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Analysis of Options to Move Beyond 20 Percent Greenhouse Gas Emission Reductions

Background and Evaluation of Impact Documents

Stefan Schleicher, Claudia Kettner, Angela Köppl (WIFO), Barbara Anzinger, Bernhard Cemper, Andreas Türk (Wegener Center), Andreas Karner (KWI)

April 2011

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AUSTRIAN INSTITUTE OF ECONOMIC RESEARCH

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Austrian Institute of Economic Research
University of Graz – Wegener Center for Climate and Global Change
KWI Consultants & Engineers

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Abstract

The issues addressed in the Communication Analysis of options to move beyond 20 percent greenhouse gas emission reductions and assessing the risk of carbon leakage(COM(2010) 265) opens the discussion about a redesign of the energy and climate policy of the EU. Our analysis of the Communication reveals the following key findings:

- A more ambitious reduction target for 2020 needs to be embedded in a long-term strategy for GHG reductions until 2050.
- The new challenges for international climate policy have shifted from controversies about targets to a competition of technologies.
- In this competition for technological innovation the EU is facing a widening technology gap relative to the USA and China.
- Any future emissions reduction policies should therefore be closely tied to an ambitious technology initiative.
- The estimated costs in the Communication of 0.54 percent of GDP in order to achieve a 30 percent target need a detailed explanation.
- According to our analysis, a supporting technology initiative requires investments beyond 2 percent of GDP each year and new finance mechanisms.

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Project Report

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Acronyms

AAU	Assigned Amount Units
ACES	American Clean Energy and Security Act
APA	American Power Act
ARRA	American Recovery and Reinvestment Act of 2009
AWG-LCA	Ad Hoc Working Group on Long-term Cooperative Action under the Convention
BAM	Border Adjustment Measures
BAT	Best Available Techniques
BAU	Business as Usual
CAA	Clean Air Act
CAAA	Clean Air Act Amendment
CAPRI	Common Agricultural Policy Regional Impact model
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CEE	Central and Eastern Europe
CER	Certified Emission Reduction
COP	Conference of the parties
DG	Directorates-General
EB	Executive Board
EC	European Commission
EEPR	European Energy Programme for Recovery
EII	European Industrial Initiatives
EPA	Environmental Protection Agency
ERC	European Research Council
ERU	Emission Reduction Units
EU ETS	European Emission Trading Scheme
EUAs	EU Allowance Unit of one tonne of CO_2
FP7	Seventh Framework Programme for research and technological development
GAINS	Greenhouse Gas and Air Pollution Interactions and Synergies
GIS	Green Investment Scheme
IIASA	International Institute for Applied Systems Analysis
ICT	Information and Communications Technology

IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
JRC	Joint Research Centre
JTI	Joint Initiative
LEPII	Laboratoire d'Economie de la Production et de l'Intégration Internationale
LULUCF	Land Use, Land Use Change and Forestry
MGGRA	Midwestern Greenhouse Gas Reduction Accord
NAP	National Allocation Plan
NPV	Net Present Value
POLES	Prospective Outlook for the Long term Energy System
PRIMES	Energy System Model
R&D	Research and Development
RGGI	Northeast and Mid-Atlantic Regional Greenhouse Gas Initiative
SET	Plan Strategic Energy Technology Plan
UNEP	The United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
WCI	Western Climate Initiative

1 Executive Summary

The consultation invited by the Communication

The Communication on more ambitious greenhouse gas emission reductions

The Communication **Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage** (COM(2010) 265) invites consultation about a redesign of the energy and climate policy of the EU.

The issues addressed

In a nutshell this Communication opens the discussion about a redesign of the energy and climate policy of the EU by addressing the following issues:

- Options for a more ambitious reduction target for 2020
- Economic evaluations of these options
- Implications for economic innovation and employment

Our key findings

A policy shift from targets to technologies

Responding to the consultation opened by this Communication, our analysis reveals the following key findings:

- A more ambitious reduction target for 2020 needs to be embedded in a long-term strategy for GHG reductions until 2050.
- The new challenges for international climate policy have shifted from controversies about targets to a competition of technologies.
- In this competition for technological innovation the EU is facing a widening technology gap relative to the United States and China.
- Any future emissions reduction policies should therefore be closely tied to an ambitious technology initiative.
- The estimated costs in the Communication of 0.54% of GDP in order to achieve a 30% target need a detailed explanation.
- According to our analysis, a supporting technology initiative requires investments beyond 2% of GDP each year and new finance mechanisms.

1.1 Perspectives for a more ambitious emission reduction target

The need for a long-term roadmap

The need for a roadmap until 2050

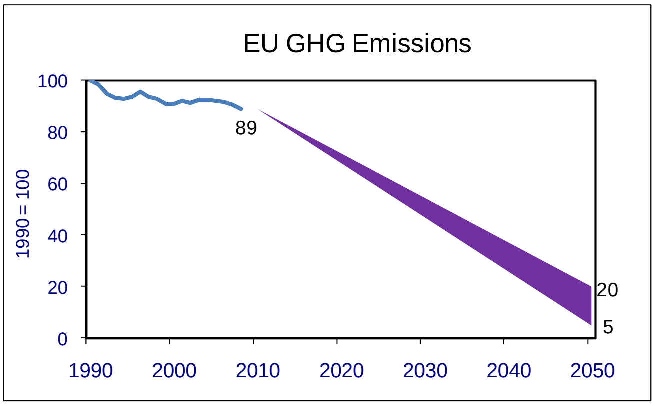
Discussions about a more ambitious EU emission reduction target for 2020 need to be embedded into a long-term roadmap that outlines reduction paths until 2050.

This is necessary because of the impact of current investment decisions on energy demand over many decades.

Perspectives for radical reductions

There is an emerging consensus that limiting the global temperature increase to 2°C would require radical reductions of GHG emissions in the range of 80% to 95% in the industrialised countries by 2050.

Figure 1-1: EU GHG emissions paths up to 2050



Source: Own graph

Searching for feasible reduction paths

Assuming a linear reduction path, the compatible targets for 2020 would be 28% or 32%, respectively, as indicated in Figure 1-1.

It would be premature, however, to draw conclusions about 2020 targets, since there is not sufficient information available about the dynamics of feasible long-run reduction paths which will depend on

- the diffusion rate of new technologies, e.g. the introduction of electric cars or the renovation rates of the building stock,
- the limits of physical and financial resources, e.g. the availability of renewables and long-term financing, or
- historic decisions, such as the thermal quality of the building stock.

1.2 From controversies about targets to a competition of technologies

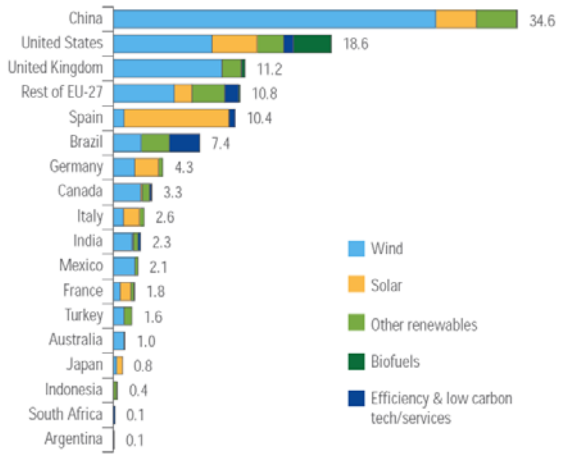
The new architecture of climate policy after Copenhagen

From the Kyoto Protocol to the Copenhagen Accord and the Cancun Agreements

In many ways the Copenhagen Accord of December 2009 marked a departure from the architecture of multilateral climate cooperation, which is chiefly embodied in the Kyoto Protocol.

The Cancun Agreements of December 2010 basically transfer the Copenhagen architecture, which reflects the positions of the United States and China, into a UN-inspired negotiating environment.

Figure 1-2: Investments in clean energy in 2009 (Billions of US$)



Source: PEW Center (2010)

Climate policy shifts from targets to technologies

The architecture of pledges and technology transfer

In a nutshell this new architecture for international climate policy rests on two pillars:

- Individual pledges of countries concerning their emissions efforts are replacing joint reduction targets in a legally binding framework.
- The transfer of technologies with accompanying financial facilities is emerging as a new agenda item, although it is still far from becoming operational and effective.

Modest pledges but strong investments in clean energy technologies

There is increasing evidence that this re-design of the climate policy agenda has already started. There is a striking contrast, however, between the rather modest unilateral emission reduction pledges of some countries, as China and the United States, and their actual efforts to invest in clean energy technologies.

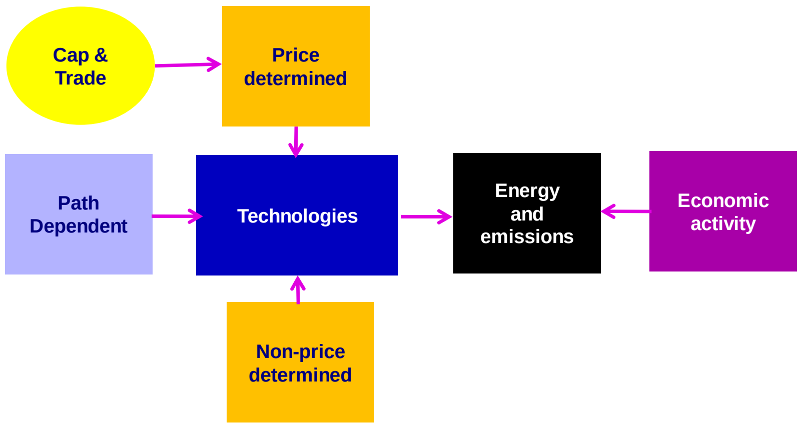
The new geography of clean energy investments

China has become the biggest investor in clean energy

The new agenda in climate policy is reflected to a remarkable extent in China, which has been rather hesitant to commit to reduction targets but highly ambitious with innovative energy technologies. This becomes evident in the new geography of clean energy investments as indicated in Figure 1-2, which was produced by PEW Center (2010). This demonstrates how China has become the one state with the largest investments in the sector.

Although the EU investments in total still exceeded China in 2009, China expanded its investments by about 30% in 2010 as reported by Bloomberg New Energy Finance, thus probably changing this situation. China now represents about one fifth of total world demand for clean energy investments.

Figure 1-3: Drivers for the state and change of technologies



Source: Own graph

Understanding the drivers of technological change

Technologies are not only price-determined

Since climate policy discovers the key role of technologies, we need to obtain a better understanding about the technologies' current state and their drivers for change.

As demonstrated in Figure 1-3, technologies are only to some extent determined by prices, e.g. energy prices. Non-price determined motives, such as strategic considerations, may be more important. In addition we need to realise that current technologies often reflect historic decisions.

The limits of cap-and-trade for inducing technological change

A cap-and-trade based climate policy mainly relies on price incentives to deliver technological change. Such price-induced incentives may not however elicit the radical technological changes sought. For reasons of international competitiveness the emissions cap and the related carbon price signals are restricted and thus may not be sufficient to trigger the switch to a technological change as envisioned in a perspective up to 2050.

1.3 Responding to the agenda of the Communication

Developing a shared energy vision for 2050

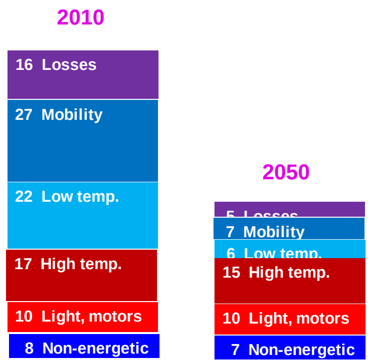
A radical transformation of the energy system by 2050

New reduction targets for 2020 need to be checked for consistency with long-term reduction paths. If the EU is committed to GHG emission reductions between 80% and 95% by 2050, a radical transformation of our energy system will be required.

Emphasising the services of the energy system

The outlines of such a transformation emerge if we look at the current structures of European energy systems in an innovative way that links energy flows to their related energy services. This is done in Figure 1-4, which uses Austria as an example. Current energy flows are normalised to add up to 100. Typically losses during transformation and distribution, the use of energy for mobility and low temperature services account for two thirds of energy consumption in Europe.

Figure 1-4: A feasible transformation of the European energy system



Source: EnergyTransition, Koeppl, A. et al. (2010)

Maintaining the required energy services with half of the current energy flows

Switching to high-efficiency co-generation for heat and power, to heat-pumps, to low- and plus-energy buildings standards and to electric vehicles should result in an increase of energy productivity over the next four decades by a factor of at least four.

Envisaging smaller productivity increases in the remaining energy consumption for high temperature processes in manufacturing, the use of electricity for lighting, electric motors and electronics, and the non-energetic use of energy, it is quite reasonable to suggest that Europe could provide all required energy services in 2050 with just half of the energy flows of 2010.

Achieving a GHG reduction of at least 80 %

Achieving emission reductions of at least 80% suddenly appears feasible if the volume of renewables that has been agreed upon for 2020 is doubled in the following three decades up to 2050.

Thus, the transformation to high-efficiency structures for transforming and applying energy is a prerequisite for any radical emission reductions.

Engaging in an ambitious technology initiative

A technology initiative for high-efficiency and low carbon energy systems

The EU has many reasons for engaging in an ambitious technology initiative with a focus on high-efficiency and low carbon energy systems:

- The global competition for these technologies is currently led by China and the United States with the EU threatened with falling behind.
- Energy security for the EU requires a decisive shift to high-efficiency and low carbon technologies.
- Maintaining credibility in the international climate policy negotiations requires demonstrable progress in the development and implementation of innovative energy technologies.

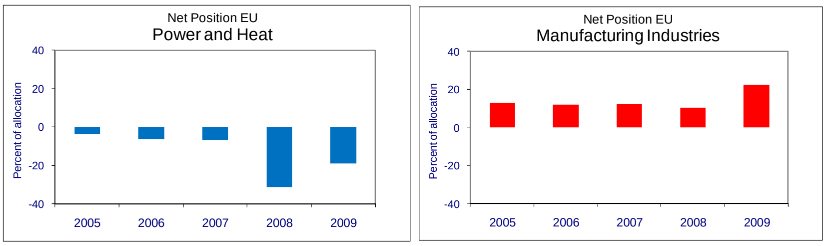
Although the EU already has a broad spectrum of technology programs, these seem to be fragmented and not at the top of the policy agenda.

Targets follow from technologies

Targets emerge from technology decisions

Having agreed upon a shared vision for the long-term energy paths and a supporting technology initiative, any agreements about more ambitious reduction targets for 2020 as well as 2030 should only emerge as a by-product of the preceding technology policy decisions.

Figure 1-5: Sectoral net positions of EU ETS from 2005 to 2009



Source: CITL, own calculations

Lessons learned from the EU ETS

This of course reverses past EU policy procedures about emission reductions which started with targets and hoped these would induce technological changes. So far, however, this has hardly materialised for the EU ETS, looking at its first five years as depicted in Figure 1-5. During this period the emission cap was binding for the whole system only in 2008 and the manufacturing sector was always in surplus of emission allowances. Before drawing conclusions for a tighter cap at least two issues need to be addressed.

The first deals with the excess of allowances that result from the economic crisis and not from abatement efforts, the hot air phenomenon in the EU ETS. The second concerns the industrial base in Europe, since extending the current set-up of the EU ETS to a 30% target – as suggested by the Communication – would require the elimination of every third emission unit by 2020.

New targets need a revised effort sharing

The distribution of the emission reduction needs between ETS and non-ETS sectors and the distribution of the efforts in non-ETS sectors among Member States are essential for the effort sharing.

