The role of energy efficiency in the framework of the EU energy and climate strategy – a policy-based scenario analysis

Stefan Lechtenböhmer
Wuppertal Institute
Germany
stefan.lechtenboehmer@wupperinst.org

Stefan Thomas
Wuppertal Institute
Germany
stefan.thomas@wupperinst.org

Christoph Zeiss
Wuppertal Institute
Germany
christoph.zeiss@wupperinst.org

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Abstract

Based on a comprehensive scenario analysis of the EU's GHG emissions by 2020, we show that the 20% energy savings target set in the Action Plan "Doing more with less" in 2006 is still the most significant and thus indispensable strategy element within an ambitious EU climate and energy strategy targeting at a 30% reduction of GHG emissions by 2020[1].

The scenario analysis provides a sector by sector projection of potential future energy use and GHG emissions, combined with a detailed policy analysis of the core policies on energy efficiency by the EU and its Member States taken from current research results by the authors and others.

Consequently the paper identifies and quantifies the current implementation deficit in the EU and shows that, despite of sufficient targets, implementation is still significantly lacking in almost all fields of energy efficiency. Some, e.g. transport sector and buildings, are still substantially far from receiving the necessary political impetus. The paper also demonstrates co-benefits of a strong energy efficiency strategy, e.g. the achievability of the targets of the RES directive, which crucially depends on a strong efficiency policy.

We conclude that the efforts of the energy efficiency policy of the EU and its Member States have to be significantly intensified in order to fulfil its role in the climate and energy strategy. To achieve this, we offer an analysis of the current weaknesses of EU energy efficiency policy and derive recommendations on how the EU can still reach its targets for 2020.

Introduction

In March 2007, the European Council committed to reducing the EU's greenhouse gas (GHG) emissions by 20% by 2020 compared to 1990. At the same time, it endorsed an EU objective of a 30% reduction in greenhouse gas emissions by 2020 as its contribution to a global and comprehensive agreement for the period beyond 2012. Yet the condition was set that other developed countries commit themselves to comparable emission reductions and that economically more advanced developing countries commit themselves to contributing adequately according to their responsibilities and capabilities.

On January 23rd, 2008, the EU presented its plans for a climate package (EC 2008). Together with other energy and climate policy actions already tabled (in particular the Action Plan for Energy Efficiency), this package shall put the EU on the right track to achieve its mentioned climate and energy targets.

By a scenario analysis of the EU's GHG emissions by 2020 based on a recent scenario study conducted by the Wuppertal Institute on behalf of WWF Europe (WI 2007), we show that the 20% energy savings target set in the Action Plan "Doing more with less" in 2006 is still the most significant strategy element within the EU climate and energy strategy.

For this purpose a "30%-P&M" Scenario has been developed, based on earlier work by the Wuppertal Institute (WI 2005, 2006, (cf. Lechtenböhmer et al. 2005, 2007). This scenario draws upon existing analyses of GHG mitigation potentials in

1. As proposed by the EU in case that other developed and key developing countries take up comparable targets

all sectors and shows a pathway for the EU to reduce its GHG emissions by 2020 by almost 30% domestically. In this study no use of flexible mechanisms has been assumed, although the Kyoto regime, the EU ETS, and also the new RES Directive provide a high flexibility to fulfil policy obligations partially abroad[2]. Although this provides policymakers and individual actors with additional flexibility to achieve the 30% target, we present here a scenario on a full domestic 30% GHG emission reduction. Such a scenario plus an active support of emerging and developing countries in containing their emissions would come close to targets of the Bali Roadmap[3]. These are for the industrialised countries to reduce their GHG emissions by 25–40% by 2020 and for developing countries to show "measurable, reportable and verifiable" steps for tackling their emissions, supported by cleaner technology, financing and capacity-building.

METHODOLOGY OF THE SCENARIO ANALYSIS

Our analysis consists of two scenarios. The Business as usual (BAU) scenario assumes continuing policies and measures. It relies on the most recent energy and transport projections for Europe (DG TREN 2008) amended by further analyses for other greenhouse gases and emission sectors. Its main purpose is to serve as a reference scenario for the "30%-policies and measures (P&M) scenario". The P&M strategies and assumptions are based on evaluation and extrapolation of detailed analyses in all sectors, for many countries, for important energy-using goods and appliances. A number of most relevant studies were chosen for a previous study (see WI 2005), and the selection was updated here.

The quantification and combination of potentials, strategies, policies and measures for the 30%-P&M scenario, and the calculation of scenarios were carried out using the Wuppertal Scenario Modelling System. This system uses a technology-oriented, sectoral, bottom-up energy model and it applies an expert-based simulation approach in order to formulate potentials and strategies and to estimate market penetration rates of new technologies, market shares of fuels, etc.[4]. Estimates of gross domestic product (GDP), population are taken as exogenous variables and have been quoted from the current DG TREN (2008) baseline scenario (see Table 1). The model further does not account for eventual feedbacks from energy policies to those socio economic drivers. Due to the expert based approach, all future decisions e.g. on the implementation of savings potentials, on market shares and on the development of new power plants are made by judgement. Existing potentials for energy efficiency and renewable energy sources, available technologies and their costs as well as the expected oil price development are taken into account but not used in the form of a mathematical optimisation.

