in the Roadmap, "If the EU delivers on its current policies, including its commitment to reach 20% renewables, and achieve 20% energy efficiency by 2020, this would enable the EU to outperform the current 20% emission reduction target and achieve a 25% reduction by 2020.''). In this context, the Commission has said that it will monitor the impact of new measures to implement the 20% energy efficiency target on the ETS[135]. The following lessons can be drawn from this impact assessment in this respect.

The preferred package includes a number of measures that only impact non-ETS sectors. It also includes a number of measures that primarily target ETS sectors (for example, CHP requirements). The initial costs of these proposed measures are recovered during the operation period and (over)compensated over the lifetime. In this respect, there is in the middle and long run no additional burden. The preferred package further includes a number of measures that primarily target non-ETS sectors but of which effects materialise in ETS sectors, as a result of measures that lead to electricity savings and hence affect power demand in ETS sectors (e.g. end-use energy efficiency improvements including the Energy Savings Obligation). Taken together, it is expected that part of the GHG reductions induced by the additional energy saving measures proposed materialises in installations covered by the ETS. An exact quantification at this point is difficult due to overlaps between measures and the flexibility provided for implementation and would need further study.

Impacts on the ETS are presented in the overall 20% efficiency model runs, albeit results differ substantially depending on the model used, as explained in section 5.3.1. While both models project a further decrease in GHG emissions, they show different results regarding the impact on the ETS price. In this respect, the E3ME model run projects a drop to zero of the ETS price in 2020 whereas the PRIMES scenarios project a much lower impact (a reduction from €16.5/t in the PRIMES 2009 reference scenario to €14.2/t in 2020). This lower ETS price impact until 2020 in PRIMES is explained among other things by different baselines used, a higher share of modelled measures with GHG reductions materialising in non-ETS sectors, the full market foresight assumed and an unlimited ETS banking flexibility until 2050 assumed. It is appropriate to monitor impacts of the proposed measures on the ETS.

The share of renewable energy in the generation mix increases while the share of nuclear decreases. This will make it easier and cheaper for MS to reach their renewable energy targets. Additional costs to the total energy system rise by between 2.6% and 4.7% compared

[135] COM(2011)112

to the reference scenario[136]. The increase in energy efficiency will tend to increase electricity prices in the short term from 141€/MWh to 146€/MWh due to the need to finance the fixed costs of energy efficiency measures[137]. However, in the long run, this increase pays off by stabilising electricity prices through a lower demand.

It can therefore be confirmed that the package of policy measures put forward is capable of reaching the 20% objective and reaping additional benefits that remain tangible beyond 2020. The additional costs of achieving the overall 20% target through the set of measures proposed are proportionately small. It can be concluded that the overall economic, social and environmental impacts of the options presented above will make a strong positive contribution to EU policies and serve as a pillar for the success of the Europe 2020 strategy.

7. MONITORING AND EVALUATION

To monitor and evaluate progress several aspects will regularly be assessed:

- **Overall progress on energy savings and expected progress**

Progress on the energy saving targets will be monitored using the well-established energy consumption statistics (gross inland consumption minus non energy uses). As energy consumption figure is influenced by the development of economic activity (GDP), the indicator of energy intensity, depicting the energy consumption against the level of GDP can be drawn upon as an additional indicator. Furthermore, Member States would be required to report on progress towards their national targets on energy efficiency, using in their National Reform Programmes if appropriate.

- **Legal transposition and implementation of the new Directive/Regulation**

The Commission will adopt a pro-active role in organising measures to assist Member States with the implementation of the legislative proposal. The legislative proposal is accompanied by an Implementation Plan that identifies the main risks to the timely and correct implementation of the legislation and the actions and instruments that are appropriate to be used to counter those risks. Concerted Actions (regular meetings with national energy agencies and bodies in charge of implementing the legislation) and permanent dialogue with Member States (e.g. via committees and bilateral meetings) will be key tools to ensure effective implementation. Transposition verification and a full conformity check will be undertaken. Recourse to EU pilot requests will also be made in the pre-litigation phase.