Both distribution parameters need to be revised in a more ambitious target.

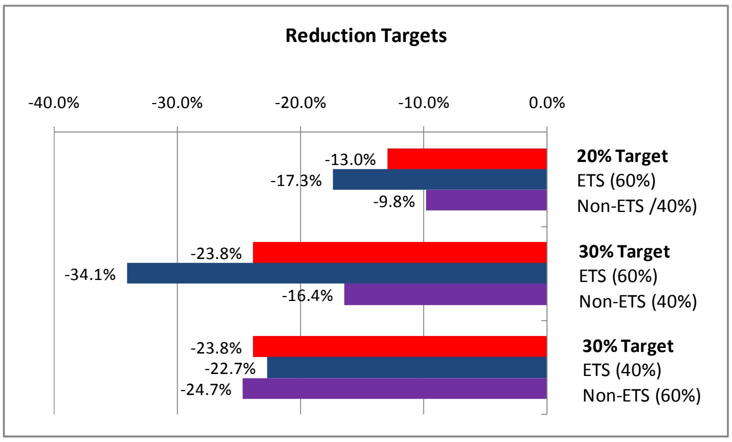
Distributing the reductions between ETS and non-ETS sectors

A comparison of different reduction scenarios for 2020 yields the following conclusions, summarised in Figure 1-6.

- Compared to a 20% reduction target for 2020 over 1990, the total reduction requirements increase from 13% to 24% over 2005 when moving to a 30% target.
- The distribution of the reduction requirements between ETS and non-ETS sectors is essential for determining the relative reductions efforts.
- Extending the current 60 : 40 distribution between ETS and non-ETS sectors requires a 34% reduction effort for the ETS sectors compared to 16% for the non-ETS sectors.

Since there is not sufficient evidence to justify this asymmetry in effort sharing, reversing this distribution yields a 23% reduction for the ETS sectors and a 25% reduction for the non-ETS sectors, and thus comes closer to equal relative reduction efforts and available reduction potentials.

Figure 1-6: Distributing the reductions between ETS and non-ETS sectors



Source: Own calculations based on EC documents

Distributing the reductions of non-ETS sectors among Member States

Similarly an extension of the current modulation of non-ETS sector reductions would require at least a stabilisation of emissions even in countries such as Bulgaria and Romania, which under the current agreements are allowed to expand their emissions by up to 20%. Meeting such a stringent cap would only be feasible with a massive inflow of technologies and financing.

A thorough economic evaluation

The additional costs suggested in the Communication for a 30% target

The Communication proposes that the costs of stepping up the reduction target from 20% to 30% will be close to the cost reductions caused by the economic crisis. Thus, in 2020 the costs of a 30% reduction target are estimated 0.54% of GDP or 0.2% up for a 20% target. These costs are supposed to be inclusive of the measures for the 20% renewables target.

Why the economic impacts need to be re-evaluated

There are a number of reasons to call for a thorough re-evaluation of the economic impacts both of a 20% and a 30% target, mainly flowing from two issues:

- There is a need to differentiate between investments and user costs for energy services. Only the latter are relevant for cost comparisons. This analysis is still missing.
- The investments needed for meeting both a 20% and a 30% target should be described in more detail, e.g. broken down for buildings, mobility, and restructuring energy supply.

Estimating investments and user costs of energy services

Based on the research project EnergyTransition, which is led by the Austrian Institute of Economic Research, we make two suggestions:

- We estimate that achieving a target beyond 20% requires additional investments amounting to at least 2% of GDP each year until 2020 if economic activity returns to pre-crisis growth rates.
- We emphasise, however, that many investments will have a useful life span beyond 2020, therefore the corresponding user costs of energy services will not necessarily be higher, depending on assumptions about investment cost reductions, depreciation rates, capital costs and energy prices.

Mobilising new finance

New financial instruments and their distribution between old and new Member States

The transition to high-efficiency and low carbon energy systems requires investments that seem thus far to have been underestimated. We support, however, all arguments that call for an ambitious technology initiative by the EU for engaging in this emerging competition for innovative technologies. Such a commitment poses at least two challenges for financial resources:

- First, there is a need for new finance instruments that deal in particular with long-lasting infrastructure, such as buildings and energy transformation units.
- Secondly, given the inequalities in economic welfare and investment opportunities between old and new Member States, the issue of an adequate distribution of financial resources will become more significant.

Thus, the credibility of any emissions reduction commitments will hinge crucially on a supporting technology initiative and an accompanying mobilisation of financial resources.

2 Scope, perspectives, and evaluations of the Communication

The Communication on options to move beyond 20 % greenhouse gas emission reductions

On 26 May 2010 the European Commission published the Communication *Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage (COM(2010) 265).*

This Communication is accompanied by the Staff Working Documents *Background information and analysis (SEC(2010) 650).*

Based on these documents we provide an analysis of the issues related to a more ambitious greenhouse gas emissions target for the EU.

The issues addressed

This Communication opens the discussion about a redesign of the energy and climate policy of the EU by addressing the following issues:

- A long-term roadmap for EU GHG reductions paths.
- Options for a more ambitious reductions target for 2020
- Economic evaluation of a more ambitious reductions target
- Assessing the risk of carbon leakage
- Implications for economic innovation and jobs

2.1 Long-term roadmap for EU GHG reduction paths

The current EU commitments

In December 2008 the EU agreed to cut EU-GHG emissions by 20% by 2020 compared to 1990 levels.

This unilateral commitment of the EU was accompanied by an additional commitment to increase this reduction target to 30% on condition that other developed countries commit themselves to comparable efforts.

2.1.1 The proposition of the Communication

Perspectives for a roadmap to 2050

The Communication clearly states that the conditions for moving to a 30% target are not met. By addressing, however, a long-term roadmap to 2050, a different argument is presented for opening a discussion about a more ambitious reduction target.

The Communication refers to scientific evidence that for limiting the global temperature increase to 2°C – a target both contained in the Copenhagen Accord and the Cancun Agreements – emission reductions of 80% to 95% would be needed for developed countries by 2050 compared to 1990.

2.1.2 Compatible emissions paths

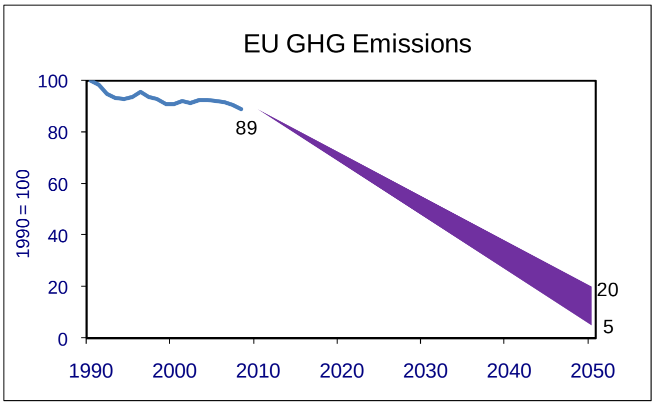
Perspectives for emission paths

We indicate in Figure 2-1 and Table 2-1 the perspectives for emissions paths that are compatible with such a long-term road map by assuming linear reduction paths either for a 80% or 95% reduction target.

Under such a linear reduction path the compatible targets for 2020 would be 28% or 32%, respectively. Thus the current target of 20% would be not sufficient.

A more thorough analysis would be needed, however, which deals with the dynamics of possible reductions paths. These might be accelerating in some sectors, e.g. by switching to electric cars, or decelerating in other sectors, e.g. by limitations in the availability of renewables.

Figure 2-1: EU GHG emissions paths up to 2050



Source: Own calculations

Table 2-1: EU GHG emissions paths up to 2050

Reduction Paths to 2050	1990	2000	2010	2020	2030	2040	2050
80% Reduction Target	100	91	89	72	54	37	20
95% Reduction Target	100	91	89	68	47	26	5

Source: Own calculations

2.1.3 Current trends of EU GHG emissions

Total greenhouse gas emissions

Different trends in old and new Member States

For obtaining a first impression about the feasibility of a more ambitious reductions target we present in Figure 2-2, Table 2-2 and Table 2-3 the current trends of total EU greenhouse gas emissions.

It is obvious that we need to distinguish the different dynamics in the old

Member States (EU15) and the new Member States (EU16-27).

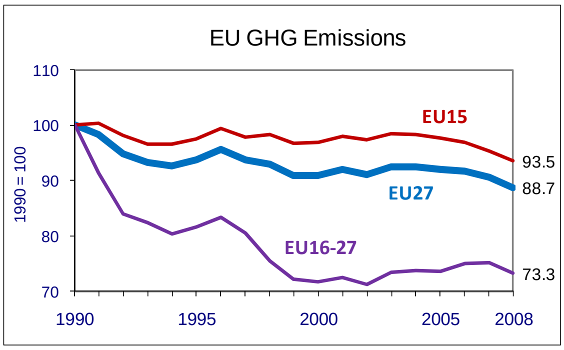
Up to about the year 2000 the declining emissions trend was caused by economic restructuring in the new Member States. This trend has more or less flattened out. On the other hand emissions remained roughly stable in the old Member States up to 2005 and started to decline afterwards.

This means that the EU will have no problems to fulfil its Kyoto target of a 8% reduction in the commitment period 2008 – 2012 last but not least due to the special restructuring effect of the new Member States.

The Austrian trends are different

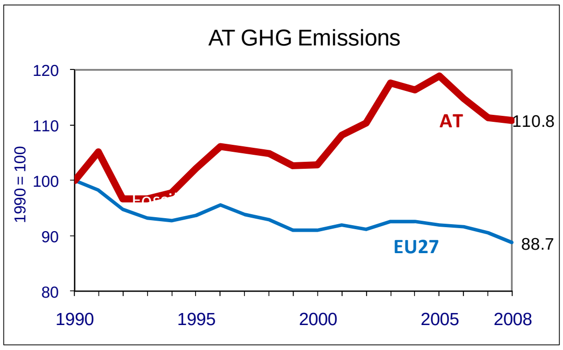
As Figure 2-3 indicates Austria does not follow the EU trends. The Austrian GHG emissions expanded after 1990 by almost 20% until they peaked in 2005.

Figure 2-2: Current trends of EU GHG emissions



Source, EEA, own calculations

Figure 2-3: Current trends of Austrian GHG emissions



Source, Umweltbundesamt, own calculations

Table 2-2: Current trends of EU GHG emissions (Million tons CO_2e)

GHG Emissions [mill tons]	1990	1995	2000	2005	2006	2007	2008
EU27	5,567.026	5,214.688	5,062.303	5,116.735	5,099.814	5,038.775	4,939.738
EU15	*4,244.651*	*4,136.737*	*4,114.482*	*4,144.796*	*4,108.170*	*4,046.189*	*3,970.473*
EU16-27	*1,322.375*	*1,077.950*	*947.821*	*971.939*	*991.644*	*992.586*	*969.265*

Source, EEA (2010), own calculations

Table 2-3: Current trends of EU GHG emissions (Index 1990 = 100))

GHG Emissions [1990 = 100]	1990	1995	2000	2005	2006	2007	2008
EU27	100.0	93.7	90.9	91.9	91.6	90.5	88.7
EU15	*100.0*	*97.5*	*96.9*	*97.6*	*96.8*	*95.3*	*93.5*
EU16-27	*100.0*	*81.5*	*71.7*	*73.5*	*75.0*	*75.1*	*73.3*

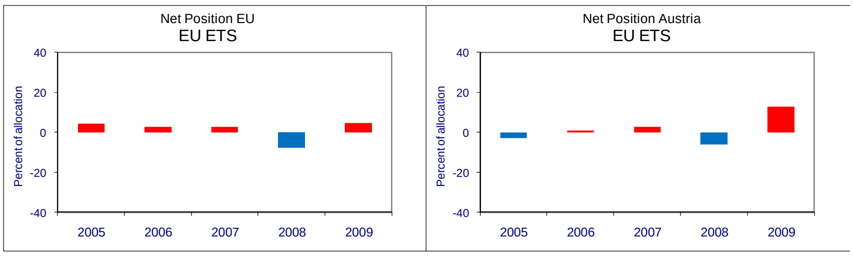
Source, EEA (2010), own calculations

EU ETS greenhouse gas emissions

Not binding overall caps

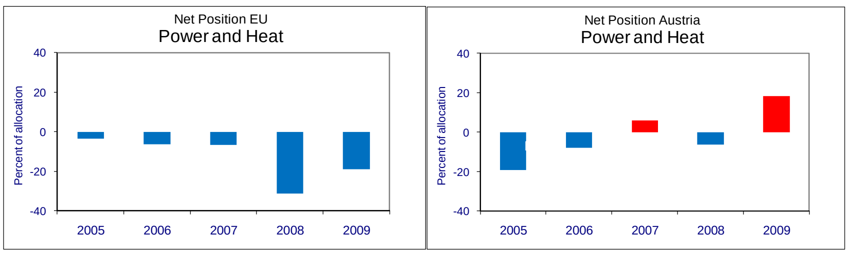
A look at the EU ETS in Figure 2-4 reveals that the overall cap so far was only binding in 2008 and it is most likely that not only in Perod 1 (2005 - 2007) but also in Period 2 (2008 - 2012) there will be more emission allowances than actual emissions. This has a strong bearing on the incentives generated from EU ETS for triggering technological change.

Figure 2-4: Total sector net positions of EU ETS from 2005 to 2009



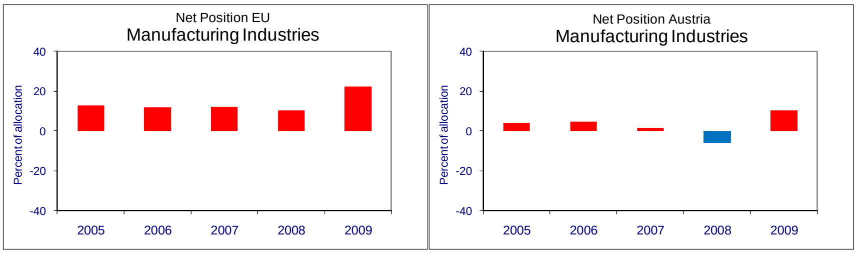
Source: CITL, own calculations

Figure 2-5: Power and heat sector net positions of EU ETS



Source: CITL, own calculations

Figure 2-6: Manufacturing sector net positions of EU ETS



Source: CITL, own calculations

Differences between power and manufacturing sectors

Comparing Figure 2-5 and Figure 2-6 we discover fundamental differences between the power sectors and the manufacturing sectors as the power sector between 2005 and 2009 was always in a short position but the manufacturing sector was always in a long position.

The Austrian net positions

The Austrian positions mainly follow those for the EU total but exhibit mostly smaller net positions, i.e. the allocations were close to the actual emissions.

2.2 Options for a more ambitious reductions target for 2020

The Communication discusses as alternative to the existing 20% reductions target for 2020, a step-up to 30%.

2.2.1 The proposition of the Communication

The Communication suggests the following design for a more ambitious reduction target:

- Moving from 20% to 30% reduction of GHG emissions by 2020 compared to 1990.
- Splitting the effort between ETS and non-ETS sectors as agreed for the 20% target, namely in the relation 60 to 40.
- Recognizing the higher reduction potentials in the new Member States which however would imply mobilising adequate public and private financial resources.

The Communication lacks details both as to the distribution of the non-ETS sector reductions among Member States and suggestions about the mobilisation of the addressed financial resources.

2.2.2 The current 20% reduction target

We summarize in Table 2-4 the basic structure of the 20% reduction target as agreed upon in the December 2008 decisions.