Corresponding to its relevance for GHG emissions, the energy sector is modelled with the greatest detail using appliance or end-use specific sub-models for every demand sector (households, tertiary, industry, transport) and a purpose-oriented model of the transformation sector[5]. GHG emissions in the energy sector are calculated based on the final and the primary energy balance. CH_4 and N_2O emissions in the energy sector are estimated by sub-sector using a simplified approach based on current sector-specific implied emission factors[6]. Other sectors and greenhouse gases are covered by specific sub-models which are adapted to the (currently limited) information available in these sectors.

In the scenario analysis no explicit ranking and selection of GHG mitigation potentials and strategies by cost criteria has been made, due to the problematic nature with regard to the different cost and benefit functions of actors in different countries and sectors and under different perspectives (e.g. micro-economic: company level; macro-economic: state level).

The main underlying assumptions for the selection, calculation and extrapolation of the sectoral scenarios are:

- The delivery of substantial emissions reductions versus the BAU scenario by an exploitation of roughly 80% of the available emissions reduction potential. The estimates of the potential rely mainly on previous studies (WI 2005, 2006). They have been updated here, taking into account the fact that a part of the potential cannot be achieved any more by 2020 due to slow exchange of existing stocks etc. They have, however, not been updated with regard to more recent world market energy prices, which have been assumed to be significantly higher in the most recent baseline by DG TREN 2008 and in our assumption (see Table 1) compared to the assumed price level in the original studies[7].
- The updated emissions reduction potentials taken into account for the 30%-P&M scenario are, typically cost effective in a national economic perspective – calculated with long-term real interest rates typically between 3% and 5% and payback times equal to economic lifetimes of investments[8] and using average projected energy prices over the life times of the investments. We know that a significant share of these potentials, in spite of being economical no regret options, will not be implemented by market forces alone due to

2. This can reduce costs of GHG mitigation, provide valuable incentives for technology transfer and strengthen energy and climate links between the EU and neighbouring regions. However, there are limits to this, since recent research showed that newly industrialising countries need to achieve own emissions reductions vs. baseline projections of between 15 and 30% (den Elzen and Höhne, 2008).

3. At the UN Climate Conference in Bali, Indonesia from 3 to 15 December 2007 a roadmap for the further negotiations was adopted. Its target is to conclude a new international agreement as successor for the Kyoto Protocol at the Climate conference in Kopenhagen in December 2009. During the negotiations the EU and others pledged to set a target for industrialised nations to reduce their GHG emissions by 25 to 40% vs. 1990. However, the final decision only refers to the the respective reults of the AR4 by the IPCC.

4. The expert-based approach is described in detail in Lechtenböhmer & Thomas (2004). However, for the scenario analysis described here a simplified approach was used due to budget and time constraints.

5. A description of model detail and philosophy as applied for Germany is given in Fischedick, Hanke and Lechtenböhmer (2002). For this work the models have been adapted using the same philosophy but partly lower disaggregation levels.

6. To achieve a more precise calculation of CH4 and N2O from the combustion of fuels, a technology-specific approach would be needed (see IPCC 1996, 2000). However, the contribution of these gases to the total GHG emissions of fuel combustion is well below 2.5%, which justifies a simpler approach.

7. It is assumed that the current relatively low level of world market energy prices will not be sustainable and price trajectories will be back to the projected increasing trend soon.

8. Economic lifetime varies from typically 12 to 15 years for appliances in residential and tertiary sectors, to 25 to 30 years for retrofitting of buildings, industrial equipment and power plants (cf. Blok 2005). These payback times and interest rates, however, don not correspond to the criteria used by for-profit companies for their investment calculations. This means that the gap between the investors profitability criteria and the macroeconomic optimum has to be bridged by respective policies and measures, raning from financial support to legal requirements for GHG mitigation investments.

Table 1: Core socio-economic assumptions of the baseline scenario compared with the IEA 2008 BAU Scenario

	1990	1995	2000	2005	2010	2015	2020
GDP (gross domestic product) (in bln €$_{2005}$)							
BAU / P&M / DG TREN *)	8,109	8,712	10,046	10,949	12,430	14,059	15,689
IEA (2008)						13,731	14,928
Crude oil price (in USD$_{2005}$/barrel)							
BAU / P&M	30	19	30	50	100	100	100
DG TREN					55	58	61
IEA (2008)					94	94	104
Primary energy use (in Mtoe/a)							
BAU / DG TREN *	1,650	1,651	1,712	1,811	1,854	1,928	1,968
IEA (2008)	1,653	1,651	1,712	1,814	1,856	1,897	1,903
CO_2-emissions (Mt/a) **in Mrd t.**							
BAU / DG TREN *	4,047	3,820	3,821	3,947	3,997	4,157	4,253
IEA (2008)	4,044			3,944	3,975	4,006	3,949
Share of renewable energies in primary energy use (%)							
BAU / DG TREN	4.4	5.1	5.9	6.8	8.2	8.8	10.0
IEA (2008)				6.8	8.7	10.8	12.7

*We use the assumptions of the most recent DG TREN baseline scenario for the BAU and the P&M scenario.
Source DGTREN (2008); IEA (2008), EIA (2009)

numerous barriers. However, the scenarios also take into account that they should be attainable by appropriate and realistic strategies, policies and measures, based on experience by some Member States (cf. e.g. Thomas 2007).