- **Progress with individual measures**

Some of the measures proposed would leave Member States with substantial flexibility for determining the concrete design features (e.g. energy saving obligations), others would require Member States to collect statistical data (public sector buildings' renovation target, efficiency of power generation), or analyse barriers and develop appropriate policy response (e.g. barriers to ESCOs and to inclusion of energy efficiency considerations in public spending). However, the administrative costs for these monitoring bodies can be restricted by

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[136] PRIMES 20% reference scenario
[137] Ibid 136

assigning this task to existing bodies like the government authorities already set up under Article 4(4) ESD.

To collect the necessary information for monitoring of the progress with individual measures it may be appropriate to require that the Member States report on these in the framework of the simplified reports (Option B2). This would allow for best practice exchange.

The Commission will analyse the information coming from Member States on the implementation of these reports and propose further measures or binding targets, if needed.

- **Review of overall energy efficiency progress in 2013**

The procedure retained for setting energy efficiency targets includes a review of the effectiveness of the present approach in 2013. This review will coincide with the overall review of the national targets supporting the various Europe 2020 headline targets. By mid-2013, three consecutive sets of National Reform Programmes will be available which give an overview of the (development of) national target formulations as well as the key measures to support these targets. In addition, the 2011 National Energy Efficiency Action Plans will be fully analysed. Taken together, these reports will deliver a sound basis for an evaluation of whether the indicative targets and measures undertaken and adopted (including in the framework of the legislative proposal assessed in this IA) will be ambitious enough to reach the overall EU 20% energy efficiency target. In addition, these data will be used in an additional round of modelling with one or more macroeconomic models to verify and complement the results.

EUROPEAN COMMISSION

Brussels, 22.6.2011
SEC(2011) 779 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

{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

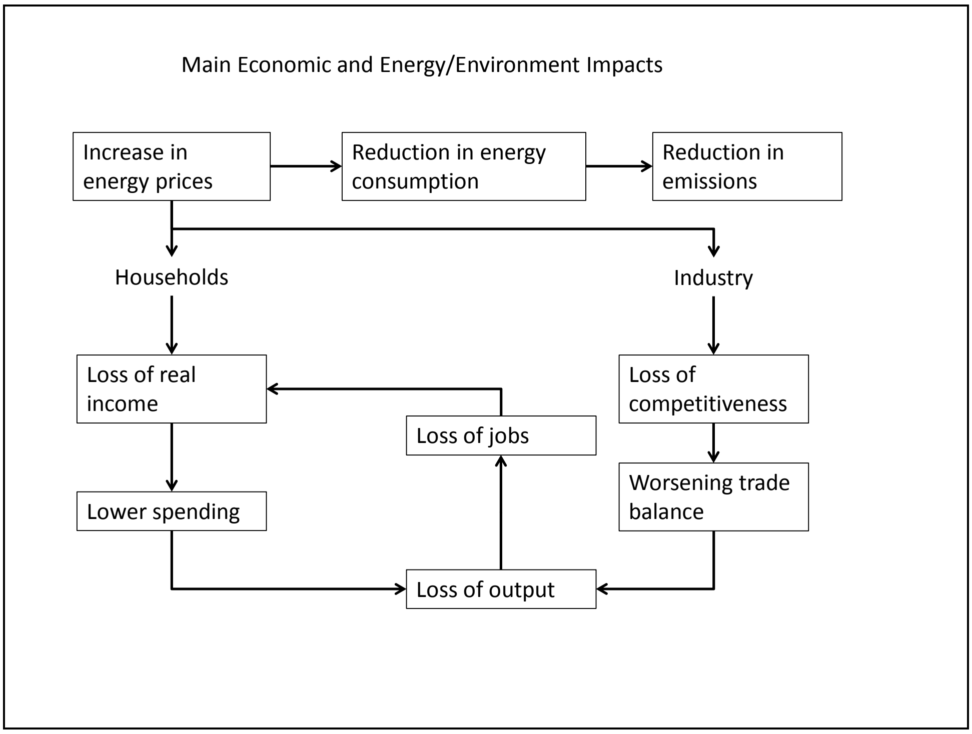
	A0	Additional impacts								
		A3A	A3B	A3C	A3D	A3E	A3F	A3G	A3H	A3I
GDP (2000 m euro)	12537127	70895	24746	39602	39373	29821	35804	33064	29895	14123
Consumption (2000 m euro)	7155944	-25335	-2793	-11456	-36386	-5999	-26200	-3659	-6155	1073
Investment (2000 m euro)	3177669	93138	26011	49271	67609	30830	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

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[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 Rep	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 Rep	%	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.