The split of the overall reductions between ETS and non-ETS sectors

Total 1990 emissions of 5,557 million tons (Mt) CO_2e need to be reduced by 663 Mt in order to arrive at a 20% reduction in 2020. This translates into a reduction of 13% over 2005.

Since the December 2008 decisions specify emission caps for the non-ETS sectors for all Member States this implies 290 Mt reductions for the non-ETS sectors and 373 Mt reductions for the ETS sectors. Thus the split of total reduction requirements is 56% to 44% between ETS and non-ETS sectors.

We also list in this table the data of the corresponding EU documents which deviate slightly because of revisions in the database.

The split of the overall non-ETS reductions among Member States

A second decision concerns the distribution of the overall non-ETS reductions requirement among the Member States as documented in Table 2-5 and Figure 2-7.

The so-called modulation of the overall reduction requirements implies for the 20% reduction target additional emissions for new Member States which are compensated by matching reductions in the old Member States.

Table 2-4: The distribution of the 20% reduction target between ETS and non-ETS sectors

	1990 Mt CO_2e	2020 Mt CO_2e	2020/1990 %-Change			EC Proposal 2020/1990 %-Change
EU Total	**5,567.0**	**4,453.6**	**-20.0%**			**-20%**
	2005 Mt CO_2e	**2020** Mt CO_2e	**2020/2005** %-Change	**Reduction** Mt CO_2e	%-Shares	EC Proposal 2020/2005 %-Change
EU Total	**5,116.7**	**4,453.6**	**-13.0%**	**663.1**	**100%**	**-14%**
EU ETS	2,149.0	1,776.3	-17.3%	372.7	56%	-21%
EU Non-ETS	2,967.7	2,677.3	-9.8%	290.4	44%	-10%

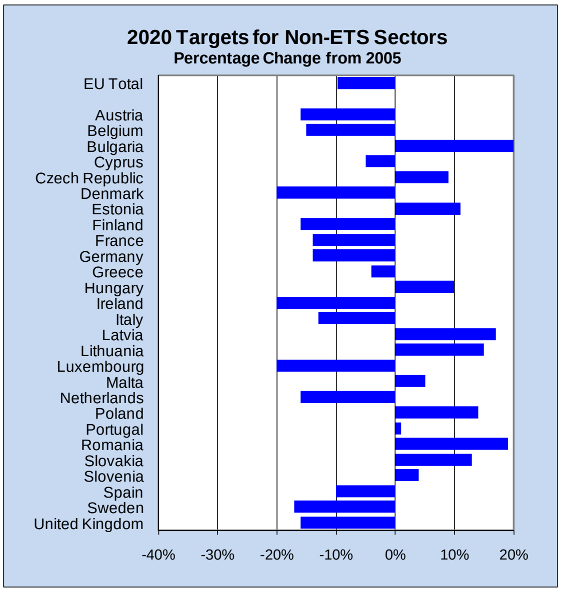
Source: Own calculations based on Commission documents

Table 2-5: The country distribution of the 20% reduction target for non-ETS sectors

Non-ETS Sectors	2005	2020	
	Mt CO_2e	Mt CO_2e	%-Change
EU Total	**2,967.7**	**2,677.3**	**-9.8%**
Austria	60.6	50.9	-16.0%
Belgium	84.3	71.6	-15.0%
Bulgaria	30.1	36.1	20.0%
Cyprus	4.5	4.3	-5.0%
Czech Republic	51.3	56.0	9.0%
Denmark	28.2	22.5	-20.0%
Estonia	2.7	3.0	11.0%
Finland	24.0	20.1	-16.0%
France	413.8	355.9	-14.0%
Germany	499.1	429.2	-14.0%
Greece	62.0	59.5	-4.0%
Hungary	50.0	55.0	10.0%
Ireland	52.1	41.6	-20.0%
Italy	359.7	312.9	-13.0%
Latvia	7.4	8.7	17.0%
Lithuania	10.6	12.2	15.0%
Luxembourg	10.1	8.1	-20.0%
Malta	0.8	0.9	5.0%
Netherlands	128.8	108.2	-16.0%
Poland	155.8	177.7	14.0%
Portugal	50.4	50.9	1.0%
Romania	78.7	93.7	19.0%
Slovakia	19.8	22.3	13.0%
Slovenia	11.2	11.6	4.0%
Spain	275.8	248.2	-10.0%
Sweden	45.6	37.8	-17.0%
United Kingdom	450.4	378.3	-16.0%

Source: Own calculations based on Commission documents

Figure 2-7: The country distribution of the 20% reduction target for non-ETS sectors



Source: Own calculations based on Commission documents

2.2.3 Moving to a 30% reduction target

We present in Table 2-6 and Table 2-7 two options for moving to a 30% reduction target depending on the distribution of the reduction requirements between ETS and non-ETS sectors.

The essential effort sharing distribution between ETS and non-ETS sectors

Compared to 2005 until 2020 1,220 Mt emissions need to be reduced in order to meet an overall 30% emissions reduction. Essential, however, for the effort sharing between ETS and non-ETS sectors is the distribution of the reduction volume among these sectors.

Using roughly the same 60 : 40 distribution between ETS and non-ETS sectors implies - as can be seen from Table 2-6 - reduction requirements of 34% for the ETS sectors and 16% for the non-ETS sectors compared to 2005. It is extremely difficult to develop an operational scenario for the EU ETS sectors which would result in a reduction of GHG emissions by more than one third over the next 10 years.

We therefore reverse this distribution to 40 ; 60 between ETS and non-ETS sectors. As Table 2-7 indicates this implies reduction requirements for the ETS sectors of 23% and 25% for the non-ETS sectors.

As there is ample evidence for higher reduction potentials in the non-ETS sector we recommend to reverse the current 60 : 40 distribution of the reduction requirements between ETS and non-ETS sectors.

Table 2-6: The 60 : 40 distribution of the 30% reduction target between ETS and non-ETS sectors

	1990 Mt CO_2e	2020 Mt CO_2e	2020/1990 %-Change
EU Total	**5,567.0**	**3,896.9**	**-30.0%**

	2005 Mt CO_2e	2020 Mt CO_2e	2020/2005 %-Change	Reduction Mt CO_2e	Reduction %-Shares
EU Total	**5,116.7**	**3,896.9**	**-23.8%**	**1,219.8**	**100%**
EU ETS	2,149.0	1,417.1	-34.1%	731.9	60%
EU Non-ETS	2,967.7	2,479.8	-16.4%	487.9	40%

Source: Own calculations based on Commission documents

Table 2-7: The 40 : 60 distribution of the 30% reduction target between ETS and non-ETS sectors

	1990 Mt CO_2e	2020 Mt CO_2e	2020/1990 %-Change
EU Total	**5,567.0**	**3,896.9**	**-30.0%**

	2005 Mt CO_2e	2020 Mt CO_2e	2020/2005 %-Change	Reduction Mt CO_2e	Reduction %-Shares
EU Total	**5,116.7**	**3,896.9**	**-23.8%**	**1,219.8**	**100%**
EU ETS	2,149.0	1,661.1	-22.7%	487.9	40%
EU Non-ETS	2,967.7	2,235.8	-24.7%	731.9	60%

Source: Own calculations based on Commission documents

Reduction requirements for the non-ETS sectors

The implications of a 40 : 60 distribution of the reduction requirements given a 30% overall target among the non-ETS sectors can be seen in Table 2-8 and Figure 2-8.

We use the same modulation for the distribution of the reduction requirements as under the 20% target. Compared to Table 2-5 for a 20% target we realize, however, that now all Member States need to engage in substantial reductions up to 33% for the non-ETS sectors.

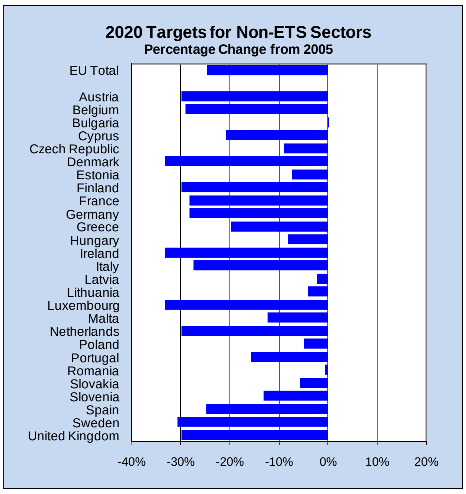
This in turn raises the issue of providing adequate financial funds for the new Member States in order to make their reduction potentials effective.

Table 2-8: The 40 : 60 distribution of the 30% reduction target for non-ETS sectors

	2005	2020	
	Mt CO_2e	Mt CO_2e	%-Change
EU Total	**2,967.7**	**2,235.8**	**-24.7%**
Austria	60.6	42.5	-29.9%
Belgium	84.3	59.8	-29.0%
Bulgaria	30.1	30.2	0.2%
Cyprus	4.5	3.6	-20.7%
Czech Republic	51.3	46.7	-9.0%
Denmark	28.2	18.8	-33.2%
Estonia	2.7	2.5	-7.3%
Finland	24.0	16.8	-29.9%
France	413.8	297.2	-28.2%
Germany	499.1	358.4	-28.2%
Greece	62.0	49.7	-19.8%
Hungary	50.0	45.9	-8.1%
Ireland	52.1	34.8	-33.2%
Italy	359.7	261.3	-27.3%
Latvia	7.4	7.2	-2.3%
Lithuania	10.6	10.2	-4.0%
Luxembourg	10.1	6.8	-33.2%
Malta	0.8	0.7	-12.3%
Netherlands	128.8	90.3	-29.9%
Poland	155.8	148.4	-4.8%
Portugal	50.4	42.5	-15.7%
Romania	78.7	78.2	-0.6%
Slovakia	19.8	18.7	-5.6%
Slovenia	11.2	9.7	-13.2%
Spain	275.8	207.3	-24.8%
Sweden	45.6	31.6	-30.7%
United Kingdom	450.4	315.9	-29.9%

Source: Own calculations based on Commission documents

Figure 2-8: The 40 : 60 distribution of the 30% reduction target for non-ETS sectors



Source: Own calculations based on Commission documents

2.2.4 Comparing different reduction targets

The different reduction scenarios discussed above are summarized in Figure 2-9 and yield the following conclusions:

The sensitivity of the distribution efforts between ETS and non-ETS

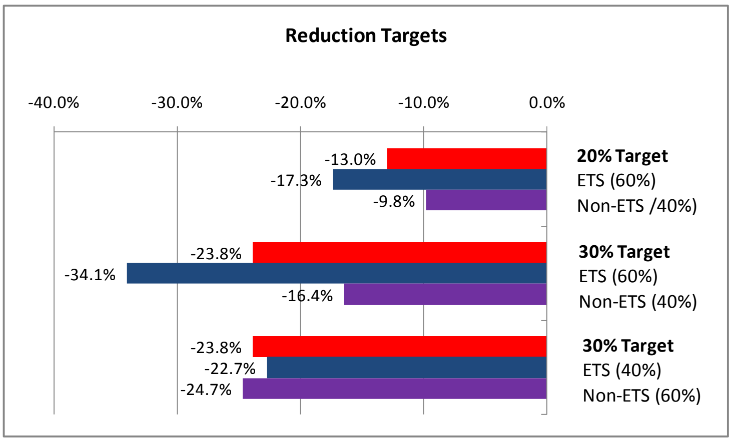
- Compared to a 20% reduction target for 2020 over 1990 the total reduction requirements increase by moving to a 30% target from 13% to 24% over 2005.
- An essential role as to the relative reductions efforts plays the distribution of the reduction requirements between ETS and non-ETS sectors.
- A 60 : 40 distribution requires a 34% reduction effort from the ETS sector compared to 16% for the non-ETS sectors.

Reversing this distribution calls for a 23% reduction by the ETS sectors and a 25% reduction by the non-ETS sectors.

Financial funding schemes for New Member States needed

Asking for higher reduction efforts by the non-ETS sectors is in line with empirical research evidence but requires new financial funding schemes for the new Member States in order to make their reduction potentials effective.

Figure 2-9: Comparison of different reduction targets



Source: Own calculations based on Commission documents

2.3 Economic evaluation of a more ambitious reductions target

The Communication provides a number of arguments why a more ambitious reductions target might be beneficial from an economic point of view. These arguments, however, need a careful evaluation.

2.3.1 The proposition of the Communication

The concept of costs used

The economic evaluation in the Communication is based on a cost concept that includes additional investment needs net of the benefits of energy savings but does not address additional benefits.

The impact of the economic crisis

In view of the economic crisis assumptions about average GDP growth up to 2020 were lowered from 2.4% to 1.7% per annum.

Assumptions for the oil price were raised from $66 to $88 per barrel.

The suggested costs for the 20% target

Based on a set of assumptions which are dominated by the above indicated projections for economic activity and energy prices, the Communication states that the costs for meeting the 20% reduction target will be 0.32% of GDP in 2020, down from 0.45% estimated before the economic crisis.

In absolute numbers this means that the costs of the climate and energy package estimated to be about €70 billion in early 2008 will come down to €48 billion.

The suggested additional costs for moving from a 20% to 30% target

The Communication proposes that the costs of stepping up the reduction target from 20% to 30% will be close to the cost reductions caused by the economic crises. Thus, in 2020 the costs of a 30% reduction target are estimated at 0.54% of GDP. These costs are supposed to include also the actions needed for meeting the 20% renewables target.

This means in absolute numbers that the costs for a 30% reduction target are €81 billions, thus €11 billion above the pre-crisis estimate for meeting the 20% target.

2.3.2 The need for a re-evaluation of the economic impacts

Why the economic impacts need to be re-evaluated

We have a number of reasons to call for a thorough re-evaluation of the economic impacts both for a 20% and a 30% target based mainly on two factors:

- Investments are not necessarily identical to the costs of an economic action.
- The amount of investments needed for meeting both a 20% and a 30% target seem to be way too low if we consider bottom-up information.

The need for a different methodological approach

Making investments comparable by user costs

The first objection related to the economic impact of reduction targets in the Communication concerns the cost concept used.

Adding up investments needed for meeting a specific target might be very misleading for several reasons given the interpretation of costs:

- Investments differ with respect to the number of years in use, e.g. a high-efficiency cogeneration unit may be used for less than 15 years whereas the impact of renovating a building may be experienced over several decades.
- Investments, therefore, need to be made comparable by calculating their user costs of capital per unit of time, e.g. per annum. This requires besides the amount of investment costs, assumptions about deprecia-

tion rates and capital costs.

- These user costs of capital together with the operating costs yield the full user costs which are the only relevant indicator for comparing the cost effects of various actions for meeting a reduction target.

The need for using bottom-up information

Making investment costs visible by bottom-up information

The methodology used for determining the amount of investments needed does not reveal details about the physical amount and related unit costs of different investment activities as renovating buildings, introducing electric cars or installing generation units for renewables.

It is this detail of information, however, which is needed for making statements about investment requirements credible.

2.3.3 A cautious evaluation of the Communication's economic impact analysis

Two cautious conclusions

Based on the above presented arguments about the deficiencies of the economic impact analysis presented in the Communication and the accompanying documents we draw two cautious conclusions:

Additional investment requirements are much higher

- First, the estimated additional investment requirements for meeting a 20% target (0.32% of GDP) and a 30% target (0.54% of GDP) appear to be way to low. Based on experiences collected in the project Energy-Transition which was lead by the Austrian Institute of Economic Research we estimate that achieving the 20% target requires at least 2% of GDP in additional investments up to 2020 if economic activity returns to pre-crisis growth rates.

