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Analysis of 20% cost-effective energy savings in the Green Paper on Energy Efficiency

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Acknowledgement/Preface

This report is the result of an analysis performed as part of an Impact Assessment Energy Efficiency Action Plan for DG-TREN, European Commission in the period March-July 2006 (ECN project no. 77769). Part of Chapters 2 to 4 is based on an earlier analysis of M. Menkveld from ECN Policy Studies. Chapter 5 is based on information from Peter Tipping of Atkins, UK.

Abstract

The Green Paper on Energy Efficiency states that the European Union could save at least 20% of its energy consumption in a cost-effective manner. In this report an assessment is made of the robustness of this statement and the factors that play a role in actually reaching this goal. Issues regard the definition of 20% savings, the underlying studies and how the 20% is realised, experiences elsewhere, the contribution of the Energy Service directive and which directives contribute to the Green Paper target.

It is concluded that a considerable strengthening of energy efficiency policy, at EU and/or country level, is needed to have the 20% savings statement come true. However, a substantial part of EU-energy efficiency policy can be relied on. Moreover, enduring high energy price levels can help to realise the target to some extent.

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1. Introduction

In the 'Green Paper on Energy Efficiency' the European Commission (EC, 2005) states "According to numerous studies the European Union could save at least 20% of its present energy consumption in a cost-effective manner."

In the following an assessment is made of the robustness of this statement and the factors that play a role in actually reaching this goal. The questions to be answered are:

- How is the 20% defined?
- Do the studies mentioned underpin the 20% statement?
- How is the 20% realised (which policies, which saving measures in which sectors)?
- Is there track record elsewhere for 20% achievable savings?
- How does the Green Paper contribute to overall energy use developments?
- What is the relationship with the savings target in the Energy Service directive?
- Which policy measures should be regarded as part of the baseline, and which policy measures as part of Green Paper contribution?

Finally some observations are made and a conclusion is drawn.

2. The 20% savings definition

On Page 4 of the Green Paper the European Commission states that the EU could save at least 20% of its present energy consumption in a cost effective manner. It suggests a total amount of saved energy, equal to 20% of present energy consumption, here presumed to be 2005. However, according to Annex 1 of the Green Paper it regards "how the EU could achieve a reduction of EU energy consumption by 20% compared to the baseline projections in 2020". In the Green Paper reference is made to European energy and transport scenarios from DG TREN (EC, 2004).

Energy consumption is defined as total primary energy consumption of the 25 EU Member States. The 20% energy savings encompasses energy savings in energy supply sectors as well, e.g. electricity production.

Cost effective can be interpreted in different ways. One of the studies, the World Energy Assessment 2000 (Jochem, 2000) the EC is referring to, uses the term 'life cycle costs'. This suggests that the pay-back time of the investment can be equal to the technical lifetime of the saving measure. This is an extended definition of cost effectiveness compared to other sources, e.g. the 3, 5 or 8 year pay-back time that is currently used in the Netherlands (Menkveld et al, 2005).

3. Underpinning in background documents

The following background documents[1] mentioned in the Green Paper are discussed:

1. The mid-term potential for demand side energy-efficiency in the EU (Lechtenbohmer, 2005).
2. Public Sector Leadership: Transforming the Market for Efficient Products and Services (Harris et al, 2005).
3. Improving energy efficiency by 5% and more per year? (Blok, 2005).
4. Cost-effective climate protection in the building stock of the EU15 and new Eastern European Member States (Ecofys Gmbh, 2005).
5. World Energy Assesment 2000, Chapter 6: Energy end-use efficiency (Jochem, 2000).
6. 'White and Green': Comparison of market-based instruments to promote energy efficiency (Farinelli, 2005).
7. Cross-country comparisons of energy efficiency trends and performance in CEEC - Synthesis report (ADEME/DEA, 2004).
8. Cost-effective climate protection in the building stock of the new EU-MS - Beyond the EU energy performance of buildings directive (EURIMA, 2005).

Only the study of the Wuppertal Institute (Document 1) presents a scenario analysis for the EU where 20% extra savings are realized with what are clearly new policies. However, the general assumptions in this scenario differ from that in the scenario the Green Paper is referring to (Mantzos, 2003 and EC, 2004). The results of a 'policy and measures' scenario (P&M) are compared with that of a 'business-as-usual' (BAU) scenario. The related publication of the Wuppertal Institute provides a good overview of the main policies and measures in different sectors. Some doubts regard the time scale to reach the additional savings. In 2010 the P&M scenario predicts already 10% less energy use from new policies implemented in 2006 at earliest. For some instruments (Emission Trading System, ETS) Member States are bound to existing agreements. Not clear is whether account is taken of fixed replacement rates for appliances, installations and buildings.