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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

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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

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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.

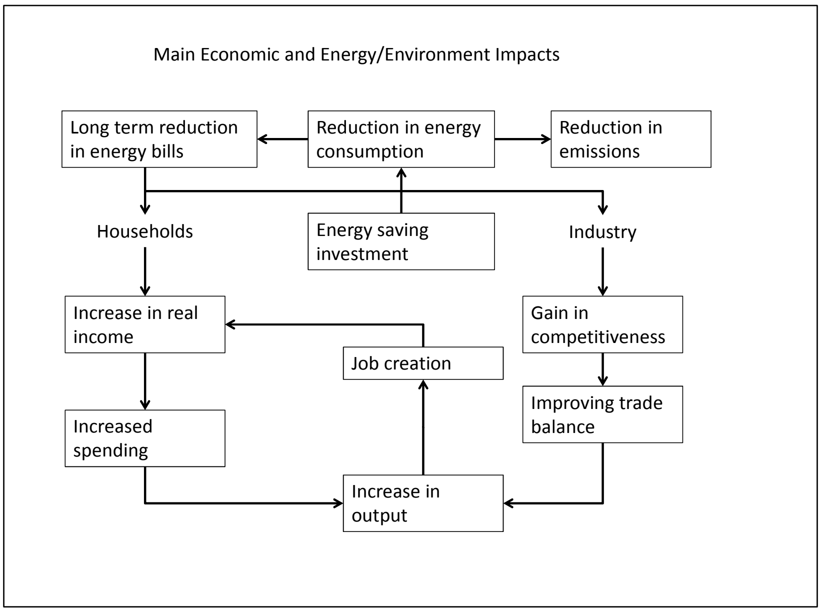
Developing a harmonised European saving obligation would lead to extra administrative burden and costs for the Member States that have introduced saving obligations, as they would need to change some or all of their administrative models to the harmonised EU scheme. In sum, the extra economic, social 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
Consumptio n (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)

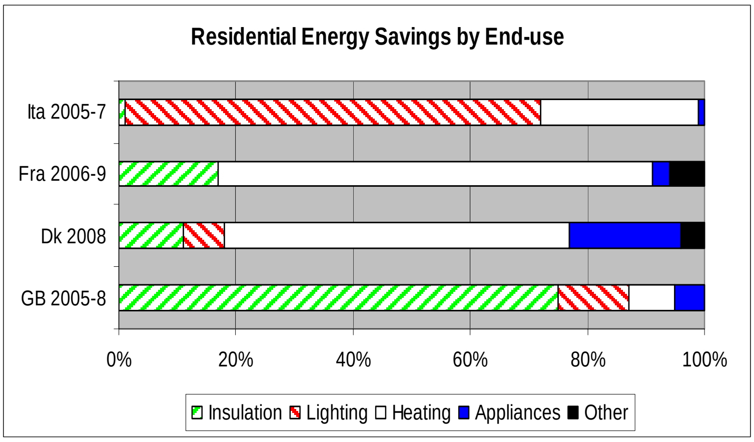
	A3Bi Income tax	**A3Bii** Energy price increase	**A3Biii** Revolving fund	**A3Ei** Income tax	**A3Bii** Energy price increase	**A3Biii** Revolving fund
1 All households	0,01	0,06	0,037	0,11	0,213	0,177
2 Exp groups: first qun	-0,051	-0,022	-0,052	-0,039	0,021	-0,028
3 Second quintile	-0,025	0,005	-0,023	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).

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[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.

[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

Policy options / **Evaluation criteria**	**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

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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.

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.

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].

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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.

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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

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

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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 frequency of billing 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**.

In Option C6, 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

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.