But user costs will not necessarily increase

- Second, considering that many investments will have a useful life span beyond 2020, the corresponding user costs will not necessarily be higher, depending on assumptions about investment cost reductions, depreciation rates, capital cost and energy prices.

Dealing with the economic crisis

Statements in the Communication about a lower price-tag for achieving the reduction targets because of the economic crisis may also cause misleading interpretations if it is implicitly suggested that a lower economic activity helps to achieve emissions target commitments.

Dealing with beyond-GDP issues

Reference should also be given to the ongoing discussion about measuring economic welfare beyond the conventional GDP accounting framework. This issue needs to be disentangled, however, from the decline of GDP rates because of the current economic crisis.

2.3.4 An example: Switching from low energy to passive house standards for new buildings

We demonstrate the methodology suggested for evaluating the economic impact of activities for emissions reductions for the case of new buildings by comparing the impacts of switching from low energy to passive house standards.

Comparing investment and user costs

Table 2-9 and Source: EnergyTransition, Köppl et al. (2010)

Table 2-10 indicate the investment costs and the derived user cost for new buildings with low energy standards and passive house standards (PHS), respectively.

Given the assumptions made about a depreciation period of 40 years, capital costs of 2.5% per annum and constant energy prices, we obtain some remarkable results:

- Despite about 10% higher investment costs the expected user costs for multi-family residential buildings with passive house standards are almost identical to buildings with low energy standards.
- For single family buildings the expected user costs are about 5% higher for passive house standards but this gap will shrink if future energy prices increase.

Table 2-9: Investment costs and user costs for new buildings in low energy standard (LES)

New buildings LES		Single family residential		Multy family residential	
Unit activity	1 m2	2008	2020	2008	2020
Investments					
Depreciation period	years	40	40	40	40
Interest rate	% p.a.	2.5	2.5	2.5	2.5
Investment price	€/m2	1,450	1,102	1,110	844
User cost of capital	€/m2 p.a.	72.5	55.1	55.5	42.2
Operating					
Energy flow	kWh p.a.	70.0	60.9	70.0	60.9
Energy price (mix)	€/MWh	82.0	82.0	82.0	82.0
Energy cost	€/m2 p.a.	5.7	5.0	5.7	5.0
Net cost of 1m2 LES	€/m2 p.a.	78.2	60.1	61.2	47.2

Source: EnergyTransition, Köppl et al. (2010)

Table 2-10: Investment costs and user costs for new buildings in passive house standards (PHS)

New buildings PHS		Single family residential		Multy family residential	
Unit activity	1 m2	2008	2020	2008	2020
Investments					
Depreciation period	years	40	40	40	40
Interest rate	% p.a.	2.5	2.5	2.5	2.5
Investment price	€/m2	1,600	1,216	1,200	912
User cost of capital	€/m2 p.a.	80.0	60.8	60.0	45.6
Operating					
Energy flow	kWh p.a.	15	15	15	15
Energy price (mix)	€/MWh	145	145	145	145
Energy cost	€/m2 p.a.	2.2	2.2	2.2	2.2
Net cost of 1 m2 PHS	€/m2 p.a.	82.2	63.0	62.2	47.8
Net cost of 1 m2 LES	€/m2 p.a.	78.2	60.1	61.2	47.2

Source: EnergyTransition, Köppl et al. (2010)

3 The Communication in the EU policy context

In May 2010 the European Commission published the Communication "Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage" (COM (2010) 265). In several respects this is a remarkable document since it discusses EU climate policy in a much wider context than just climate issues and emphasizes the role of technological change.

In the following we refer to this document as the Communication. We provide in this chapter an overview of the history of the Communication and discuss the Communication's key messages.

3.1 The origin: the EU Energy and Climate Package

In order to obtain a better understanding of this Communication we need to analyze it in the framework of EU energy and climate policy.

A key element of this policy is the Energy and Climate Package which was adopted in 2008 in order to position Europe as an international frontrunner in the area of climate policy, but also due to other reasons, such as energy security.

The brief history of the package

An integrated approach to climate and energy policy

In March 2007 the EU leaders endorsed an integrated approach to climate and energy policy that aims to combat climate change and increase the EU's energy security while strengthening its competitiveness. They committed Europe to transforming into a highly energy-efficient, low carbon economy.

The origin of the 20-20-20 targets

To kick-start this process, the EU heads of state and government set a series of demanding climate and energy targets to be met by 2020. These comprise

- a reduction in EU greenhouse gas emissions of at least 20% below 1990 levels,
- a share of 20% of EU gross final energy consumption from renewable resources, and
- a 20% improvement of energy efficiency compared to projected levels of primary energy use.

Collectively these numbers are known as the 20-20-20 targets.

A conditional 30% target

The EU leaders also offered to increase the EU's emission reduction target to 30% by 2020 on condition that other major emitting countries in developed and developing regions commit to comparable efforts under a global climate agreement. After the climate summit of Copenhagen in December 2009 and in Cancun, 2010, however such a global agreement is still far from becoming visible.

The political decisions in December 2008

In January 2008 the European Commission proposed binding legislation to implement the 2020 targets.

The final legal text of this energy and climate package, which contains only the 20% reduction target and the 20% renewables target, was agreed in December 2008 by the European Parliament and came into force in June 2009.

The need for reassessing the package

Meanwhile at least two events triggered a process for reassessing the climate and energy and climate package. One is the fundamental re-design of global climate policy after the Copenhagen summit. The other is the deep economic crisis of 2009 which caused EU ETS emissions to drop by about 12% compared to the previous year.

The need for reassessing the package after Copenhagen

Although the Copenhagen summit did not yield the desired result of a full, binding international agreement to tackle climate change, it showed that countries which account for about 80% of global emissions are willing to cut emissions and to come forward with reduction pledges. According to the current status these pledges will, however, not be sufficient to achieve the so-called 2°C target, which is considered crucial for preventing a disastrous climate change. The European Commission therefore sees the need for a reassessment of the energy and climate package also against the background of bringing a new dynamic into the international negotiation process.

3.2 The Communication on moving to more ambitious emission targets

In May 2010 the European Commission presented the Communication (COM (2010) 265) on options for moving to a more ambitious greenhouse gas reduction target. Together with the accompanying background documents this Communication stimulates discussions both in research and policy making about the future of EU climate and energy policy.

3.2.1 The key messages of the Communication

Key messages of the Communication

The key messages of the Communication can be summarised as follows:

- As carbon prices will be lower than expected by 2020 due to the economic crisis, the potential of the 20% reduction target as an incentive for technological change and innovation has decreased.
- Europe's lead in the green energy revolution cannot be taken for granted as global competition becomes fiercer. A more ambitious target could stimulate innovation in low-carbon technologies and create new jobs.
- A 30% target would be in line with a reduction path to meet the 2050

target. A lower 2020 target would require stronger reductions later, significantly increasing costs.

- From the current perspective a 30% target would cost only an additional €33 billion (0.2% GDP)) to the estimated costs of the 20% target.
- A higher 2020 target is a political signal for other countries to increase their reduction effort.

3.2.2 The supporting arguments of the Communication

The Communication together with supporting documents provide arguments for moving to a higher reduction target, including impacts of the economic crisis, cost aspects, the role of innovation and green technologies, energy security and consistency with the 2050 reduction path.

Impact of economic crisis

The economic crisis led to an immediate reduction of greenhouse gas (GHG) emissions. Verified emissions in the ETS sector in 2009 fell 11.6% below 2008 or 14% compared to 1990 levels. Carbon prices fell correspondingly from €25 per ton CO_2 to €8 in 2009 (COM (2010) 265).

Estimated costs have fallen by €22 billion

The Communication argues that through the economic downturn absolute costs for meeting the 20% target have fallen. The costs of achieving the 20% target are reduced by some €22 billion when accounting for the recession and are now estimated to be €48 billion in the year 2020 (0.32% of GDP in 2020) instead of €70 billion, respectively. But this cost reduction comes at a time where businesses have much less capacity to find investment financing and face great uncertainty how long a stable recovery will take.

Reasons for lower costs of the Climate and Energy Package

There are a number of reasons why the costs of the Climate and Energy Package have become much lower:

- The lower economic growth has effectively reduced the stringency of the 20% target.
- The rise in oil prices provided an incentive to improve energy efficiency, thus energy demand has fallen.
- The carbon price is likely to remain lower as allowances not used in the second trading period can be banked for future trading periods (COM (2010) 265).

Banking of allowances

According to the Communication, the flexible architecture of the ETS will allow companies to carry over some 5% to 8% of allowances into the third phase of the EU ETS (2013-2020) which are unused due to the economic crisis in the 2008-2012 period. Thus the impact of the crisis will have consequences lasting several years. In addition the achievement of renewable energy targets reduces emissions further and the carbon prices will be below the projections made in 2008. With a lower carbon price government revenues from auctioning could be halved. Simultaneously businesses face depressed demand and the challenge of finding sources of funding (COM (2010) 265).

Investing in environmental technologies is a major driver of growth

The development of resource-efficient and green technologies is a major driver of growth. During the economic crisis stimulus packages channelled investment towards environmental technologies and countries are attracted to the greener option also because of its potential to create large numbers of new jobs (COM (2010) 265).

Furthermore, the EU energy and climate package has the vision to restructure the industrial base towards a more sustainable future and to seize the opportunities provided by Europe's early investment in green technology. But even though Europe is heavily investing in green technologies as electric vehicles and renewables this position is challenged by countries like USA and China.

Enhancing energy security

The Communication emphasizes the role of shifting investment towards environmental technologies to achieve an increased energy security. The IEA warned that by 2015 there will be excess oil demand which will cause a further increase in oil prices and potentially repress renewed economic growth. Increasing domestically-sourced energy like renewable energy reduces the reliance on imports. Although drivers as the target for renewable energy, product standards for energy-efficient products and vehicles and green public procurement exist, Europe has to further boost incentives for a domestic development of these industries.. Options like carbon capture and storage (CCS) are heavily dependent on carbon prices, therefore a lower CO_2 price is a much less powerful incentive for change and innovation (COM (2010) 265).

Consistency with long term target

The long term goal is to limit the temperature increase to 2°C which requires a GHG emission reduction of 80% to 95% by 2050 for developed countries, compared to 1990. To reach this goal it will be necessary to reduce domestic emissions by 70%. The 20% target yields a reduction of 25% in 2030 and will not be enough to take the EU to its 2050 level of ambition at optimal cost. Delaying action now will result in higher reduction costs beyond 2020. For example, the IEA has estimated that at the global level, every year of delayed investment on more low-carbon energy sources adds €300 to €400 billion to the price tag (COM (2010)).

3.2.3 Possible options to reach a 30% target

The Communication outlines several options to reach a 30% target, including a recalibration of the EU ETS.

Recalibrating the EU ETS by setting aside a share of the allowances planned for auction

Since the EU ETS is the primary tool to drive emission reductions it should be the starting point for options for going beyond 20%.

If the EU increases its reduction goal to 30%, the main contribution from ETS could come through a gradual reduction of the allowances auctioned. Tightening the cap would raise the level of environmental effectiveness and would strengthen the incentive effect of the carbon market. Reducing auctioning rights by 1.4 billion allowances (15%) over the whole period 2013 to 2020 would be sufficient and would increase auctioning revenues by a third. The additional revenue should then be used to invest in low-carbon solutions for the future (COM (2010) 265).

Rewarding fast movers that invest in top performing technology

The benchmarking system provides an opportunity to identify those who make rapid progress in improving performance and to reward them with extra free allowances.

Benchmarking is a very broad concept which is used for various purposes.

Traditionally, benchmarking processes helped judging and improving industry performance. A benchmark is a performance measure based on agreed and verified factors not necessarily at the highest performance level. In the context of climate change policies, benchmarking is used for the allocation of free emissions rights, regulatory scheme to set performance targets, to define GHG emission caps, to judge the national, EU-wide or international comparability of sector efforts etc. (Törner, Egenhofer and Georgiev, 2009).

Sharing the burden of reaching the 30% target

The Commission staff working document SEC(2010) 650 argues that the greatest potential for emission reductions is in the electricity sector through a combination of improved demand-side efficiency and a reduction of carbon-intensive supply side investments. Replacing ageing electricity generating capacity by low-carbon investments represents one solution in this context. The effort sharing sector, which covers all sectors not included in the EU ETS (e.g. transport, buildings, agriculture and waste), households and services can also achieve substantial emission reductions, mainly from better technologies for heating.

Distribution between efforts in the ETS and non-ETS sector in the case of a 30% reduction target remains the same

According to the Communication the distribution between efforts in the ETS and non-ETS sector in the case of a 30% reduction target therefore remains largely the same as for the 20% target. In the case of moving to a 30% target, in 2020, the ETS cap would be 34% rather than the current 21% below 2005 emissions, while the overall target for sectors not covered by the ETS would be 16%, rather than the current 10% below 2005 emissions (Com (2010)).

Greater volume of cohesion policy funding towards green Investments

As regards the geographical distribution, the emission reduction potential for moving from 20% to a 30% target is proportionally higher in the poorer Member States. The Communication emphasizes that it will be necessary to mobilize public and private financial resources to enhance emission reductions in new Member States without jeopardizing economic growth. The EU's cohesion policy is an important instrument in this regard (COM (2010) 265).

3.3 The EU Emission Trading Scheme (EU ETS)

The achievement of the Kyoto Protocol targets was one of the main reasons for the European Union to implement the EU ETS. Also for the period up to 2020 it remains one of the key instruments of Europe's climate policy. The Communication emphasizes that the EU ETS plays a key role in reducing GHG emissions. Thus it is crucial to evaluate the performance of the EU-ETS and assess its opportunities and limits. This section provides an overview of the history of the EU ETS and the planned revisions.

3.3.1 Milestones of the EU ETS

UNFCCC of 1992 and the Kyoto Protocol of 1997

With the ratification of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 the European Union committed to stabilize atmospheric GHG concentration at "safe" levels. In 1997 the Kyoto Protocol was signed in which industrialized countries committed to reduce greenhouse gas emissions from 1990 levels on average by 5.2% in the first commitment period 2008-2012. Under the Kyoto treaty the then existing EU-15 nations agreed to meet their commitment of an 8% GHG emissions reduction collectively.

EU ETS of 2002

By the year 2000 many EU countries had difficulty reducing their GHG emissions although in the UK (due to a structural switch from coal to gas) and Germany (due to the modernization of the former DDR) considerable reductions took place. Thus, the EU ETS was enacted as one of the policy measures to enable the EU to meet its Kyoto targets. Given the need to enact policies in light of the Kyoto targets, the development of the EU ETS proceeded swiftly and was politically agreed by the EU Council of Environment Ministers on December 9, 2002 and on October 2003 the EU ETS Directive was formally adopted and entered into force.

Key facts of the EU ETS

The EU ETS is in force since 2005 and is the world largest cap & trade system. Currently, the EU ETS covers some 11,500 energy-intensive installations in power generation and manufacturing. Until now 27 EU Member States and Iceland, Liechtenstein and Norway are participating. The EU ETS is open to establishing formal links with compatible mandatory cap & trade systems for GHG in other parts of the world and from 2012 onwards, emissions from air flights to and from European airports (involves approximately 4,000 aircraft operators) will be included.

3.3.2 Aims of the EU ETS

Cost-effective reductions

The EU ETS is seen as a cost-effective instrument since it should allow the EU to achieve the emission reduction target under the Kyoto Protocol at a cost below 0.1% of GDP. By imposing a mandatory cap the achievement of the environmental target is guaranteed

Low carbon economy

In the Communication the European Commission for the first time also emphasized its role to drive the shift towards a low-carbon economy.