K. Blok (Document 3) shows the substantial technical possibilities but does not describe how these measures are implemented with policy measures. The WEA-report (Document 5) presents economic saving potentials for different sectors in 2020 and describes possible policy measures. However, the saving potentials are related to energy consumption in a base-year and not to energy trends in a BAU-scenario.

The article on the White and Green project (Document 6) claims that a white certificate system can lower energy use in buildings in the EU-15 with 15% in 2020 compared to a BAU scenario, without costs. Studies of Ecofys on (possible strengthening of) the Energy Performance of Buildings directive (EPBD, Documents 4 and 8) regard the built environment only and focus on reduction of CO_2-emissions. Due to differences in fuel mix these results are transferable into energy efficiency increases only if assumptions are made regarding future fuel mix. EPBD and white certificates both regard energy consumption in buildings and dwellings; this prevents adding the two potentials because an overlap in claimed effects seems probable. The study described in Document 2 regards the public sector that constitutes only a small part of the built environment.

[1] Other studies mentioned, such the WWF brochure and the study of Krause are already covered by the listed studies.

The study in Document 7 states that CEEC economies (Hungary, Czech Republic, Slovak Republic, Slovenia, Poland, Latvia, Lithuania, Estonia, Bulgaria and Romania) are 50% more energy intensive than the EU-15. In principle, closing this gap with Western economies could contribute considerably to the overall 20% saving. However, it is suggested in this study that some closing of the gap is already part of BAU scenarios. In that case the fast CEEC efficiency improvement reduces somewhat the otherwise significant contribution that CEECs would make to reach the 20% savings.

4. How is the 20% realised?

In the scenario analysis of the Wuppertal Institute (Lechtenbohmer, 2005) the following policies and measures have been supposed.

Households
- Standards for energy use of electric appliances (including stand-by use) in combination with regularly strengthened energy labelling for all appliances and financial support.
- Insulation of buildings and efficiency improvements of heating systems by extension of the EPBD standards to all new and renovated buildings, EU standards for building parts, subsidies on low energy and passive heated dwellings, better conversion efficiency in hot water production, obligatory installation of solar boilers in new and renovated dwellings.

Tertiary
- Labelling and standardisation of electric office appliances and building installations (air conditioning, lighting).
- Extension of EPBD to all smaller buildings and obligatory demolition of old buildings.

Industry
- Further development of the ETS.
- Standardisation for electric motors.
- Execution of energy audits.

Electricity production:
- More renewable energy generation (wind and biomass).
- Increase of the share of combined heat and power (CHP), above the target in the directive.
- Higher conversion efficiencies due to a fuel shift to gas (new Gas Combined Cycle generation according to Best Available Technology or BAT).

Transport
- Target in ACEA covenant to emission limit of 100 g CO_2/km.
- Improved energy efficiency of airplanes and lorries/trucks.
- Savings in freight transport by shifts in modal split, training of drivers, logistics, telematics (sea shipping not regarded as most of energy use is outside the scope of the study).

For the different final sectors the study specifies in a transparent manner how much they contribute to the goal for extra energy savings in the EU (see Table 4.1).

Table 4.1 *Final energy demand by sector for BAU and P&M scenario in 2020*

	BAU [Mtoe]	P&M [Mtoe]	Reduction [%]
Industry	365	292	20
Tertiary	194	148	24
Households	313	260	17
Transport	418	323	23
Total end use	1290	1023	21

In absolute terms the biggest contribution originates from savings in transport and industry. Including energy supply about 60% of the total emission reduction is realised under the emission trading scheme (ETS), by renewables, fuel shifts and energy savings. This outcome from the analysis is due to an assumed decrease in allocated emission rights of 2.8% per year. However, in practice this development can only be achieved if sector- and technology-specific policies and measures are combined with this tightening of the national caps. For other (end use) sectors the considerable energy savings achieved are realised thanks to policy measures that go beyond present European and national policy.

5. Is there track record elsewhere for 20% achievable savings?

EU-15 Members
Historically it has been widely accepted that the potential savings from energy efficiency across all sectors are around 20% of current use and that realizing this potential was the major element in meeting carbon dioxide reductions. This should be seen as an overall target as the sectors, as well as the EU Member States, are at different stages of implementing efficiency measures.

Today, most national governments within the 25 EC Member States are unwilling to commit to binding targets in any sector. Despite support for hard targets in principal, EU energy ministers have stated their preference for non-binding indicative national targets only (EC, 2006).