UNDERLYING SOCIOECONOMIC ASSUMPTIONS AND CORE BAU RESULTS

The basic data, economic assumptions and the main results for the BAU scenario have been derived from the latest available EU energy and transport projections (DG TREN 2008). Between the first study and today, a drastic spike in crude oil prices occurred. In spring 2005 the oil price was about $40/barrel, during the main work for the study the price soared to $140/barrel, today its price is back to the level of 2005. There were no studies available which showed high price scenarios like we experienced. Even when the oil price seems now to be stable between 40 and $50/barrel, the fundamental market data, especially the mid term development in upstream exploring and developing as well as the rising demand leads to high price expectations . Additionally there are strong hints for reaching the peak of oil production, which would lead to an even further tightening at the market (see e.g. UK Industry Task Force, 2009). In this study we assumed as a conservative approach an oil price of $100/b (real value, based on 2000) in 2020. This price is located above the price assumptions of DGTREN (2008) and more in line with IEA (2008). All other assumptions are based upon the DG TREN (2008) baseline scenario.

Results for the 30% P&M-Scenario

In the following we give first an overview of the quantitative results of the 30% P&M scenario. After this we discuss the results and consequences of the scenarios for the main policy fields, emission trading, energy efficiency including combined heat and power generation, and renewable energies.

ALLOCATION OF GHG EMISSION REDUCTIONS

Figure 1 shows that under BAU conditions EU GHG emissions will not significantly decline in coming years[9]. It also shows that in the 30%-P&M scenario GHG emissions can decline much faster than in recent years. Compared to the BAU scenario, annual GHG emission reductions by almost 1.5 billion tons of CO_2 equivalent have to be mobilized. 41% of these reductions can be achieved by exploiting energy efficiency potentials mainly on the demand side. 27% can be achieved by an accelerated use of renewable energies versus BAU and 19% by the net switch to cleaner fuels (including CHP). Further 13% of reductions versus BAU may be instrumented by diverse policies and measures to reduce emissions from other greenhouse gases and from non-combustion sectors.

According to the 30%-P&M scenario, about 55% of all GHG emission reductions versus BAU have to be achieved in sectors falling under the ETS (only combustion related CO_2 emissions), 32% in the other sectors which are instrumented by the EU Member States (MS), and 13% in other gases and sectors (partly falling also under the ETS but mainly to be instrumented by the MS). The high share of the ETS in the emission reductions of the 30%P&M scenario vs. BAU demonstrates the importance for tight CAPs on the overall emissions from the ETS. There are, however, strong interactions between the ETS and other policy fields. E.g. the RES targets provide for a significant increase of renewable electricity generation, which in turn mitigates the demand for ETS-allowances from fossil electricity generation. This effect also holds true for policies targeted at supporting energy efficiency in large industries, saving electricity and supporting combined heat and power generation (CHP). This mitigating effect on the demand for allowances has a dampening effect on certificate prices and thus strengthens the political feasibility of tight CAPs.