Clean development

Another goal of the EU ETS is to invest and develop clean technologies in developing countries and economies in transition. It allows companies to use credits from emission-saving projects carried out under the Kyoto Protocol's Clean Development Mechanism (CDM) and Joint Implementation (JI) instrument to offset a proportion of their emissions. Up to certain limit CDM and JI credits can be used for compliance by companies under the EU ETS.

3.3.3 Trading periods of the EU ETS

Phase 1

Phase 1, from 2005 to 2007, was a three-year pilot phase of learning by doing in preparation for the Phase 2, the Kyoto commitment period. It established a price for carbon, free trade in emission allowances across the EU and the necessary infrastructure for monitoring, reporting and verifying actual emissions from the installations covered. The generation of verified annual emissions data filled an important information gap and created the basis for setting the caps on national allocations of allowances for Phase 2. In phase 1 banking of allowances was not allowed and at least 95% of the allowances have been allocated to installations free of charge. In the first compliance period, a non-compliance penalty tax of €40 per tonne of excess CO_2 has been in place.

Phase 2

Phase 2, which is running from 2008 to 2012, coincides with the first commitment period of the Kyoto Protocol. The 2005-2007 pilot phase was necessary to ensure that the EU ETS contributes fully to the achievement of the Kyoto target in an effective way during Phase 2. On the basis of the verified emissions reported during Phase 1, the Commission has cut the volume of emission allowances permitted in Phase 2 to 6.5% below the 2005 level, thus ensuring that real emission reductions will take place. At least 90% of the allowances have been allocated to installations free of charge in Phase 2. In Phase 2 the non-compliance penalty per tonne of excess CO_2 emissions has been increased to €100, plus restoration of the GHG emitted without having surrendered allowances.

Phase 3

Phase 3 will run for eight years, from 2013 to 2020. This longer period will contribute to the greater predictability necessary for encouraging long-term investment in emission reductions. The EU ETS will be substantially strengthened and extended from 2012 on, enabling it to play a central role in the achievement of the EU's climate and energy targets for 2020.

3.3.4 Carbon prices in the EU ETS

Carbon prices

Figure 3-1 shows the trend of the EU ETS carbon price. Two major episodes of volatility in the CO_2 price can be observed: the first one is the collapse of the Phase 1 price in April 2006 and the second one is the steep decline in 2008.

The collapse of 2007

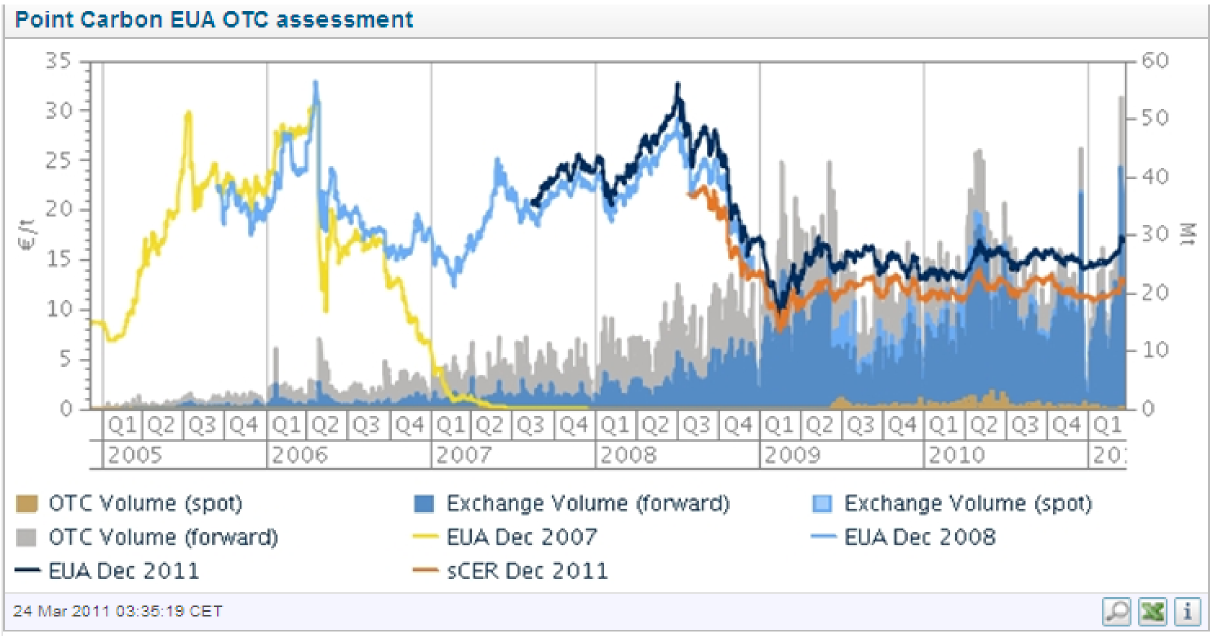
Between April 2006 and early 2007 the carbon price fell from its peak of over €30 to around €1. In Phase 1 it was not possible to bank unused allowances from Phase 1 to Phase 2. In April 2006, when the Member States and the European Commission disclosed the 2005 verified emissions for all EU ETS installations, it turned out that a positive gap between initial allocation to installations and BAU emissions forecasts prevailed, thus companies' over-allocation with allowances lead to a sharp fall in carbon prices. (Capoor and Ambrosi 2007).

The decline of 2008

The second decline in carbon prices was due to the economic slowdown.

According to Capoor and Ambrosi (2009) the demand for housing and cement, automobiles etc. decreased and thus demand and commodity prices fell with lower production and power consumption. This translated into lower emissions and a lower need for emission allowances than in a growing economy., As a result installations sold EUAs on the market. Hence the supply of allowances increased while the demand decreased which resulted in substantially lower prices for EUAs. This circumstance was amplified by the fact that companies received the allowances for free in the first place. (Capoor and Ambrosi 2009).

Figure 3-1: Price trend futures (yearly contracts) since 2005



Source: Point Carbon

Expected carbon price impacts

The implementation of CO_2 prices should lead to the following effects: On the one hand the operating costs of carbon-intensive facilities increase thus making their use less attractive. On the other hand investments in low-carbon facilities become more attractive, relative to investments in carbon-intensive facilities. But according to a recent study of Celebi and Graves (2009) CO_2 prices that are sufficient to substantially alter carbon emissions in the electric sector are likely to be high.

Impacts of price uncertainty

Additionally, projections about future carbon prices involve huge uncertainties, this matter of fact decreases the willingness to invest in long-lived, capital-intensive, carbon-mitigating equipment (whether industrial or individual) that must earn a payback over many years (Celebi and Graves, 2009).

Impacts of price volatility

Volatile CO_2 prices or price uncertainty could discourage or delay energy-saving investment

- by increasing the discount rate on net present value (NPV), or
- inducing investors to wait until the price for CO_2 is unlikely to drop below the level that would achieve an acceptable payback (i.e., at some CO_2 price above the level at which the investment would be expected to just break even).

3.3.5 Revisions of the EU ETS

Revisions of the EU ETS in 2008

To be compatible with the 20% GHG reduction by 2020 the European Commission projects that this will require a much steeper reduction path for industrial emissions. The European leaders thus aimed for an ETS reform proposal for the post-2012 period, which was presented on 23 January 2008. The revision of the EU ETS was negotiated by the Union's heads of state and government in Brussels and the European Parliament approved the new regime in a first reading on 17 December 2008. The revised EU ETS has more harmonized rules and it aims to offer increased predictability to market operators and will enjoy stronger international credibility.

The main elements of the new system, which will enter into force in 2013 and run until 2020, concern

- widening of the scope,
- EU-wide cap of allowances,
- a reduction path until 2020, and
- auctioning.

Widening the scope of the system

The system will be modestly broadened to include certain additional ndustries and greenhouse gases as well as installations undertaking the capture, transport and geological storage of CO_2 emissions. The new sectors include the petrochemical, ammonia and aluminium industry as well as aviation Road transport and shipping remain excluded just as the agriculture and forestry sector. In addition, the coverage of the EU ETS is extended to nitrous oxide (N_2O) and perfluorocarbons (PFCs).

EU-wide reduction cap

The current system of national caps on emission allowances will be replaced by an EU-wide cap of allowances.

Linear 1.74% reduction each year

A linear 1.74% reduction in the EU-wide cap on allowances each year until 2020 and beyond is the target of the European energy and climate policy. Total EU ETS emissions will be capped at 21% below 2005 levels by 2020 (maximum of 1,720 million allowances). This means that by 2020 the number of emission allowances will be 21% below the 2005 level. The upfront announcement of this reduction factor provides for market operators more clarity and predictability needed for investments decisions in emission reductions.

Towards full auctioning

Another aim is the progressive move towards full auctioning of allowances instead of the current system of cost-free allocation. From 2013 onwards at least 50% of allowances will have to be bought at auctions with the aim of reaching full auctioning by 2027. For the power sector full auctioning should be the rule from 2013 onwards, which will lead to an expected rise in electricity prices by 10% to 15%. In other sectors, free allocation will gradually be completely phased-out on an annual basis between 2013 and 2020. Nevertheless, certain energy-intensive sectors could continue to get all their allowances for free in the long term if the Commission determines that they are "at significant risk of carbon leakage".

Redistribution of auction revenues

The auction revenues shall be allocated to member states according to the following guidelines:

- 88% shall be distributed amongst Member States on the basis of their emissions.
- 10% shall be distributed for the purpose of solidarity and growth.
- 2% shall be distributed amongst Member States with greenhouse gas emissions at least 20% below their emissions in the base year applicable to them under the Kyoto Protocol in 2005.

Monitoring, reporting and verification

More harmonized rules for monitoring, reporting and verification of emissions should be implemented. These will enhance the reliability and credibility of the scheme.

Linking and offsets

There is the possibility to link the EU ETS to mandatory cap & trade systems in third countries not only at national level but also at regional or state level.

The rules for the use of carbon credits from CDM and JI projects in third countries should be harmonized. These rules are designed in a way that encourages third countries to ratify the future global climate agreement.

Excluding small installations

Member States may exclude small installations emitting under 25,000 tonnes of CO_2 per year from the system provided these installations are subject to measures that will have an equivalent effect on their emissions.

10 % reduction in non-ETS sector

Sectors not covered by the ETS, such as transport (except aviation), buildings, agriculture and waste, are to achieve an average GHG reduction of 10% by 2020.

To achieve this target, the Commission has set national targets according to countries' GDP per capita. Richer countries are asked to make bigger cuts – up to 20% in the case of Denmark, Ireland and Luxembourg – while poorer states (notably Portugal, as well as all countries that joined the EU after 2004 except Cyprus) will be entitled to increase their emissions in the non-ETS sectors – by up to 19 and 20% respectively for Romania and Bulgaria – in order to take their high expectations for GDP growth into account.

Use of CCS technology

Industrial GHG prevented from entering the atmosphere through the use of so-called carbon capture and storage (CCS) technology is to be credited as 'not emitted' under the EU ETS.

Up to 300 million allowances will be made available from the new entrants' reserves until the end of 2015 to subsidise the construction of twelve carbon CCS demonstration plants and support projects on innovative renewable energy technologies. The implementation of CCS demonstration plants will help to reduce GHG emissions further, but is heavily reliant on carbon prices, thus it will be essential for the EU ETS to provide a sufficient long term carbon price signal (SEC (2010) 650, Part I).

4 The Communication in an international context

Decisive role for the US and China

The USA and China are the two countries that emit most GHG emissions worldwide. Thus it is essential for the global goal of staying beyond a 2°C temperature increase that these two countries implement ambitious initiatives to reduce GHG emissions. But the emission reduction pledges agreed on in Copenhagen are not sufficient for reaching the 2°C target. Thus it is essential that the US and China realize their decisive roles and the benefits of an emission reduction. At the moment, both countries sensed that investing in environmental technologies yields economic gains. Thus they aim to take the lead in the green technology sector.

4.1 The new climate architecture after Copenhagen

4.1.1 The new international climate policy context

From the Kyoto Protocol to the Copenhagen Accord

The new architecture outlined in the Copenhagen Accord

In many ways, the Copenhagen summit of December 2009 marked an important departure from the practice of multilateral climate cooperation over the previous two decades.

The Copenhagen Accord, which was driven by the US and strongly influenced by China and a few other emerging economies, is characterized by a voluntary pledge and review system for emission reductions, and therefore a fundamental change of the current UN based multilateral approach. The Copenhagen Accord reflects the US vision for international climate architecture but is not in line with the EU approach of the continuation of Kyoto-style top-down climate architecture after 2012.

Switching to a bottom-up architecture

Top-down approaches

A top-down approach such as the Kyoto Protocol – an approach based on internationally agreed targets – would be based on formal engagement between sovereign actors, usually states, along traditional channels of multilateral diplomacy. Such negotiations tend to result in binding international commitments adopted through an international treaty, often complemented by centrally integrated processes and hierarchical institutions, which in turn shape and drive domestic implementation efforts.

Bottom-up approaches

Under a bottom-up approach, such as the Copenhagen Accord, by contrast, countries retain the ability to define both the nature and scope of their climate efforts; while they may cooperate with other partners by coordinating their activities and defining common aspirations, decision making remains decentralized and focused on the national level, rather than being assigned to any international institution.

Proponents of bottom-up approaches highlight the importance of flexibility, which they believe will allow each actor to define activities that are technically, economically, and politically acceptable in light of local or regional conditions. As a direct corollary, however, bottom-up approaches will generally not provide the same degree of certainty and reciprocal confidence afforded by a formal top down agreement, potentially deterring some actors from adopting commitments without assurance that others will engage in similar efforts.

Fading support for a multilateral approach

EU is increasingly isolated

The European Union and many developing countries still favour a multilateral science and rules-based approach, or a second commitment period under the existing Kyoto Protocol in combination with a treaty under the convention. The EU hoped to convince several major industrialized countries to join such a Kyoto-style agreement, e.g. Russia and Japan may have interest in a continuation of the Kyoto-mechanism.

Other countries, such as Japan or Russia, do not support a second commitment period under the Kyoto Protocol. Neither Japan nor Russia are currently supporting the EU position. The US did not move from their view since Copenhagen and the divergence of views became bigger than ever.

Cancun confirmed the architecture of Copenhagen

The Cancun Agreements

The Cancun summit of December 2010 essentially confirmed the new architecture of international climate policy that was outlined in the Copenhagen Accord.

Although the Cancun Agreements, the documents of the Cancun summit, fall short of binding commitment, these are the main topics that will be pursued in the next round of climate negotiations:

- Actions in climate policy should be targeted to keep the increase in global average temperature below 2°C above pre-industrial levels.
- The pledges and review system of the Copenhagen Accord is transferred to the UN negotiation environment.
- A Green Climate Fund should provide a new finance mechanism worth $200 billion a year by 2020 to poorer countries.
- A framework for adaptation activities and technology transfer is initiated.
- The option of a Kyoto-type agreement is kept open.

4.1.2 The Copenhagen pledges

Comparison of the reduction pledges

Almost all Annex I countries have pledged quantified economy-wide emission targets for 2020 and also 37 non-Annex I countries have pledged mitigation actions in the Copenhagen Accord.

In order to compare the individual pledges from countries or regions as shown in Table 4-1: The Copenhagen pledges and actions translated into simulation scenarios all Annex I emission reduction targets are translated into reductions from the same base year 1990 and all non-Annex I mitigation actions, including the emission intensity targets of China and India, are expressed in emission reductions from Business-as-Usual (BAU) in 2020. For countries that have not submitted a pledge, the assumption is made that emissions remain at the BAU baseline level.