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)

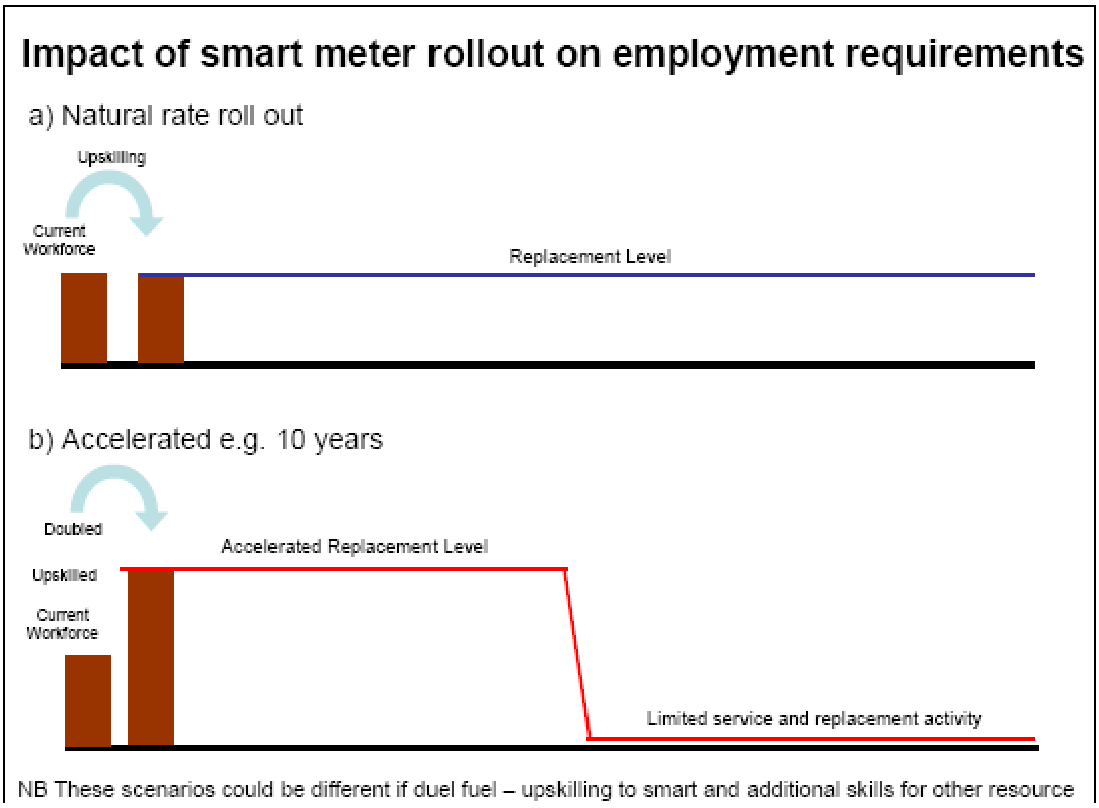
[122] Empowering electricity customers: Customers choice and demand response in competitive markets, IEA report (draft), 2011

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 <u>intrusiveness of metering and billing</u>. 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.

<u>Health impacts</u>
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

<u>Respect of subsidiarity/proportionality</u>
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.*

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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.

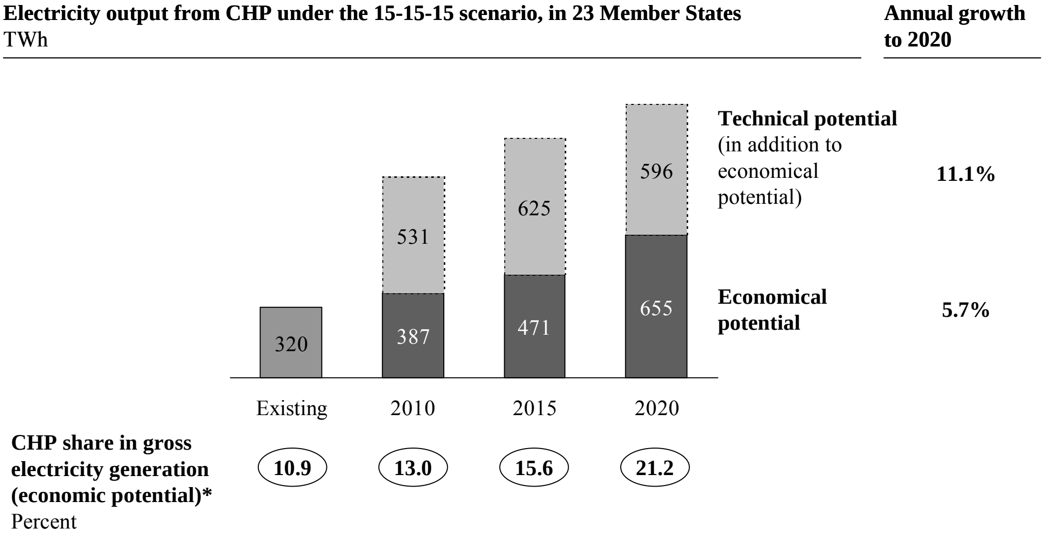
Yet the focus on the Directive is on evaluation and reporting. Only the setting up of a GO system based on harmonised calculation methods and the priority dispatch obligation by TSOs can be considered as concrete operative action.