9. For further information on the BAU scenario see DG TREN (2008)

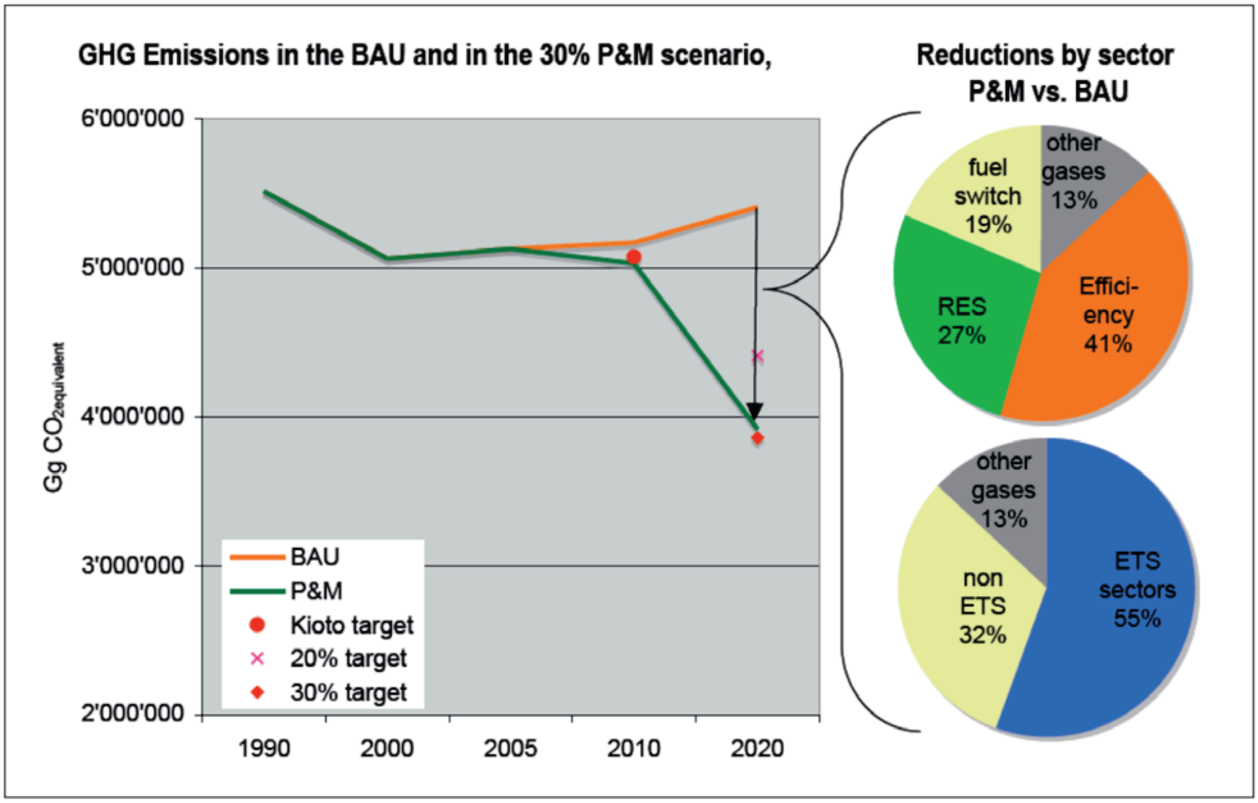

Figure 1. Overview of GHG emission reductions in the 30%-P&M scenario vs. BAU. Other gases: all Kyoto-Gases and sectors apart from combustion related CO_2; Source: WI 2008, EEA 2008, GHG Inventory, DG TREN 2008

The table 2 provides the overall results of the 30%-P&M scenario compared with the BAU scenario. The 30%-P&M scenario is a backcasting exercise: its aim is to demonstrate by detailed and realistic bottom-up calculations that the Kyoto target for the EU15 and the MS, which have individual targets, is possible to achieve.

The main emission reductions will be achieved in the field of energy related emissions which are projected to decrease by 28.6% versus 1990 by 2020. This is a reduction of about 31.6% versus BAU. In the other emission sectors, fugitive emissions from energy, agriculture and waste – apart from process related emissions from industry – even higher emission reductions are expected. However, the larger part of these emission reductions will be achieved in the BAU development already, due to structural changes such as declining coal production and declining number of cattle and existing legislation e.g. the landfills directive (see WI 2005). In order to achieve 30% GHG emission reductions by 2020 domestically, a comprehensive policy package – as assumed in the 30%-P&M scenario – is necessary.

REQUIREMENTS FOR ENERGY EFFICIENCY IN THE 30%-P&M-SCENARIO

The 30%-P&M scenario strongly relies on demand side energy efficiency as a main driver for GHG emission reductions. The **final energy demand** in the 30%-P&M scenario decreases by 6.5% from 2005 to 2020. With nearly half of the overall savings, the main saving effect appears in the residential sector. The final energy demand in this sector is reduced by about 11.6% vs. 2005. Picturing the changes in final energy demand by fuel, there is a sharp drop in solid fuels, decreasing by about 59% and oil, decreasing by about 20%. In contrast, the demand for district heat (48%) and direct use of renewable energies (134%) grows significantly.

The **energy supply side** of the 30%-P&M scenario shows a decrease in the primary production by more than 12%. The energy production from fossil fuels is expected to decline significantly, especially in the share of solid fuels (mainly coal) and oil, which is more or less equivalent to the BAU scenario. Solid fuels decrease by 45%, oil drops even further and decreases by more than 60%. The primary energy production from natural gas decreases by 39%. The opposite effect appears in the renewable energies, where the production will almost double between 2005 and 2020. Main drivers in the renewables area are biomass and waste as well as wind energy. The growth in solar energy is also exorbitant, however its total share still is considerably lower. In spite of the declining domestic energy production, the net imports can be maintained by 2015 at about the level of 2005 in absolute terms. By 2020 even a reduction of energy imports is possible in the 30%-P&M scenario. This is enabled by the absolute reduction of primary energy use in the 30%-P&M scenario by 12% between 2005 and 2020.

Electricity generation is projected to increase only slightly in the 30%-P&M scenario. Between 2005 and 2020, the increase will be about 4%. The share of different energy carriers will, however, change significantly. Fossil electricity generation will decline by almost a quarter with an underlying switch from condensing power plants to CHP, nuclear generation will decline by about 20% due to the assumption that the existing

Table 2: Total GHG emissions in the Policies and Measures Scenario by Gas and UNFCCC Source Category.