Table 4-1: The Copenhagen pledges and actions translated into simulation scenarios

Region	Declared country targets and actions	Simulated scenarios	
		Low & Fragmented	High & Linked
Australia & New Zealand	Australia -5% to -25% from 2000; New Zealand -10% to -20% from 1990	+10.5% from 1990 (20% offsets)	-11.5% from 1990 (20% offsets)
Canada	-17% from 2005 domestic reductions; max. 10% credits from CDM	+3% from 1990 (10% offsets)	+3% from 1990 (10% offsets)
EU-27 & EFTA	EU-27, Liechtenstein and Switzerland -20% to -30% from 1990; Norway -30% to -40% from 1990; Iceland -30% from 1990; Monaco -30% from 1990	-20% from 1990 (20% offsets)	-30% from 1990 (20% offsets)
Japan	-25% from 1990	-25% from 1990 (20% offsets)	-25% from 1990 (20% offsets)
Russia	-15% to -25% from 1990	-15% from 1990 (no offsets)	-25% from 1990 (20% offsets)
United States	-17% from 2005	-3.5% from 1990 (20% offsets)	-3.5% from 1990 (20% offsets)
Non-EU Eastern Europe	Ukraine -20% from 1990; Belarus -5% to -10% from 1990; Croatia -5% from 1990	-16% from 1990 (20% offsets)	-16.5% from 1990 (20% offsets)
Brazil	-36% to -39% from BAU	-36% from BAU	-39% from BAU
China	Carbon intensity -40% to -45% from 2005	-0.2% from BAU	-8.5% from BAU
India	Carbon intensity -20% to -25% from 2005	+45% from BAU	+36% from BAU
Oil Exporting countries & Middle East	Indonesia -26% from BAU; Israel -20% from BAU	-8.5% from BAU	-8.5% from BAU
Rest of the World	Korea -30% from BAU; Mexico -30% from BAU; South Africa -34% from BAU; many other pledges (incl. Costa Rica, Maldives, Marshall Islands)	-6% from BAU	-6% from BAU

Source: Dellink, Briner and Clapp (2010).

All emission reductions are excluding LULUCF. The 20% limit on offsets in most Annex I regions is in line with the assumption in OECD (2009). All emissions are based on IEA and US-EPA data.

Oil exporting countries and Middle East include Middle East, Algeria, Libya, Egypt, Indonesia and Venezuela.

4.2 The EU in a changed global policy context

4.2.1 Fading support for EU positions

The leading role of the EU for the Kyoto Protocol

As is widely recognized, the Kyoto Protocol would not have come into force if the EU had not provided leadership in the 1997 negotiations and in the struggle to secure its entry into force in 2005. Europe's Emission Trading System provides a model for international emissions trading under the climate treaty and remains the world's preeminent experiment in reducing greenhouse gas emissions through a flexible market-based instrument.

The fading role of the EU in and after Copenhagen

The EU was not able to maintain this role during and after the Copenhagen summit.

By leading the debate on international climate policy and pioneering innovative mechanisms, the EU hoped to encourage tangible concessions by other players. However in reality the EU had not played a leading role in the final phase of the Copenhagen conference, it was the US president who brokered the final compromise. Having argued for a comprehensive deal in the run-up to the conference, European leaders were left with little choice but to endorse the watered-down version of the Accord. The Cancun summit more or less confirmed this reduced influence of the EU on the negotiations.

EU's internal controversies

Internally, the EU has been split before and after the Copenhagen conference. Countries like UK, Denmark, Sweden, and France have been favourable to a unilateral cut, while Poland and Italy have been opposed. These positions reflect different economic interests. Poland remains concerned about the impact on its coal industry and Italy has not yet invested enough in green energies.

UK, France and Germany warned to lose the race to compete in the low-carbon world

In summer 2010 UK, France and Germany teamed up to call for greater EU carbon cuts. The countries argued with the danger to lose the race to compete in the low-carbon world to countries such as China, Japan or the US – all of whom are trying to create a more attractive investment environment by introducing low-carbon policy frameworks and channelling their stimulus packages into low-carbon investment.

A higher EU target as incentive for other Annex-I countries?

The official EU line has been dictated by its desire to use additional cuts as leverage in the international climate negotiations. It has therefore linked them to equivalent pledges by the main developed countries, in particular the US. At the Copenhagen conference however there was no evidence that a higher EU target would have resulted in higher pledges by other countries. This has not changed after the Cancun conference.

Could a higher EU target help the Obama administration to get a US energy and climate law passed

The US Senate has been unable to agree on comprehensive climate legislation and is unlikely to do so until the next presidential elections in 2012. This prevents Canada and possibly Australia from introducing more effective legislation. Japan's government also finds it more difficult to act. Thus a higher EU target would hardly result in a higher US target.

4.2.2 The positions of the Communication on the new climate architecture

The Communication outlines three options for a new climate architecture

The Communication the EU outlined three options for a new climate architecture after 2012:

- A single new international agreement, replacing the Kyoto Protocol but, to various degrees, incorporating its key elements, such as internationally binding targets for Annex I countries,
- A second commitment period under the Kyoto Protocol for those countries who are willing to remain within the Kyoto Protocol, together with a new legally binding agreement under the Convention for the other countries, or
- A second commitment period under the Kyoto Protocol, together with a set of decisions under the Convention.

All of the three options include the continuation of a Kyoto-style agreement with internationally binding targets at least for a group of Annex-I countries. This position is strictly opposed, however by the US and China.

4.3 Contradictions in the US climate policy

US climate policy exhibits many contradictory signs if we compare the ambitious policy outlines by the Obama administration with the lacking policy support on a federal level or if we look at many regional climate initiatives. in addition we discover the importance that is given to a deliberate technological change within these initiatives.

4.3.1 The US has still a crucial role in climate policy

The continuing crucial role of the US

The US is after China the second biggest emitter of GHG in the world and based on per capita emissions it is the largest one, respectively. It was the US that played a crucial role in designing the Kyoto Protocol, even though it never ratified it. Now it is again the US who plays a major role in designing a post-2012 climate architecture.

About 15 bills for a federal US energy and climate law introduced in the Congress

While several initiatives have been implemented on the regional level, on the federal level it seems to be very difficult to establish a federal climate law, although there were about 15 bills for a federal US energy and climate law introduced in the US Congress in the last years.

Also EPA can regulate GHG emissions

Since 2009 also the EPA is legitimated to implement greenhouse gas regulations. It remains therefore open, whether a US energy and climate law or a regulation set by the EPA will regulate US greenhouse gas emissions in the future.

4.3.2 Early activities in the US

Clean Air Act (CAA)

The Clean Air Act of 1963

The first federal legislation involving air pollution control was the Clean Air Act (CAA) of 1963. It established a federal program within the US Public Health Service and authorized research into techniques for monitoring and controlling air pollution.

The Clean Air Act amendments of 1990

The legal basis for current federal programs regarding air pollution control are the 1990 Clean Air Act Amendments.. This legislation modified and extended federal legal authority provided by the earlier Clean Air Acts of 1963 and 1970.

New regulatory programs for the control of acid deposition (acid rain) and for the issuance of emission permits to stationary sources have been authorized. The Environmental Protection Agency (EPA) was provided with even broader authority to implement and enforce regulations reducing air pollutant emissions and apart from that 1990 amendments emphasized more cost-effective approaches to reduce air pollution (US EPA 2007).

The role of EPA

Through the limitation of certain air pollutants the EPA helps to ensure basic health and environmental protection from air pollution in the whole US. The CAA gives EPA the authority to limit emissions of air pollutants coming from sources like chemical plants, utilities, and steel mills. And the limits set by EPA are the weakest pollution limits individual states can have, although they may have stronger air pollution laws. (US EPA 2010).

Endangerment finding

In 2009 the EPA issued the findings of an “endangerment finding”. As a consequence the EPA is able to implement laws regulating greenhouse gases.

4.3.3 Activities of the Obama Administration

Obama's agenda blocked by political setbacks

Barack Obama's ambitious legislative agenda, including environmental policy, is threatened by political setbacks and an electorate questioning his priorities in the midst of tough economic crisis. “One of my top priorities next year is to have an energy policy that begins to address all facets of our over-reliance on fossil fuels” Obama said in October 2010. “We’re going to stay on this because it is good for our economy, it’s good for our national security, and, ultimately, it’s good for our environment.” (Lehmann and Marshall 2010).

No energy and climate bill has passed the congress

Despite the fact that the Obama Administration put the implementation of an energy and climate law including a cap & trade system on the top of its priorities so far no bill has passed the Congress. Nevertheless three major bills, the Lieberman-Warner bill, the Waxman Markey bill and the Kerry-Lieberman bill, deserve attention because of their remarkable contents.

The Lieberman-Warner Climate Security Act of 2008

Climate Security Act of 2008

The Lieberman-Warner Climate Security Act of 2008 would have established a market-based cap & trade program for greenhouse gas (GHG) emissions in the United States, and establish other measures to reduce GHG emissions if it have been enacted into law. It was the first cap & trade legislation to proceed to the Senate floor through regular order (through the committee process).

Regulation of 87% GHG emissions within a cap & trade system

87% of US GHG emissions would have been regulated with the cap & trade program of the bill, including coal-fired power plants and other entities that use more than 5,000 metric tons of coal, natural gas processors and importers, petroleum processors and refiners, manufacturers and importers of more than 10,000 metric tons of GHGs (as measured in CO_2 equivalents), and any entity that emits more than 10,000 metric tons (CO_2e) of HFCs as a by-product of the manufacture of hydro chlorofluorocarbons (HCFCs). HFCs would have been regulated by a separate cap & trade program. (Pew Center n.d. a).

Emissions reductions of 4% by 2012,-19% by 2020 and 71% by 2050

The cap & trade system would have implied for covered GHG emissions compared to 2005 reductions of 4% by 2012, 19% by 2020; and 71% by 2050. 75.5% of all allowances would have been allocated for free in 2012 and the proportion of allowances auctioned would increase from 24.5% in 2012 to 58.75% by 2032 (Pew Center n.d. a).

Use of domestic and international offsets and banking and borrowing allowed

In order to contain the cost of the cap & trade system the bill allows numerous measures as the use of domestic and international offsets and the banking and borrowing of allowances. The bill establishes a Carbon Market Efficiency Board and a cost-containment auction of a fixed quantity of allowances each year which would initially be offered only to those with compliance obligations and within a certain price range. Additionally, a working group creating regulations to protect the market from fraud and manipulation would have been founded.

Carbon leakage provisions and recycling of auctioning revenues

The bill also addresses carbon leakage: It would include a measure that would require importers of certain commodities from countries that do not have GHG control programs to submit special allowances, funds for assisting vulnerable communities abroad, promoting international technology development, and conserving forests and wildlife in other countries. According to be the bill auctioning revenues would have to be used for low carbon investment

Other ey measures

The bill would provide funds for low-income energy consumers and assist in worker transition.

Funds and incentives for the development and deployment of CCS technology would be provided along with funds for: renewable energy; increasing the energy efficiency of buildings, appliances, manufacturing; research into low-carbon electricity generation and advanced energy projects; increasing the use and manufacture of hybrid and advanced vehicles; and increasing the production of cellulosic biofuels.

It also includes a low-carbon fuel standard. Besides that, funds for the states and mass transit projects and wild-life conservation and adaption projects would be allocated, among others.

Waxman-Markey: American Clean Energy and Security Act (ACES)

American Clean Energy and Security Act

The American Clean Energy and Security Act 2009 (ACES/ H.R. 2454), also called the Waxman-Markey bill, passed the US House of Representatives on

June 26 by a vote of 219 to 212. The bill is named after Committee Chairman Henry Waxman (D-CA) and Rep. Edward Markey (D-MA), chairman of a key subcommittee who introduced the bill on May 15 2009

Cap & trade system as the central measure

The outstanding measure of the bill is the introduction of a cap & trade system which would cover seven GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

Emissions reductions of 4% by 2012,-19% by 2020 and 71% by 2050

The established emission caps would lead compared to 2005 to aggregate GHG emissions reductions for all covered entities of 3% in 2012, of 17% in 2020, of 42% in 2030, and of 83% in 2050.

Installations covered by the cap & trade system would include: large stationary sources emitting more than 25,000 tons per year of GHGs, producers (i.e., refineries) and importers of all petroleum fuels, distributors of natural gas to residential, commercial and small industrial users (i.e., local gas distribution companies), producers of F-gases, and other specified sources.

Auctioning volumes

In the first years of the cap & trade system, approximately 20% of allowances are auctioned. This percentage increases over time to about 70%by 2030 and beyond.

Five distinct titles to tackle climate change

The Waxman-Markey Bill addresses besides *carbon trading* four other areas.

Clean Energy: The bill would set standards for conventional and renewable energy technologies and provide funds to support the development of clean energy projects and technologies (e.g. a federal renewable electricity and efficiency standard, carbon capture and storage technology, performance standards for new coal-fuelled power plants, R&D support for electric vehicles and support for deployment of smart grid advancement)

Energy Efficiency: The bill would mandate new energy efficiency standards for appliances, buildings, transport and industry and provide funds to support energy efficiency projects and technologies (provisions related to building, lighting, appliance, and vehicle energy efficiency programs).

Transitioning to a Clean Energy Economy: The bill would provide financial assistance to those industries and persons affected by the bill's provisions and protect consumers from increases in energy prices (provisions to preserve domestic competitiveness and support workers, provide assistance to consumers, and support for domestic and international adaptation initiatives).

Offsets from Domestic Forestry & Agriculture: The bill would provide opportunities for domestic emissions from the forestry and agricultural sectors

A US technology fund for exporting green technologies

The Waxman-Markey bill provides for a clean technology fund. The bill authorizes assistance for deploying clean technologies to developing countries to projects that achieve substantial reductions in greenhouse gas emissions through deployment of low- or zero-carbon technologies. Only developing countries that have ratified an international treaty and undertaken substantial greenhouse gas reductions are eligible.

For detailed measures included in the ACES see Table 4-2.

Kerry-Lieberman: American Power Act 2010 (APA)

American Power Act

Senator Lieberman together with Senators Kerry and Graham on December

2010

10, 2009, presented the Framework for Climate Action and Energy Independence in the US Senate.

The Framework outlines the principles that will be used to craft comprehensive climate change legislation that creates jobs, protects national security interests, and reduces emissions (Kerry and Graham 2009).

Proposed legislation included:

In 2009 senators Kerry, Graham and Lieberman tried to build consensus within the Senate to pass the legislation, which would include:

- A market-based solution to achieve a pollution reduction target of -17% in the short term and -80% in the long term compared to 2005 levels.
- Investments to develop and deploy new clean energy technologies, including nuclear energy, renewable energy, clean coal, and energy efficiency.
- Increased domestic production of oil and natural gas onshore and offshore.
- Transitional support for low- and middle-income families to ease costs and for businesses to ensure compliance and avoid carbon leakage.
- A mechanism to moderate the price of carbon to prevent market volatility and vigilant carbon market oversight.
- Domestic and international offsets.
- A strong, international agreement with real, measurable, verifiable and enforceable actions by all nations, long-term financial assistance to developing countries, and enhanced technology cooperation with intellectual property rights protection.

Political controversies

A few days before the three senators wanted to announce the legislation senator Graham wrote a letter on April 24, 2010 where he stated that he would no longer participate on negotiations on the energy bill due to some disputes (Eilperin J. 2010).

Thus the announcement of the draft legislation was delayed, but on May 12, 2010 senators Kerry and Lieberman presented the American Power Act (APA). Table 4-2 presents the key measures of the American Power Act and compares it with the measures proposed in the American Clean Energy and Security Act.