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.

[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.

[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	-

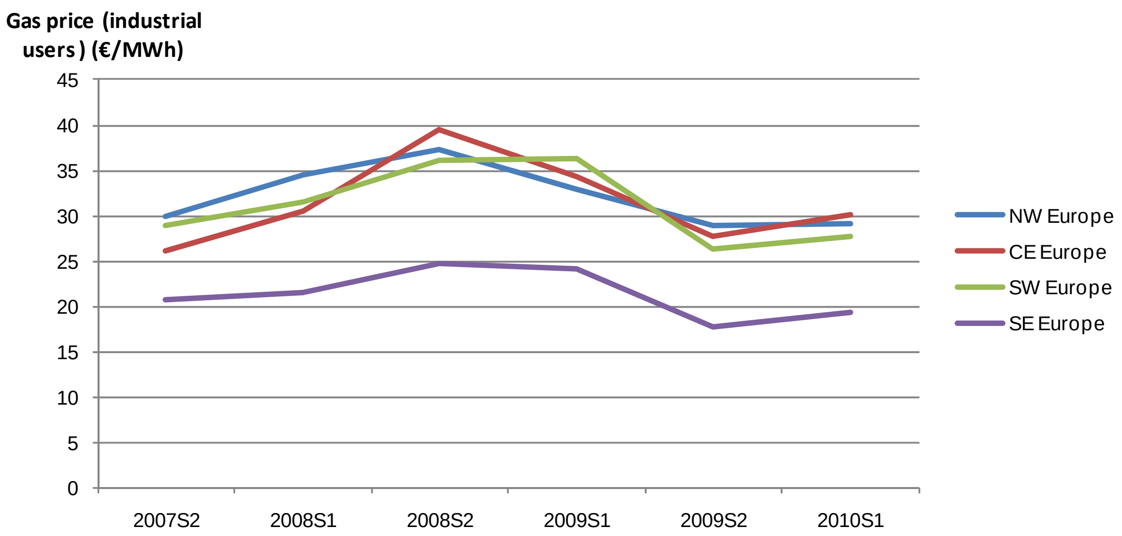
Source: ECN

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.

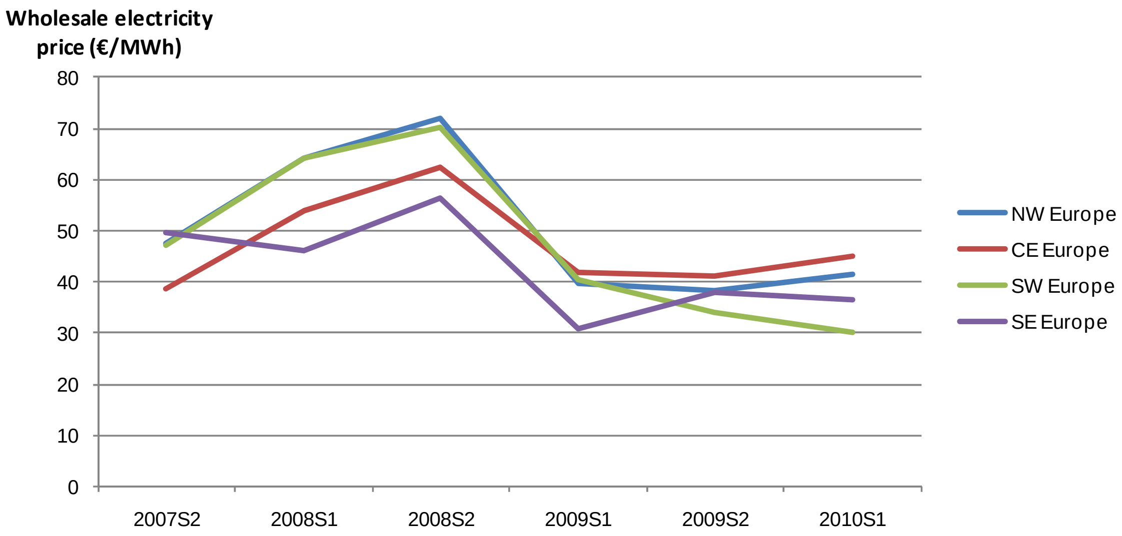
– Fuel price/gas price: The spread between the price of natural gas and electricity is one of the decisive factors for the economic viability of CHP. The larger the difference, the more profitable CHP is. The value of the heat output changes with the gas price. Gas prices widely differ in Europe (see 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	■ (light shading)		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.