Gg $CO_{2\ equivalent}$		1990	2005	2010	2020	2020/ 1990	2020 vs. BAU
1A*)	**Fuel combustion**	**4'157'252**	**4'028'388**	**3'613'897**	**2'966'728**	**-28.6%**	**-31.6%**
	CO_2	4'089'867	3'953'944	3'543'044	2'908'931	-28.9%	-31.6%
	CH_4	21'946	14'258	13'279	10'227	-53.4%	-30.4%
	N_2O	45'439	60'186	57'574	47'570	4.7%	-29.1%
1B	**Fugitive emissions from energy**	**154'896**	**91'871**	**85'530**	**62'036**	**-60.0%**	**-23.7%**
	CO_2	19'626	18'662	18'662	18'662	-4.9%	0.0%
	CH_4	135'183	73'106	66'766	43'271	-68.0%	-30.8%
	N_2O	87	103	103	103	18.1%	0.0%
2+3	**Industrial processes & solvent use**	**487'349**	**421'549**	**413'298**	**441'706**	**-9.4%**	**-15.6%**
	CO_2	303'837	281'602	283'224	275'914	-9.2%	-5.9%
	CH_4	1'164	1'088	1'091	1'100	-5.5%	0.0%
	N_2O	123'451	65'932	64'445	57'606	-53.3%	0.0%
	HFCs, PFCs, SF_6	58'897	72'927	64'537	107'086	81.8%	-37.5%
4	**Agriculture**	**538'084**	**481'372**	**447'288**	**363'610**	**-32.4%**	**-14.7%**
	CO_2						
	CH_4	257'456	217'714	196'207	149'256	-42.0%	-17.0%
	N_2O	280'628	263'659	251'081	214'354	-23.6%	-13.0%
5	**Land use change & forestry**	**-343'991**	**-438'522**	**-438'522**	**-438'522**	**27.5%**	**0.0%**
	CO_2	-348'813	-442'095	-442'095	-442'095	26.7%	0.0%
	CH_4	1'253	1'024	1'024	1'024	-18.3%	0.0%
	N_2O	3'569	2'550	2'550	2'550	-28.6%	0.0%
6	**Waste**	**174'499**	**103'382**	**85'191**	**35'755**	**-79.5%**	**-16.0%**
	CO_2	6'050	5'229	5'229	5'229	-13.6%	0.0%
	CH_4	159'788	88'296	70'105	20'669	-87.1%	-24.7%
	N_2O	8'661	9'857	9'857	9'857	13.8%	0.0%
Total	excluding removals	**5'516'902**	**5'130'136**	**4'648'778**	**3'873'408**	**-29.8%**	**-28.4%**
	including removals	**5'168'088**	**4'688'040**	**4'206'683**	**3'431'312**	**-33.6%**	**-30.9%**
	CO_2 excluding removals	4'419'380	4'259'436	3'850'159	3'208'735	-27.4%	-29.8%
	CO_2 including removals	4'070'566	3'817'341	3'408'064	2'766'640	-32.0%	-33.0%
	CH_4	576'790	395'485	348'473	225'548	-60.9%	-21.3%
	N_2O	461'835	402'287	385'609	332'039	-28.1%	-13.5%
	Other GHGs	58'897	72'927	64'537	107'086	81.8%	-37.5%
%-Change vs. 1990 (without H_2O **))							
	excluding removals ***)						
	CO_2 only	0.0%	-3.6%	-12.9%	-27.4%		
	Total 6 Gases	0.0%	-7.0%	-15.7%	-29.8%		
	including removals ***)						
	CO_2 only	0.0%	-6.2%	-16.3%	-32.0%		
	Total 6 Gases	0.0%	-9.3%	-18.6%	-33.6%		

*) 1A: Defintion of subsectors changed between 2005 (inventory data) and 2010 (projection data)**)H_2O and other global warming effects from planes; **) Removals of CO_2 from land use change and forestry.
Source: WI 2008 based on: UNFCCC 2008; EEA 2007; WI 2005

Table 3: Final energy savings 30%-P&M scenario vs. BAU.

	Savings vs. BAU (2020)		Share of	Savings vs. 2005		Share of
	ktoe	%	savings	ktoe	%	savings
Final Energy Demand	**260'387**	**19.3%**	**100.0%**	**75'069**	**6.5%**	**100.0%**
by sector						
Industry	69'838	19.0%	26.8%	21'936	6.9%	29.2%
Residential	64'482	19.2%	24.8%	35'709	11.6%	47.6%
Tertiary	40'619	19.8%	15.6%	8'913	5.1%	11.9%
Transport	85'448	19.5%	32.8%	8'511	2.4%	11.3%
by fuel						
(negative savings: increasing demand)						
Solids	30'974	60.9%		28'604	59.0%	
Oil	150'304	27.9%		95'398	19.7%	
Gas	84'394	29.1%		65'181	24.1%	
Electricity	47'496	15.7%		-13'089	-5.4%	
Heat (from CHP and District Heating)	-6'952	-8.2%		-29'535	-47.6%	
Other (mainly renewables)	-45'829	-58.0%		-71'490	-134.0%	

Source: own calculations, WI 2008

phase out decisions will be implemented and no new nuclear power plants will be commissioned apart from the two reactors in Olkiluoto and Flamanville already under construction[10]. Renewable electricity generation is going to almost triple over the period. This has also consequences for the RES share in electricity generation which will increase from 13.5% in 2005 to almost 36% in 2020. The CHP share is also expected to almost double to 27% in 2020 due to an intensive supporting policy for CHP expansion.

Discussion of scenario results for core policies of the climate package

THE EU EMISSION TRADING SCHEME

In the 30%-P&M scenario, the emissions from the sectors falling under the EU ETS[11] are expected to decrease by about 34% between 2005 and 2020. It is therefore necessary to amend the ETS Directive (European Parliament 2008a) by a mechanism that ensures that the current target of a linear decrease of emission allowances by 21% between 2005 and 2020 will be altered to the necessary 34% in the framework of an international agreement[12] and also to limit drastically the use of external credits such as those from CDM and JI projects. These reductions are regulated by the cap for the overall GHG emissions from installations falling under the EU ETS. However, their achievement results from a number of policies such as expansion of renewable electricity generation, energy efficiency improvements in electricity consumption and energy efficiency improvements in power plants and industry. It is thus crucial to take account for this "double counting" of the effects of the policies. As all emission reductions of installations falling under the ETS are capped, further reductions in these sectors are available for external trade and can be sold. This leads to the fact that once a cap has been fixed for the ETS sectors, further emission reductions in these sectors – regardless by which policy they might be instrumented – are not available for the national account. All other reductions have to be achieved in other sectors. Policies to achieve emission reductions in the ETS sectors will also not generate additional emission reductions exceeding the cap set for the ETS but only support the achievement of the ETS cap during one ETS period – unless the cap is made flexible for downward adjustments to reap the benefits of additional reductions from such policies. However, this is by no means an argument against sector- and technology-specific policies for energy efficiency and renewable energies:

- They will demonstrate that the EU as one of the major blocks of industrialised countries is taking domestic action for immediate reduction of emissions seriously, which is important for the international negotiations
- By overcoming market barriers for energy efficiency and renewable energies, they will enable the EU to reach the ETS caps at lower overall cost, due to the cost-effectiveness particularly of energy efficiency
- Particularly if they lead to an overshooting of the reductions in the ETS caps, they will prepare further tightening of the cap after 2020
- Not the least, the reap all the other benefits of energy efficiency and renewable energies, such as improved security of energy supply, reduced energy imports, increased purchase power and competitiveness, and job creation.

INSTRUMENTS FOR THE IMPROVEMENT OF ENERGY EFFICIENCY

The Energy End-use Efficiency and Energy Services Directive (ESD) as well as the Eco Design or Energy-using Products Directive (EuP), the Energy Performance of Buildings (EPBD), Energy Labelling, and Cars Directives, are targeted at the improvement of energy efficiency in the EU and thus a reduction of final energy demand vs. the BAU-scenario. They are – together with the CHP Directive – the most relevant Directives to achieve the target set by the Action Plan on Energy Efficiency (cp. Scholten et al. 2007). In the 30% P&M scenario, final energy savings of almost 19% or 175 Mtoe by 2020 vs. BAU are calculated based on our assumptions for the market penetration of energy-efficient solutions. Residential and industrial sectors show slightly smaller than average saving rates vs. BAU mainly due to longer life times of existing stock of buildings and machinery, while tertiary and transport sectors have slightly higher savings (see Table 2). Regarding the absolute savings vs. BAU, almost a third is allocated in the transport sector, followed by industry and residential sectors with about a quarter of all savings each.

These results illustrate that achieving the 20% primary energy savings target of the Energy Efficiency Action Plan is crucial to realize 30% domestic GHG emission reductions. In spite of its significance the 20% target has yet not been made a binding target[13] and the current implementation of the core measures given in the Action Plan indicates the need for further action:

- The preparatory studies for the EuP Directive indicate savings potentials of 62 to 119 Mtoe by 2020 if the planned minimum efficiency standards for the most important energy consuming products are rapidly implemented and the most stringent level currently discussed is imposed. The implementation process to date has been criticised for being relatively slow, however, it may speed up in the next couple of years.
- Further savings are to be expected from the EPBD. However, they partly overlap with savings estimated for the EuP, and improvements of the building shell, which are additional

10. There is a controversial discussion over new nuclear capacity ongoing. On the one hand, both projects currently under construction suffer from delays, economic and possibly also technical problems. On the other hand several MS have announced plans for new nuclear investment. Given the current concretion level of these plans, however, we do not expect one of these projects to become operational before 2020. What is more also the known problems of nuclear fuels such as proliferation, lack of appropriate storage capacities for radioactive waste and safety have not declined in recent years.

11. Here only combustion related CO_2 emissions from the energy sector and industry are taken into account. The values are not corrected for installation in these sectors not falling under the ETS nor for installations in other sectors or other non-energy emissions falling under the ETS.

12. Such a mechanism of a lineary strengthening of targets had been included in the proposal to the directive but was removed during the negotiation process.

13. In February 2009, the EP concluded a resolution in which it called "on the Commission to propose a binding goal of 20% in energy efficiency by 2020 and to accompany that proposal with concrete interim reduction targets" (EP 2009, 22).

to the EuP, take a long time to be implemented on a larger scale. Furthermore, implementation of the EPBD has been slow, and it should be amended to achieve higher levels of ambition (cf. next section).

- To which extent the ESD will achieve energy savings additional to those already included in the BAU development, is yet unclear. It will depend on the way the European Commission and the Member States interpret the Directive and calculate the energy savings counting towards the Member States' indicative annual energy savings tagret of 9% in 2016. The ESD does not state that these savings shall be additional to BAU, and furthermore, some Member States wish to count energy savings achieved before 2008, the start year of the ESD implementation. More about these issues can be found in Thomas (2009). On the other hand, the national energy efficiency actions plans prepared by the Member States show a significant level of new and augmented policies and measures (cf. Schüle et al. 2009).

In the following we give more details on the tasks to be deliverd in the several fields of action.

Energy Performance of Buildings

Heating and cooling of residential and commercial buildings (including sanitary hot water generation) account for about a third of the EU´s final energy demand. They also account for about 29% of the total final energy savings achievable versus BAU. The EPBD together with the respective subsidiary national legislations and the mainly national support schemes for building renovation forms the main policy instrument to realize these potentials.

The largest part of the energy savings potential can be found in the field of residential buildings. Here, the building shell offers the biggest potential, followed by the heating system and appliances. About 2/3 of the energy savings potential by 2020 can be found in the cold and moderate North-western EU countries. The rest of the potential is almost equally divided between new and Southern EU Member States (cf. Koskimäki & Lechtenböhmer 2008).