Complementary polices

In addition to the measures described in Table 4-2 there are various complementary policies as: technology research, development and deployment support; measures for coal; measures for transportation; measures for energy efficiency; clean energy standard (not specified in APA); measures for nuclear power (not specified in ACES) and measures for offshore oil and gas exploration (not specified in ACES).

Table 4-2: Comparison of the American Clean Energy and Security Act of 2009 (Waxman-Markey) and the American Power Act (Kerry-Lieberman)

Program Category	Design Element	ACES (June 26, 2009)	APA Draft (May 12, 2010)
Emission reduction targets	targets and timetables for covered sources under cap & trade system	97% of 2005 levels by 2012 83% of 2005 levels by 2020 58% of 2005 levels by 2030 17% of 2005 levels by 2050	95.25% of 2005 levels by 2013 83% of 2005 levels by 2020 58% of 2005 levels by 2030 17% of 2005 levels by 2050
Emission reduction levels	Economy-wide reduction goals and timetables	97% of 2005 levels by 2012 80% of 2005 levels by 2020 58% of 2005 levels by 2030 17% of 2005 levels by 2050	95.25% of 2005 levels by 2013 83% of 2005 levels by 2020 58% of 2005 levels by 2030 17% of 2005 levels by 2050
Emissions reporting	National GHG registry reporting threshold	Large stationary sources emitting >10 kt per year Vehicle fleets (with emissions >25 kt per year) at the Administrator's discretion	Large stationary sources emitting >10 kt per year, or less, at the Administrator's discretion Vehicle fleets (with emissions >25 kt per year) at the Administrator's discretion
Cost containment	Offset sources and quality requirements	Domestic and international EPA Offsets Integrity Advisory Board (OIAB) created and Administrator determines project list based on OIAB recommendations Real, additional, verifiable, permanent, enforceable Administrator to prescribe a mechanism (such as an offset reserve or insurance) to ensure offset permanence Title V establishes domestic agriculture and forestry offset program run by USDA with a positive list of potentially eligible project types	Domestic and international GHG Emission Reduction and Sequestration Advisory Committee is created to provide advice on the establishment of the offset program Additional, measurable, verifiable, enforceable Administrator to prescribe a mechanism (such as an offset reserve or insurance) to ensure offset performance Sec. 734 establishes a list of project types that must be included on the initial list of eligible projects
Cost containment	Banking and Borrowing	Unlimited banking Unlimited next year borrowing with no interest Borrowing up to 15% compliance	Unlimited banking allowed for allowances and offsets except if specifically determined by the Administrator

		obligation with vintage years 1-5 beyond calendar year at 8% interest per year	Unlimited next year borrowing with no interest Borrowing up to 15% compliance obligation with vintage years 1-5 beyond calendar year at 8% interest per year
Cost containment	Regular auction floor price	Reserve price for all regular auctions starting at $10/ton in 2012 and increasing by 5% above inflation annually	Reserve price for all regular auctions starting at $12/ton in 2013 and increases by 3% per year
Complementary policies	Technology research, development and development support	Directs allowance value to clean energy and CCS	Directs allowance value to CCS, renewable electricity generation, and electric vehicles including via a Clean Energy Technology Fund
Complementary policies	Clean Energy Standard	From 2012 through 2039, electricity utilites that sold at least 4 million MW hours of electricity energy during the preceding calendar year are required to produce a set percentage from renewable. The percentage starts at 6% for 2012-2013, increases incrementally and stays at 20% from 2020-2039	Not specified

Source: Pew Center (2010a).

The American Recovery and Reinvestment Act of 2009 (ARRA)

A $787 billion economic stimulus package

The American Recovery and Reinvestment Act of 2009 (Recovery Act or ARRA) is the economic stimulus package passed by Congress on February 13, 2009 and signed by President Obama four days later. The package totals nearly $787 billion, delivered through a combination of federal tax cuts, expansion of social welfare provisions including unemployment benefits, and domestic spending to advance economic recovery and create new jobs as well as save existing ones (Committee on Climate Change Science and Technology Integration 2009).

Substantial share related to energy and climate

The new spending involves about $42 billion in energy related investments, $21 billion in vehicles/transportation spending (transit assistance, energy efficient fleets, etc.), and about $570 million in climate science research spending. In addition, there are about $21 billion in energy-related tax incentives such as extending the renewable energy production tax credit and an additional $1.6 billion in Clean Renewable Energy Bonds.

Key components

Key components of the legislation include:

- Funding for numerous grant programs and tax incentives for clean energy technologies, including solar, wind, biomass, geothermal, marine, hydropower, fuel cells, plug-in electric vehicles, and other technologies that have the potential to reduce US GHG emissions.
- Emphasizing energy-efficient technologies, practices, and policies, including a 30% tax credit for residential energy efficiency investments, as well as mandates for improved energy efficiency standards for electric heat pumps, central air conditioners, water heaters, wood stoves, oil furnaces, and hot-water boilers.
- Increasing the investments allocated to new clean renewable energy bonds and qualified energy conservation bonds.
- Investing in critical energy infrastructure by providing loan guarantees for new or upgraded electric power transmission projects, and by providing funding for the Smart Grid and new Smart Grid technologies.
- Asserting an energy efficiency leadership role for the federal government, investing in the “green” conversion of federal facilities, and purchasing vehicles for government use with higher fuel economy, including hybrid and electric vehicles (United States Department of State 2010).

Measures to enhance the development and deployment of new technologies and to tackle climate change

Measures to enhance the development and deployment of new technologies and to tackle climate change include:

- *Modernized Transit:* $17.7 billion for transit and rail to reduce traffic congestion and gas consumption.
- *Reliable, Efficient Electricity Grid*: $11 billion to modernize the electricity grid, making it more efficient, secure, and reliable, and build new power lines, including lines that transmit clean, renewable energy from sources throughout the nation.
- Renewables and Smart Grid Energy Loan Guarantees: $4 billion to support loan guarantees for up to $40 billion in loans for renewable energy generation and electric power transmission modernization projects.
- GSA Federal Buildings: $4.5 billion for renovations and repairs to federal buildings, focused on transitioning toward a high-performance green building portfolio.
- *State and Local Government Energy Efficiency Grants:* $6.3 billion to help state and local governments make investments that make them more energy efficient and reduce carbon emissions.
- Energy Efficiency Housing Retrofits: $250 million for a new program to upgrade US Department of Housing and Urban Development-sponsored low-income housing to increase energy efficiency, including new insulation, windows, and furnaces. Funds will be competitively awarded.
- Energy Efficiency and Renewable Energy Research: $2.5 billion for energy efficiency and renewable energy research, development, demonstration, and deployment activities to foster energy independence,

reduce carbon emissions, and cut utility bills. Funds are awarded on a competitive basis to universities, companies, and national laboratories.

- Advanced Battery Grants: $2 billion for the Advanced Battery Grants Program, to support manufacturers of advanced vehicle batteries and battery systems.
- Home Weatherization: $5 billion to help low-income families reduce their energy costs and increase energy efficiency by weatherizing their homes.
- Smart Appliances: $300 million to provide consumers with rebates for buying energy-efficient Energy Star products to replace old appliances, which will lower energy bills.
- GSA Federal Fleet: $300 million to replace older vehicles owned by the federal government with more fuel-efficient vehicles, including alternative-fuel and plug-in hybrid automobiles that will save on fuel costs and reduce carbon emissions.
- Electric Transportation: $400 million for a new grant program to encourage electric vehicle technologies.
- Cleaner Fossil Energy: $3.4 billion for carbon capture and sequestration (CCS) technology demonstration projects. These demonstration projects will provide valuable information needed to advance the deployment of CCS technology, which will be critical to reduce the amount of carbon dioxide emitted into the atmosphere from industrial facilities and fossil fuel power plants.
- Training for Green Jobs: $500 million to prepare workers for careers in energy efficiency and renewable energy fields (United States Department of State 2010 p.40).

4.3.4 Regional activities

Several ambitious regional initiatives

Besides the activities at the federal level there are several initiatives at the regional level to contain GHG emissions.

The federal environmental laws (e.g. CAA) set the minimum requirements for climate policy but each state can establish a more ambitious policy to reduce the reduce GHG emissions.

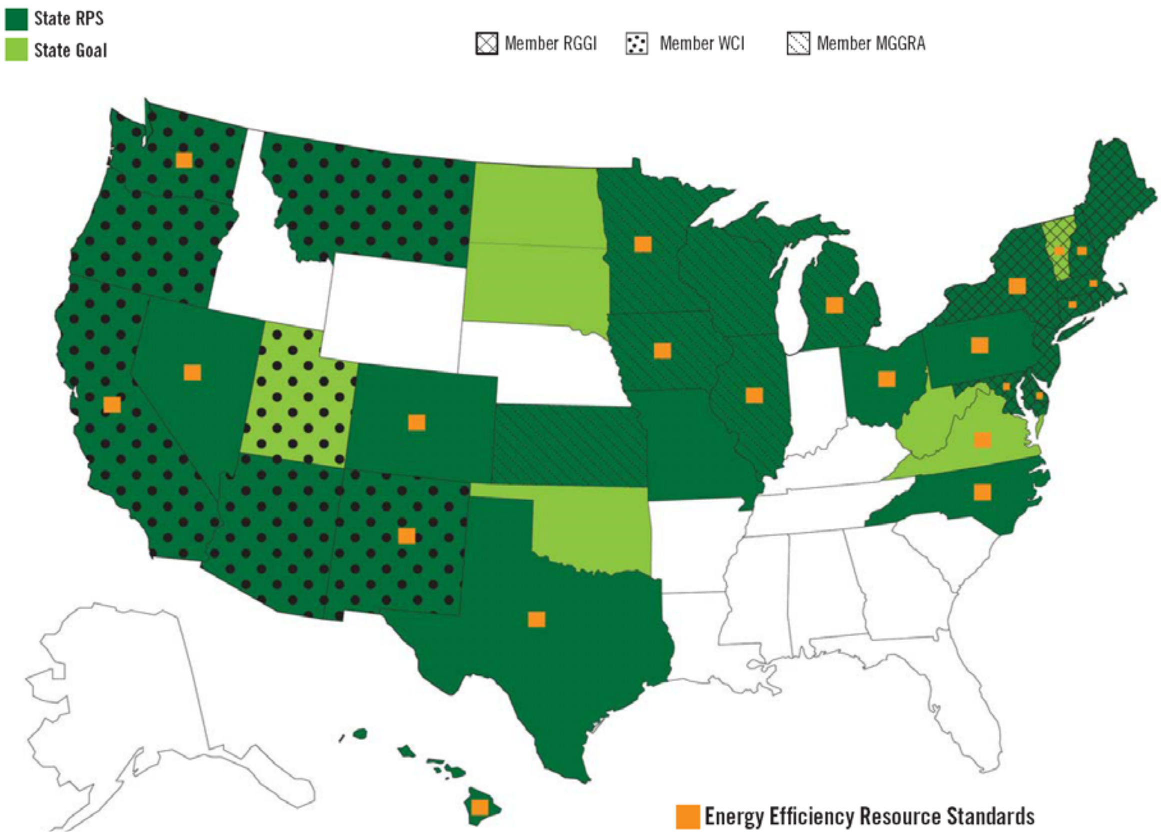
Thus there are several, to some extent very ambitious initiatives to tackle climate change, as e.g. the Western Climate Initiative or the Regional Greenhouse Gas Initiative.

Overview of Regional activities in the U.S

Regional carbon trading markets

Three mandatory regional carbon trading markets, the Northeast and Mid-Atlantic Regional Greenhouse Gas Initiative (RGGI), the Midwestern Greenhouse Gas Reduction Accord (MGGRA) and the Western Climate Initiative (WCI) are being established by state governors to limit emissions and spur energy innovation. 23 US states are participating, accounting for nearly half the nation’s population. RGGI began auctions in September 2008, WCI and MGGRA should be operational in 2012.

Figure 4-1: Regional activities in the US



Source: Wasserman A. (2010).

Figure 4-1 shows the regional activities in the US, including three mandatory regional carbon trading markets, the Northeast and Mid-Atlantic Regional Greenhouse Gas Initiative (RGGI), the Midwestern Greenhouse Gas Reduction Accord (MGGRA) and the Western Climate Initiative (WCI) that are being established.

In addition 29 states employed binding renewable portfolio and six states implemented non binding renewable deployment goals which mandate that utilities get a certain amount of their energy from renewable sources, leading to emissions reductions. 20 states have minimum energy efficiency resource standards which encourage more efficient generation, transmission and use of electricity and natural gas and 24 states have developed comprehensive climate plans. Ten states have set legislative economy-wide reduction targets and sixteen states have economy-wide reduction targets set by executive order, which have the same binding nature as law but can be repealed by future state governors.

Western Climate Initiative (WCI)

History

The Western Climate Initiative was initiated in February 2007 by the Governors of Arizona, California, New Mexico, Oregon and Washington. These countries signed an agreement directing their respective countries to develop a regional target for reducing GHG emissions. To achieve the target they aimed to develop a market-based program and besides that, every state participates in a multi-state registry to track and manage GHG emissions in the region.

The WCI combines existing GHG reduction efforts in the individual states and two existing regional efforts, namely the Western Coast Global Warming Initiative and the Southwest Climate Change Initiative.

The Western Coast Global Warming Initiative was founded in 2003 by the Governors of California, Oregon and Washington while the Southwest Climate Change Initiative was initiated in 2006 by Arizona and New Mexico.

The original five states have been joined soon by British Columbia, Manitoba, Ontario, and Quebec, and the Governors of Montana and Utah to tackle climate change at a regional level and through the joining of the four Canadian provinces (which account for three-fourths of the Canadian population) WCI became an international activity.

15% emissions reductions by 2020

The regional GHG emission reduction goal set by WCI is an aggregate reduction of 15% below 2005 by 2020.

Measures for reaching the regional goals

- These are the key measures for achieving these regional goals:
- Creating a market-based system that caps GHG emissions and uses tradable permits to incentivise development of renewable and lower-polluting energy sources
- Encouraging GHG emissions reductions in industries not covered by the emissions cap, thus reducing energy costs region wide
- Advancing policies that expand energy efficiency programs, reduce vehicle emissions, encourage energy innovation in high-emitting industries, and help individuals transition to new jobs in the clean-energy economy.

Adopted guidelines

Emission reporting requirements for capped sources and other important sources of GHG emissions have been adopted in the WCI (Western Climate Initiative 2010). Several guidelines have been developed as e.g. guidelines for establishing jurisdictional emission allowance budgets as well as guidelines for rewarding early emission reductions.

Compliance periods

The first compliance period starts in 2012 and ends in 2014. The second compliance period covers the years 2015 to 2017. In this period, the WCI cap & trade system is expanded to include transportation fuels and residential and commercial and industrial fuels not otherwise covered in the first phase. The third compliance period will be from 2018 to 2020.

The Regional Greenhouse Gas Initiative (RGGI)

RGGI startet 2009

Ten states have joined forces and implemented the Northeast and Mid-Atlantic Regional Greenhouse Gas Initiative (RGGI) in 2009, which aims at reducing CO_2 emissions of the power sector by 10% by 2018: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.

RGGI was the first mandatory, market-based program to reduce CO_2 emissions in the US. RGGI is composed of individual CO_2 budget trading programs in each participating states. Each state limits emissions of CO_2 from electric power plants, issues CO_2 allowances and establishes participation in regional CO_2 allowance auctions through independent regulations.

86 % of the allowances are auctioned

As every regulated power plant can use a CO_2 allowance issued by any participating state the ten states function as a single regional carbon market.