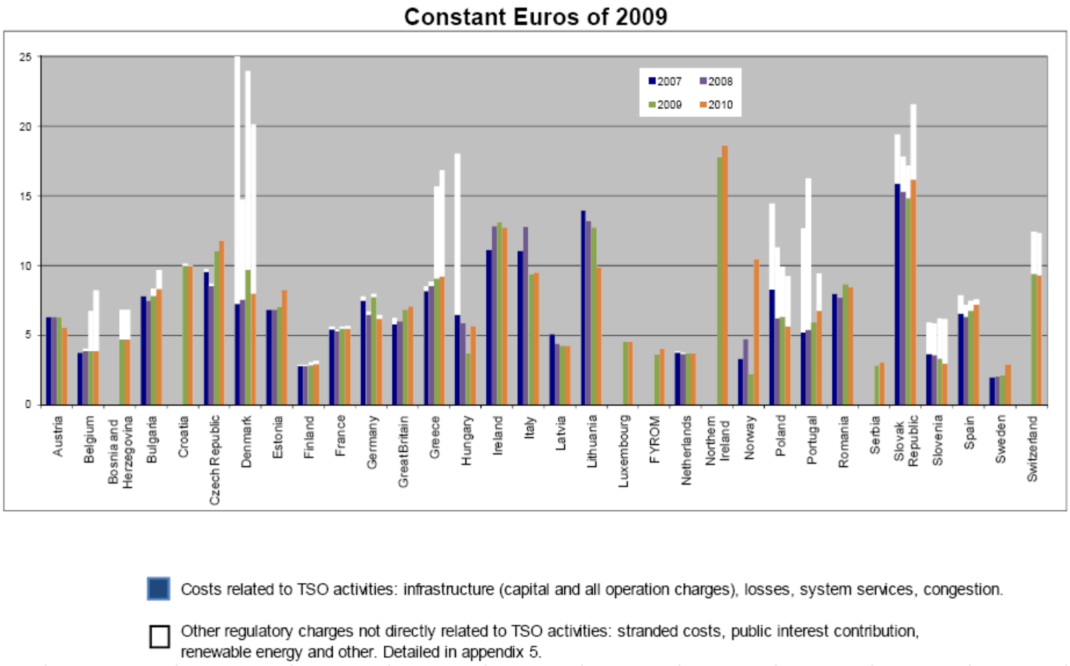
Member State	Shallow	Deep	Comment
GR			
HU			
EI			The connection charge is based on the Least Cost Technically Acceptable shallow connection method. However the Least Cost Technically Acceptable shallow connection method depends on the availability of appropriate transmission infrastructure in the area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

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	X					
BE		X	X			
BG		X			X	
DE	X	X	X			

[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

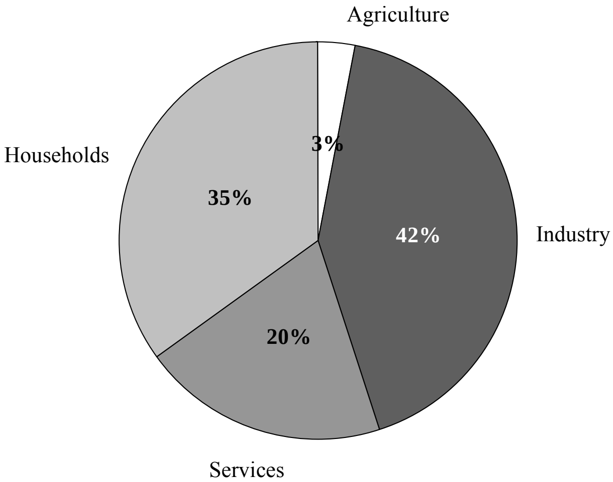
The technical potential of cogeneration is defined by the heat demand nearby, since heat, unlike electricity, cannot be transported long distances. The economic potential for cogeneration is determined by the economic viability of cogeneration that is in turn depends many factors, the most important 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.