Tertiary sector buildings are, however, not to be neglected. Here, about half of the emissions are due to electricity use. Consequently, large and very cost-effective energy savings and emissions reductions can be achieved, e.g., in lighting, ventilation, air conditioning, commercial cooling and circulation pumps within optimised heating systems. In the 30%-P&M Scenario, a quite ambitious programme to improve current standards of new buildings and the renovation of existing buildings has been assumed:

- Building codes for new buildings will be strengthened stepwise, leading to a market share of passive house and low energy house technology of about 30 to 40% of new buildings each by 2020. The rate of compliance to the building standards will be improved as well.
- The energetic refurbishment rate will increase from current values below 1% up to 2.5% per year, due to stronger policies. This includes the fact that in most refurbishments energetic improvements will be incorporated at improving standards. Problems here are among others the training of skilled workers and an effective control of compliance to standards.
- Improving the efficiency of the space heating system – i.e. heat generator (boiler), heat distribution (e.g., pipes, hydraulic optimisation, circulators), heat emitter (e.g. radiator) and control of the system – by 10% as compared to the BAU scenario will lead to a reduction in energy demand of more than 11% by 2020.
- It should be noted that there is a partial overlap between these numbers and the energy savings expected from energy performance standards, most notably for boilers, under the EuP Directive.

To achieve this high speed of improving the energy performance of buildings, EU Member States have to speedily implement new regulations, which may even exceed the provisions of the revised EPBD in some cases. Here, mandatory standards with EU-wide harmonisation for the ambition level of the building regulation might have supported more stringent regulations in all MS. Most important and additional to high standards, MS have to substantially size up investment into building renovation, which needs significant financial support both for energy audits and for implementing energy efficiency improvement actions, but also for local focal points or energy agencies, among other measures. Such measures will also contribute to achieving the Member States' targets under the Energy Services Directive.

The Industry Sector

The industrial production sector accounts for more than a quarter of all final energy demand reduction in the 30% P&M scenario. With savings vs. BAU by almost 20% it contributes an equal share to the energy savings target. However, energy savings achieved in this sector are almost completely covered by the ETS. This means that all policies and measures, which have to be targeted at increasing energy efficiency in industry, are a direct support for competitiveness and support tight caps under the ETS.

EU energy efficiency legislation for the industry sector includes the reference documents on best available technology (BREF) under the Integrated Pollution Prevention and Control (IPPC) Directive, the effects of EuP standards on appliances and installed equipment that are also used in industry, the effects of the Buildings Directive on industrial buildings, indirectly the EU ETS, and Member States' measures taken as well as energy services promoted under the Energy Service Directive in non-ETS sectors and consumers.

A proven policy package that Member States can apply to achieve additional energy savings in industry includes promotion of energy management, energy audits and investments, in combination with voluntary agreements with individual companies and reporting on concrete end-use actions they have taken. Financial support for energy audits and investments can improve the impact of this combination and be granted through, e.g., reductions in energy taxes, soft loans, and direct grants. Countries such as Denmark, Finland, the Netherlands, and Sweden have achieved good results with such packages of instruments (for Denmark and Netherlands see Thomas, 2007). Energy performance contracting can be a mean to implement

Table 4: Energy intensity reduction in transport, 2005 to 2020.

	BAU Scenario	P&M Scenario
Passenger transport activity (toe/Mpkm)	7%	32%
Private cars	11%	37%
Freight transport activity (toe/Mtkm)	5%	18%
Trucks	7%	17%

Energy intensity is expressed in energy use per person or ton kilometre.
Source: WI 2008, DG TREN 2008

Table 5: CHP expansion in the BAU and P&M scenario

	2005		2020			
Share of CHP (in ktoe)			BAU		P&M	
in electricity generation	30'700	12.7%	56'089	17.8%	71'308	23.2%
in final energy demand	69'671	5.9%	75'174	5.8%	86'953	7.4%

Source: WI 2008, DG TREN 2008

actions with longer payback periods in cross-sector technology areas such as heating, cooling, compressed air, and lighting. It can be pushed to higher market shares by a government risk insurance for Energy Service Companies against bankruptcy of their industrial clients, as well as by special consultancy of energy agencies to potential clients.

The Transport Sector

With a savings potential of about 90 Mtoe in the 30%-P&M scenario, the transport sector accounts for the largest share of almost one third of final energy savings versus BAU by 2020. These savings mean that the increasing trend of final energy demand in this sector can be stopped and consumption can be brought back slightly below 2005 levels.

To achieve this potential, a comprehensive package for all transport segments is needed. In private cars, it is assumed here that 120 gCO_2/vkm will become mandatory for all new cars by 2010 with further strengthening of this value to 100g/vkm before 2020. By this measure, the specific energy consumption of private cars could be reduced by about 37% by 2020 versus only 11% in the BAU scenario. For trucks, the achievable efficiency improvement is about half that size. Additionally, strong policies have to be implemented on transport demand and on a changed modal split favouring environmentally more sound transport modes such as walking and biking, buses, rail and ships.

The current decision on the CO_2 emissions for new private cars by the EU (European Parliament 2008c) is considerably less ambitious than assumed in the 30%-P&M scenario. Due to the different instruments like phase-in, eco innovations and derogation, it seems unlikely that the target of 120 g CO_2/km in 2010 will be reached. Therefore the actual energy intensity reduction in transport will be smaller than assumed in the scenario. In order to achieve the overall target, the target of 95 g/vkm value in 2020 should be implemented immediately and without further exceptions. Other measures to increase energy efficiency and reduce emissions in the transport sector should be actively exploited.