Possibly this has to do with the development of energy efficiency progress so far. According to the results of the Odyssee project on energy indicators (Odyssee, 2005) the EU-15 countries attained about 10% energy efficiency improvement in the period 1990-2002. This boils down at about 0.8% energy savings per year. This figure represents both autonomous and policy induced energy savings. However, this figure is valid for a period with rather low energy prices and without substantial European policy on energy savings (see Chapter 8).

In some countries authoritative organisations may publish indicative 'average' claims for energy efficiency savings according to their target audience. Assuming that such claims are justified on national practical evidence/experience, these would give a useful barometer of 'expected savings' in various sectors. However, a non-exhaustive websearch of English language national and authoritative organisations confirmed that few claims of achievable energy savings are being published to promote stakeholder interest. Notable exceptions were as follows.

In the UK DEFRA's Climate Change Programme document (DEFRA, 2006) proposes 20% saving from efficiency measures by 2020. The Carbon Trust (UK) estimates that businesses and public sector organisations can achieve a 10% cut to heating, lighting and power bills without capital investment and 20% with a little investment (Carbon Trust, 2006). Some 'best practice' business examples have reported 50% savings. In the household sector the Energy Saving Trust quotes that a 22% reduction target is possible (EST, 2006). Ofgem are consulting with Energy Supply companies for a further 20% reduction in household energy consumptions under the Energy Efficiency Commit obligation (Ofgem, 2005).

The Sustainable Energy Agency in Ireland (SEI, 2006) agrees that the business sector can see a 20% reduction, and the Danish Energy Agency quotes typical savings of 15% (DEA, 2005).

Newer Member States (accession May 2004)
The Member States most recently granted accession have great potential for energy savings but also have their own sets of barriers - for example, Lithuania has minimal oil and gas reserves of its own. The Czech Republic Energy Efficiency Centre's annual report quotes 20% for various industrial schemes (SEVEn, 2005). According to the Polish Foundation for Energy Efficiency the economic potential for the industrial sector is 30-33% savings; the technical potential of the residential and commercial building sectors are estimated to be 35-45% savings, with an economic potential of 20-35% (FEWE, 2004). The economic potential will increase if energy efficiency measures are combined with renovation of existing buildings. The potential savings from electric motors are estimated to be 10-12% of electricity consumption and the economic potential 6-8%.

Organisations for the Promotion of Energy Technologies (OPETs), created by the EC and funded under the Joule Thermie programme to cover the rational use of energy, generally do make indicative energy saving claims. Many organisations, either at national or European level, make more specific savings claims for measures to reduce energy consumption in their sector. For example the International Union of Railways (UIC) identifies possible reductions between 2 and 10% for rolling stock design and over 10% for adoption of double-deck rolling stock (UIC, 2006).

6. Contribution of Green Paper in perspective

The Green Paper (EC, 2005) aims at 20% total savings of primary energy in the period up to 2020. This means extra savings beyond autonomous trends as highlighted earlier.

The table in the appendix presents a rough picture of Green Paper savings fitting into total energy consumption developments. Total energy consumption in 2000 is set at 100 units. Final energy users are divided into ETS-energy use and ESD-energy use. Energy supply as a whole is supposed to be part of the ETS-scheme. For end-use sectors an energy demand growth of 2% (excluding energy savings) has been assumed, in line with the trends in the Wuppertal study (Lechtenböhmer, 2005). For electricity production a 1% higher demand growth has been supposed.

In the baseline a 1% per year efficiency improvement has been assumed. This is somewhat higher than the realized 0.8% yearly efficiency improvement from 1990 on, as found in the Odyssee-project on energy indicators (Odyssee, 2005). To realise extra savings of 20% in the period 2005-2020 an additional 1.5% efficiency improvement per year must be accounted for in the calculation scheme. With these extra savings total energy consumption actually decreases after 2000 (see line 'Total'/ 'with extra savings'). This is in accordance with the results from the Wuppertal study.

From this simple analysis it follows that in the period 2005-2020 total yearly savings of 2.5% will result from the process of reaching the 20% goal of the Green Paper (GP). However, it must be remarked that the 2.5% total savings contain autonomous savings as well. Long term historic analysis for periods with hardly any policy on energy savings suggest autonomous savings between 0.5 to 1.0% per year. For the Netherlands it has been estimated that total energy savings of 1% per year consisted of 0.7% autonomous savings and 0.3% policy induced savings (EZ, 2006). Taking the 0.7% autonomous savings figure, this means that yearly savings of 1.8% must be realised with existing and new policy measures, as to reach the goal of the Green Paper (see Table 6.1).