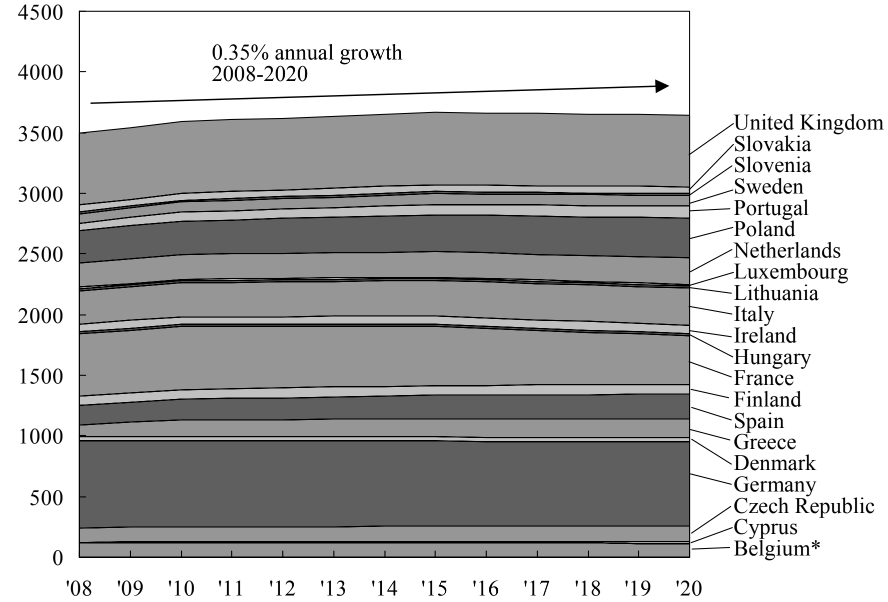
[151] Eurostat 2008 energy statistics

[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.

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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

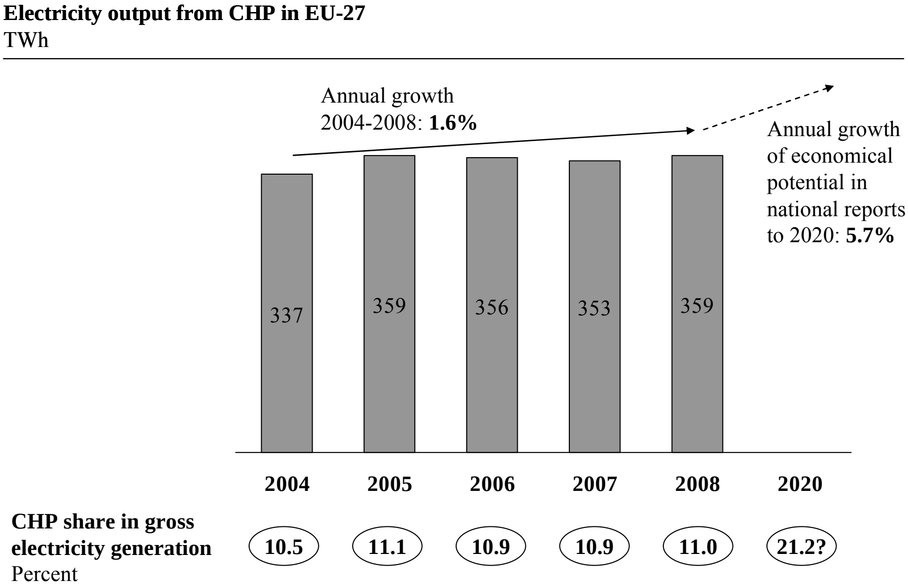
These estimates can be translated into annual cost by multiplying with a a rate of 4, 6, 8 or 10%, depending on the interest rate and period.[161]

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



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.

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.

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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 –

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].

[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).

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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**				

	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
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**	**103015 8**		**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	-		

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											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

	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
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