Cogeneration

CHP is an efficient means to provide electricity and heat in a combined process with high overall energy efficiency. Against this background, in the BAU scenario already almost a doubling of electricity generated from CHP is assumed. Heat supply, however, increases only slowly due to the investment needed for expanding district heating grids etc. The expansion in the BAU thus mainly uses existing demand but assumes an expansion of gas fired instead of coal fired generation and a further conversion of mere heat generators to CHP. Over all it turns out that the indicative target of an 18% share of CHP in electricity generation by 2010 will almost be achieved under BAU conditions but with a delay of one decade.

In the 30% P&M scenario a 20% increase of CHP heat supply (from a current 5.9% of heat supply to 7.4% by 2020) is assumed which can be achieved by expansion of industrial CHP and of municipal district heating networks. Electricity generation for CHP, of which more than 50% will come from renewable biomass in 2020, can be extended to 23% of electricity generation.

RENEWABLE ENERGY LEGISLATION

The total final energy use from renewable sources will increase by approximately 150% versus 2005 in the 30%-P&M scenario. This is roughly a doubling of the increase as compared to the baseline 2008 by DG TREN. The expansion of renewable energies will occur in the electricity generation, in transport fuels, in CHP-heat generation and in other renewable energy carriers. Together with energy efficiency measures, this will lead to almost double shares of renewable energies in all of these fields. In the framework of the 30%-P&M scenario a share of total final energy from renewable sources (as defined in the directive) of 23.1% by 2020 has been assumed. This is even higher than the 20% target currently set in the RES directive (European Parliament 2008b). A strengthening of the target thus should be decided upon at a later point in time (e.g. after conclusion of an international agreement on climate change).

These expansion paths are generally in line with a number of other scenario studies and potential analyses for the EU including the proposals made by the European Renewable Energies Council (EREC). For the transport sector, a 10% share of – mainly second generation – biofuels from sustainable production is assumed to be feasible. The RES Directive thus lays important foundations for achieving the 30% GHG emission reductions. However it becomes clear that it has to be implemented soon and its binding target needs to be achieved even earlier than 2020. It has to be noted as well that more than two thirds of the emission reductions instrumented by the RES Directive – according to the 30%-P&M scenario – will be effective in electricity and steam generation and thus help in these sectors to achieve the cap set for the ETS. They will thus not generate additional emission reductions exceeding the cap set for the ETS but 'only' support the achievement of the ETS cap – unless the cap is made flexible for downward adjustments to reap the benefits of additional reductions from RES.

It also has to be noted that the increase of the RES share by more than 10 percentage points between the BAU and the 30%-P&M scenario consists of two components. The first is an accelerated expansion of the use of renewable energy sources. The second is the strategy to reduce final energy consumption by policies and measures for energy end-use efficiency. In the 30%-P&M scenario the first strategy, expansion of investment into renewable technologies covers almost two third of the increase of the RES share to 18.6%. The other 4.5 percentage points to achieve a 23.1% RES share are a synergy resulting from implementing the energy efficiency strategy.

This means that in the 30%-P&M scenario presented here, about 40% of the renewable energy expansion targets are being met by increased energy efficiency, which relieves potentials of renewable energy sources and reduces investment needs into renewable energy generation. On the other hand, this means as well that energy efficiency needs to be targeted by RES policy almost with the same intensity as the expansion of RES supply.

Conclusion

Our paper outlines a comprehensive and consistent scenario of the EU27 GHG emissions, which proves that the GHG mitigation target of a 30% reduction vs. 1990 by 2020 could be achieved domestically.

This scenario shows that a 19% increase in energy efficiency on the demand side would contribute more than 40% of the necessary GHG emission reductions vs. BAU and would as well significantly ease the necessary efforts to implement the target of RES directive (as they are defined relative to the energy use in 2020) as well as help achieving significant GHG reductions within the ETS.

However, the implementation of the Action Plan on Energy Efficiency is still not strong and fast enough to safeguard the achievement of its 20% savings target. In the transport sector, the watering down of the GHG targets per vehicle kilometre will lead to an underachievement of energy efficiency improvement compared to our scenario. In the buildings sector, rapid action on improving building standards flanked by massive support of the investment into building refurbishment is urgently needed. And with regards to appliances, the setting of standards under the EuP Directive has to be speeded up and has to be targeted to setting the most ambitious standards for individual products as possible in order to cope with our scenario. Policies to promote the most efficient technologies and introduce even more efficient technologies to the markets must be used to make the EuP standards dynamic, allowing stepwise further tightening. Speeding up implementation and increasing the level of ambition is just as well warranted for the other EU Directives on energy efficiency to become success, most notably the EPBD and the ESD.

We can thus conclude that a successful and credible EU climate and energy policy which targets at a 30% domestic GHG emission reduction in line with the Bali roadmap – apart from challenges in other fields – most crucially relies on an improved consistency and further strengthening of the policy instruments to achieve the targeted 20% energy savings vs. baseline projections by 2020. This policy field now needs to get the political as well as financial support, which is at least proportionate to its more than 40%-share in achieving the necessary GHG emission reductions.

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