Table 6.1 *Estimated efficiency improvement 2005-2020 related to Green Paper*

	Yearly savings [%]
Autonomous	0.7
Existing policy	0.3
Total Baseline	1.0
New policy Green Paper	1.5
Total savings	2.5
Among which policy savings	1.8

7. Relationship with Energy Service directive

The directive on energy end-use efficiency and energy services (ESD, 2006) was adopted in April 2006. It requires Member States to draw up national action plans to achieve 9% final (end-use) energy savings during the years 2008-2016 on almost all energy use that is not part of the emission trading scheme (households, most tertiary sectors and transport). It regards energy savings beyond the autonomous savings, to be realized with policy measures from 1995 - and in some cases 1991 - on. The target is only indicative but the national action plans will need approval from the Commission and will be reviewed every three years. There is a clear obligation for Member States to aim to achieve the target by taking appropriate measures.

The table in the appendix presents a rough picture of ESD-savings fitting into the Green Paper target. The development of total energy consumption and the Green Paper savings have already been explained in Chapter 6. The 20% efficiency improvement of the Green Paper is equal 25.4 units (total energy use in 2000 set at 100 units, see appendix). The savings due to the ESD equal only 5.4 units, or one fifth of the Green Paper savings.

The relatively small contribution of the ESD is due to:

- The smaller scope as it regards only half of total energy consumption (no energy-intensive industry and no energy supply).
- The smaller base, as it regards 1% of fixed historic (non-growing) energy use.
- A shorter period (2008-2016 for ESD against 2005-2020 for the Green Paper).

If a correction is made for the different periods, the ESD-contribution is one-third of the Green Paper savings. After correcting also for the larger scope of ETS, the contribution of ESD-savings is two-thirds (see 'Non-ETS', last two columns in the table). This factor of two-thirds corresponds with the 1% extra ESD-savings and the 1.5% extra savings, calculated for the Green Paper.

In the preceding analysis it has been supposed that the Action Plans of the Green Paper lead to 1.5% extra savings in all end-use as well as energy supply sectors. If less than 1.5% efficiency improvement is realized in ESD-sectors, the relative contribution of the Energy Service directive will be higher than two-thirds. However, in that case the extra savings in emission trading sectors should be higher than 1.5%, in order to realize the overall goal of the Green Paper.

8. Elaboration on the baseline for the Green Paper

According to the text in the appendix of the Green Paper the 20% cost-effective savings should be realized compared to projections for 2020. However, it is not specified which projections are meant. Normally, goals in official documents are based on projections and policies that were known at the time of publication of the document. Given publication of the Green Paper mid-2005 this means that the baseline should encompass all policy measures or actions up to the end of 2004. The same holds for assumptions with regard to future economic growth, energy price levels, etcetera. The recently provided PRIMES-scenarios for EU countries (NTUA, 2006) offer such a baseline scenario, as these scenarios start from 2005, and contain existing policy up to the end of 2004. Economic growth is set at 2% per year and the oil price is assumed to decrease somewhat from the high 2005 level of 54 $/barrel.

With regard to 'existing policy' some remarks have to be made:

- National policy measures up to the end of 2004 should be present in the PRIMES-scenarios. However, no information is available yet on concrete measures. Moreover, the effect of these measures in the baseline scenario is not given as part of presented output.
- All EU directives until end-2004 should be present in the baseline as well. However, the actual effect of these directives is dependent on the implementation in all EU countries. As this often takes several years, only part of the directives can be taken as existing policy, e.g. (SAVE, 1993), (IPPC, 1996), labels and standards (Labels, 1992), (LCP, 2001), taxes (ETD, 2003) and emission trading (ETS, 2003). The Energy Efficiency Action Plan of 2000 is also part of existing policy. Probably not (completely) effective are the directives (Electricity, 2003), (CHP, 2004), (Eco-design, 2005) and (EPBD, 2006). The effect of these directives can be attributed to the extra 20% savings to be realized.
- The Green Paper goal probably was based on observed price levels and expectations in 2004/2005. Recently, energy prices have increased further compared to levels in the PRIMES-base year (NTUA, 2006). However, this further increase was not part of the baseline; moreover, it can reverse again in time. Therefore, these higher than expected prices should not directly lead to a correction of the 20% savings goal. In effect, the extra savings due to higher prices could be taken for granted when trying to realize this goal.

9. Observations and tentative conclusion

Observation

From the preceding analysis the following observations can be made:

- The 20% savings in the Green Paper does not regard total energy savings but only the extra savings beyond a BAU (Business As Usual) trend. Therefore the effects of all policy measures implemented before 2005 are not part of the 20%. The definition of cost-effectiveness goes beyond pay-back periods that many energy users accept. Both factors make it somewhat harder to reach the 20%.
- The most extensive and consistent underpinning of 20% savings is given by the Wuppertal study. However, this study supposes a number of stringent additional policy measures beyond existing policy.
- The results of the studies on the effects of several of the measures cannot be summed up due to probable overlap. The closing of the efficiency gap between western and eastern European countries is already partially accounted for in the BAU-trends and thus contributes somewhat less than assumed earlier to the 20% savings. Rebound effects are also likely, as living standards are raised in the new Member States. Both these observations point to a possible overstating of the results of policies.
- To reach the goal of 20% savings above BAU, yearly total savings of 2.5% will be necessary. Given 0.7% autonomous savings, existing and extra Green Paper policy should contribute 0.3% and 1.5% respectively, totalling 1.8% policy induced savings per year. This indicates that the effects of existing measures need to be increased somewhat more than was foreseen in the Green Paper. There the effect was expected to be roughly evenly divided between existing and new measures.
- The rate of autonomous energy savings will increase (possibly from 0.7% to 0.8-0.9%) if present high world market prices persist until 2020. In that case smaller policy induced savings suffice to realise the Green Paper target of 20%.
- In ESD-sectors (e.g. households, tertiary and transport) the goal of the Green Paper requires about 1.5 times more efficiency improvements than the target of the Energy Service directive (taking into account the shorter period and smaller scope of the ESD).
- The new PRIMES baseline scenario, containing existing policy measures up to end-2004, can be used as the baseline for the Green Paper goal of 20% energy savings.
- Given slow actual transferring of earlier EU directives into national policy, only part of all present directives should be regarded as existing policy measures in the baseline.

Conclusion

A considerable strengthening of energy efficiency policy, at EU and/or country level, is needed in the shortest run possible to make the (extra) 20% savings statement in the Green Paper come true. However, to accomplish this task a substantial part of EU-energy efficiency policy can be relied on, as many (new) directives have yet to deliver their full potential contributions. Moreover, enduring high energy price levels can help to realise the target to some extent.

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Appendix A Linking Energy Service Directive and Green Paper on Energy Efficiency

Table A.1 *Simplified overview of energy consumption and savings related to the goals of Green Paper and ESD (total energy use 2000 = 100)*

Analysis of 20% savings for Green Paper and Savings Energy Service directive															
	Change			(energy consumption 2000 = 100)							Change	Savings in Green Paper			Savings
	per year	2000		2005		2010		2015		2020	2000-2020	2000-2020	2005-2020	2008-2016	ESD
Non-ETS															
without savings	**2,0%**	60	2%	66,2	2%	73,1	2%	80,8	2%	89,2					
baseline (+savings)	**-1,0%**	60		63,0		66,1		69,5		72,9	12,9				
with extra savings	**-1,5%**	60		58,4		56,9		55,4		53,9	-6,1	26%	20%		
idem (PJ)												-19,0	-14,4	-8,7	-5,4
total savings (%)												40%	31%		-9%
ETS-end use															
without savings	**2,0%**	**20**	2%	22,1	2%	24,4	2%	26,9	2%	29,7					
baseline (+savings)	**-1,0%**	20		21,0		22,0		23,2		24,3	4,3				
with extra savings	**-1,5%**	20		19,5		19,0		18,5		18,0	-2,0	26%	20%		
idem (PJ)												-6,3	-4,8	-2,9	**0**
total savings (%)												40%	31%		
Total end-use															
without savings		80		88,3		97,5		107,7		118,9					
baseline (+savings)		80		84,0		88,2		92,6		97,2	17,2				
with extra savings		80		77,9		75,8		73,8		71,9	-8,1	26%	20%		
idem (PJ)												-25,4	-19,2	-11,5	-5,4
total savings (%)												40%	31%		
ETS-supply	**1,0%**	< extra growh electricity													
without savings	3,0%	**20**	3%	23,2	3%	26,9	3%	31,2	3%	36,1					
baseline (+savings)	**-1,0%**	20		22,0		24,3		26,8		29,5	9,5				
with extra savings	**-1,5%**	20		20,4		20,9		21,4		21,8	1,8	26%	21%		
idem (PJ)												-7,7	-6,1	-3,7	**0**
total savings (%)												40%	32%		
Total															
without savings		**100**		111,5		124,4		138,8		155,0					
baseline (+savings)		100,0		106,0		112,5		119,4		126,8	26,8				
with extra savings		100,0		98,3		96,7		95,2		93,7	-6,3	26%	20%		
idem (PJ)												-33,1	-25,4	-15,2	-5,4
total savings (%)												40%	31%		