86% of the allowances are auctioned to prevent windfall profits and enhance the investment in energy efficiency and clean energy. Since emissions have dropped faster than expected allowances prices have been low and surplus allowances appeared. Even though, the auction has been able to generate over $660 million for public purposes (by July 2010).

Design of the cap & trade system

The market-based cap & trade approach includes:

- A multi-state CO_2 emissions budget (cap) that will decrease gradually until it is 10% lower than at the start.
- Requirements for fossil fuel-fired electric power generators with a capacity of 25 MW or greater (regulated sources) to hold allowances equal to their CO_2 emissions over a three-year control period.
- Allocating CO_2 allowances through quarterly, regional CO_2 allowance auctions.
- Investing proceeds from the CO_2 allowance auctions in consumer benefit programs to improve energy efficiency and accelerate the deployment of renewable energy technologies.
- Allowing offsets (greenhouse gas emissions reduction or carbon sequestration projects outside the electricity sector) to help companies meet their compliance obligations.
- An emissions and allowance tracking system to record and track RGGI market and program data, including CO_2 emissions from regulated power plants and CO_2 allowance transactions among market participants (Regional Greenhouse Gas Initiative 2010).

4.3.5 US technology programs addressing climate change

One instrument to contain climate change is to endorse large scale deployment of renewable energy technologies in order to substitute fossil fuels by energy which has been generated with renewables. Thus, similar to other countries, investing in the development and large scale deployment of sustainable, clean technology is one major aim of the US. In order to boost innovation in the so called green energy sector several technology programs have been established at federal level in the US.

US Climate Change Science Program (CCSP)

US Climate Change Sci-

CCSP was created by the President in 2002, as part of a new cabinet-level

ence Program

management structure to oversee public investments in climate change science and technology. It is an inter-agency research planning and coordinating entity and integrates federal research on global change and climate change, as it is sponsored by 13 federal agencies. Further it integrates the planning of research and applications that are implemented by the participating agencies by using their complementary strengths.

Main goals

In 2003 the CCSP released a strategic plan for guiding climate research. In order to focus and orient research in the program and ensure that knowledge developed by the participating agencies and research elements can be integrated the following five goals have been identified:

- Improve knowledge of the Earth's past and present climate and environment, including its natural variability, and improve understanding of the causes of observed variability and change.
- Improve quantification of the forces bringing about changes in the Earth's climate and related systems.
- Reduce uncertainty in projections of how the Earth's climate and related systems may change in the future.
- Understand the sensitivity and adaptability of different natural and managed ecosystems and human systems to climate and related global changes.
- Explore the uses and identify the limits of evolving knowledge to manage risks and opportunities related to climate variability and change.

Strategic plan for climate research

In 2003 the CCSP released a strategic plan for guiding climate research. In order to focus and orient research in the program and ensure that knowledge developed by the participating agencies and research elements can be integrated the following five goals have been identified:

Different core approaches to reach the targets

To achieve the above mentioned goals the CCSP has different approaches as planning, sponsoring and conducting scientific research on changes in climate and related systems, enhancing observations and data management systems to generate a comprehensive set of variables needed for climate related research, develop improved science-based resources to aid decision making, communicate results to domestic and international scientific and stakeholder communities to enhance openness and transparency (Climate Change Science Program and the Subcommittee on Global Change Research 2003).

US Climate Change Technology Program (CCTP)

US Climate Change Technology Program

The US Climate Change Technology Program (CCTP) is a multi-agency planning and coordinating entity and is led by the Department of Energy.

The key activities of the CCTP are to accelerate the development of new and advanced technologies to address climate change, to provide strategic direction for the CCTP-related elements of the overall Federal R&D portfolio and to facilitate the coordinated planning, programming, budgeting and implementation of the technology development and deployment aspects of US climate change strategy.

Strategic goals of CCTP

In order to ensure that energy sources are secure, affordable and reliably and to discover approaches that address other environmental concerns one target of CCTP is to explore opportunities for new and advanced technologies that can address multiple societal objectives (e.g. GHG reduction.)

Thus the CCTP identified six strategic goals:

- Reduce emissions from energy end use and infrastructure
- Reduce emissions from energy supply
- Capture and sequester carbon dioxide
- Reduce emissions of non-carbon dioxide GHGs
- Improve capabilities to measure and monitor GHG emissions
- Bolster basic science contributions to technology development (Strategic Plan 2006).

4.4 The new role of China in climate policy

China has become the biggest GHG emitter and the biggest investor in clean technologies

China has become the biggest emitter of GHG emissions. On the other hand China has become a global leader in investments into clean technologies. These seeming contradictions reflect China's extreme growth path and the related energy demands which is causing severe environmental damages.

China has so far not committed to absolute emissions reductions but to a relative reduction target tied to the emissions intensity per GDP unit.

4.4.1 China's international and domestic policy positions

The role of the five years plans

Environment and the planning procedures

Despite many competitive elements China'S economy is still shaped by its planning tool, the Five Years Plan (5YP).

In the Eleventh 5YP (2007 - 2011) for the first time ecological goals were included. A department for environment was outsourced from the prior responsible departments for technology and science and for the first time connects technological needs were linked to environmental objectives.

The Twelfth 5YP (2012 - 2017) is known to set stringent GHG emission reduction goals and is naming five cities and their regions for finding individual measures to fulfil their carbon reduction targets.

The 'long term development plan (2006 - 2020)' which puts a focus on technology targets for 2020 and intensifies funding programs in future technology makes it clear that China is willing to do a big step in the area of green technologies.

Carbon markets are in the process of being installed on a voluntary level and on a regional basis.

Incentives for an active environmental policy for China

There are several incentives for China to be aware of environmental issues.

- The currently overwhelming bad environmental situation which has no proper corrective is getting more aware by China's citizens.
- The consequential charges of an ignored environmental action are rated for China at 8 to 12% of annual GDP which means that China's entire average growth is actually a borrowing on the future.
- The international industrial shift towards green technology opens China a new market where it can benefit from its favourable conditions in labour cost and a potential strong domestic market, depending on its next political steps.
- The international dependencies on energy resources caused by its growing economy could be eased by innovative energy technologies.

It is definite that China will be a global player in the green industry in the near future. China already dominates the markets for photovoltaic and wind turbines.

China's positions in international climate negotiations

China's positions in international climate negotiations

In the international negotiations for GHG targets, China has an ambivalent role. It supports the negotiations for a global treaty, however proposes only intensity targets and goals for 2020 for its own economy. Chinas arguments are:

- Present GHGs in the atmosphere are the result of industrial production of the last 50 years. This argument can be put further to demand international support on China's green industries as for example though CDM projects.
- China is still a developing economy. This implies for a long time higher GDP growth rates compared to already developed nations. In this process a fixed GHG cap is very hard to reach. In consequence China is only pledging intensity-targets. The absolute GHG emissions will significantly grow in the near future.

China's arguments are typical for the position of the developing countries and put extra pressure on the already developed countries by stressing that that any international GHG cap has to consider the present and future growth of Chinas GDP by allowing also a GHG increase.

China emphasises that it will not risk future wealth, as already achieved in the developed countries, in any international agreement.

China's lacking domestic legislation

China's current legal environmental standards are very weak and practically don't exist. Most of the environmental actions in the current 5YP are setting standards below the ones in developed countries.

There are obvious obstacles for implementing environmental policy. Interaction with the population is missing as for instance environmental associations are not legal. Financial and human resources for the newly created governmental institution for environment in 2008 with only about 300 persons which is definitely not sufficient for handling the challenging environmental tasks.

4.4.2 China's science and technology national plan

Science and Technology National Plan

The Medium-to-Long-Term Science and Technology National Plan (S&T National Plan) was published in 2006 and established the government's front-and-center role in determining the direction, quality, and quantity of China's R&D and innovation efforts to 2020. It sets four quantitative targets and five strategic focuses with the top priority given to energy technology, water resources and environmental protection.

Three key clean technologies

The Eleventh Five Year Development Plan of Science and Technology provided short term targets and goals for China's R&D and innovation activities from 2006 to 2010. It lists energy and environmental protection as key areas and highlights in particular three key clean technologies:

- Building key energy-saving technologies
- 2-3 MW wind turbine commercialization
- High quality transmission technology and equipment (Tan and Gang 2009).

Substantial increase in funding of governmental R&D

The funding of government clean technology R&D increased dramatically in the past five years, from 70.3 billion Yuan ($11 billion) in 2001 to 168.9 billion Yuan ($26 billion) in 2006. Thus, according to China FAQs (2010), the share of R&D in total government expenditure augmented from 3.7% to 4.2% from 2001 to 2006. Table 4-3 lists the most important, publicly-funded S&T programs.

Table 4-3: Important Chinese publicly-funded S&T programs

Program	Subject	Funding, Billion Yuan
863: National High-Tech R&D Program	IT, energy, resources and environment, advanced materials, biotechnology and agricultural technology, advanced manufacturing and automation, marine, space and laser technologies	20
National Natural Science Fund	Basic and applied research in the natural sciences with most funding directed to life sciences and engineering	10.5
Key Technologies R&D Program	R&D in agricultural processing and biotechnology, key manufacturing technologies, IT and high-tech industries, environment, traditional Chinese medicine, social development	6.3
973: National Basic Research Program	Basic and applied research in energy, agriculture, information, environment, population, health materials and synthesis	4
Innovation Fund for Small, Technology-based Firms	Development support in the areas of electronics and IT, biotechnology, materials, automation, environment and energy for technology-based small to medium enterprises (SMEs)	2.6
Agricultural Science and Technology Transfer Fund	Development support for agricultural technology generation, transfer and application	1.4
National New Products Program	Publication of annual list of new products that contain self-owned intellectual property rights (IPRs), have high export potential, replace import products, are made primarily with domestic parts or that adopt international standards for support through grants and other policies	0.7
Torch	Development support in areas of new materials, biological and medical technology, electronic information, integrated light and electronics and their machinery, new and efficient energy	0.3
Spark	Support of R&D and S&T education for rural economies, advanced technologies for township enterprises, the improvement of labour conditions and skills, and the creation of sustainable agricultural technologies	0.5

Source: Tan and Gang (2009).

4.4.3 China's current performance in the clean energy sector

China is taking the lead in clean energy

In an encouraging sign for the future, many governments prioritized clean energy within economic recovery funding, devoting more than $184 billion of public stimulus investments to the sector.

In 2009, China took for the first time the global lead in overall clean energy finance and investment. China built a strong manufacturing base, particularly in solar and wind, and is working now to meet its ambitious renewable energy targets by installing substantial new clean energy-generating capacity to meet the growing domestic energy consumption (Pew Center, 2010).

Table 4-4: Top ten countries in clean energy investment (2009)

Country	Investment in Clean Energy Billion US$
China	34.6
United States	18.6
United Kingdom	11.2
Rest of EU-27	10.8
Spain	10.4
Brazil	7.4
Germany	4.3
Canada	3.3
Italy	2.6
India	2.3
EU	39.3

Source: Pew Center (2010).

High growth in clean energy investment

The US clean energy investments fell 2009 by 40% compared with the previous year, thus leaving the US at the second place in overall clean energy investment of G-20 nations. As seen in Table 4-4 and Table 4-5, while China has the third highest growth in investment, the growth rate of the US lags behind five other G-20 countries despite the fact that overall clean energy finance and investment in the US more than doubled during the past five years. Other countries with strong clean energy policies as Brazil, the United Kingdom, Germany and Spain remain leaders in 2009.

Ambitious renewable energy targets

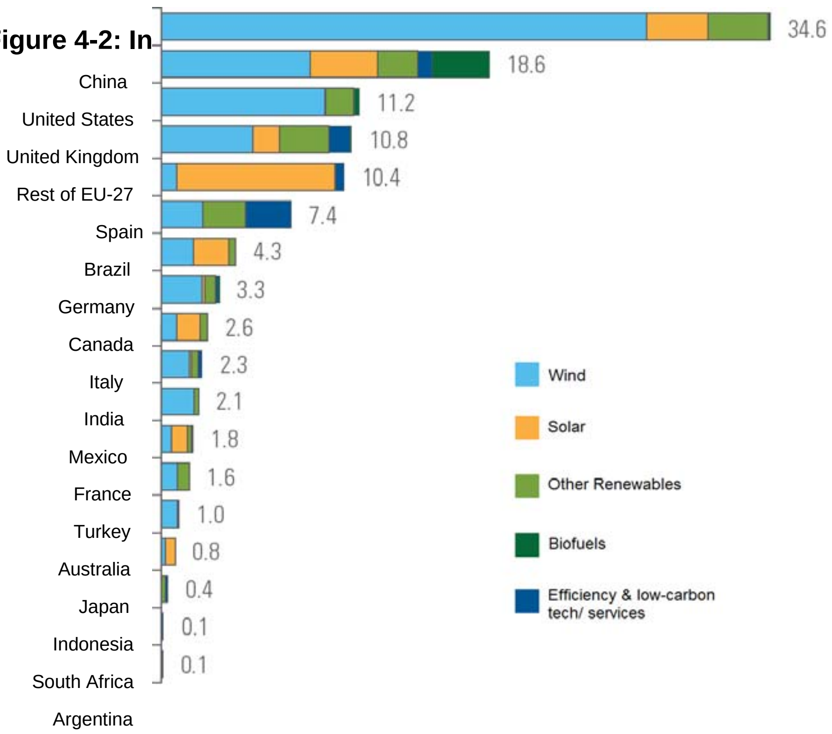
China has set ambitious targets for wind, biomass and solar energy. China doubled its wind capacity in 2009 to meet the target of installing 30 GW of wind by 2020 and China also had the lead in the G-20 in small hydro capacity and moved aggressively in the solar sector.

Table 4-5: Five-year growth (2005-2009) in clean energy investment

Country	Five-year growth in investment
Turkey	178%
Brazil	148%
China	148%
United Kingdom	127%
Italy	111%
United States	103%
France	98%
Indonesia	95%
Mexico	92%
Rest of EU-27	87%
EU	105.75%

Source: Pew Center, (2010).

Figure 4-2: In)



Source: Pew Center, (2010).

Thus Figure 4-2, a comparison of the investment in clean energy by sectors among countries in 2009, shows that China invested by far the most in renewable energy, especially in the wind sector, which is supported by a fixed-rate-feed-in-tariff. The key investment incentives of solar are rooftop and building integrated photovoltaic tax subsidies.

5 Preparing the toolbox for evaluating a more ambitious GHG reduction target

This chapter provides a toolbox of arguments for evaluating GHG reduction targets. The main instruments are dealing with emission pathways, the modelling tools for the economic analyses and insights about carbon markets and the related issues of price incentives and carbon leakage.

5.1 Emission pathways

At the Climate Conference in Cancun in December 2010 the UNFCCC adopted the goal to stay beyond 2°C temperature increase in order to avoid dangerous anthropogenic climate change. But there are several different pathways to reach this target as indicated in the Communication.

5.1.1 The 2°C target

UNFCCC target

The ultimate objective of the UN Framework Convention on Climate Change (UNFCCC) is to “stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.” (UNFCCC 1992. Article 2)

EU target of 2°C

To avoid this dangerous anthropogenic interference with the climate system the EU decided 1996 that their long term climate target is to limit the global mean temperature increase to 2°C above preindustrial levels (preindustrial is defined as 1850 to 1899 average global mean surface temperature).

In 2005 the EU reaffirmed this long term climate target. The target was first established during preparations for the Kyoto negotiations in 1996 and is mostly based upon studies about the impacts and risks expected that were assessed in the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

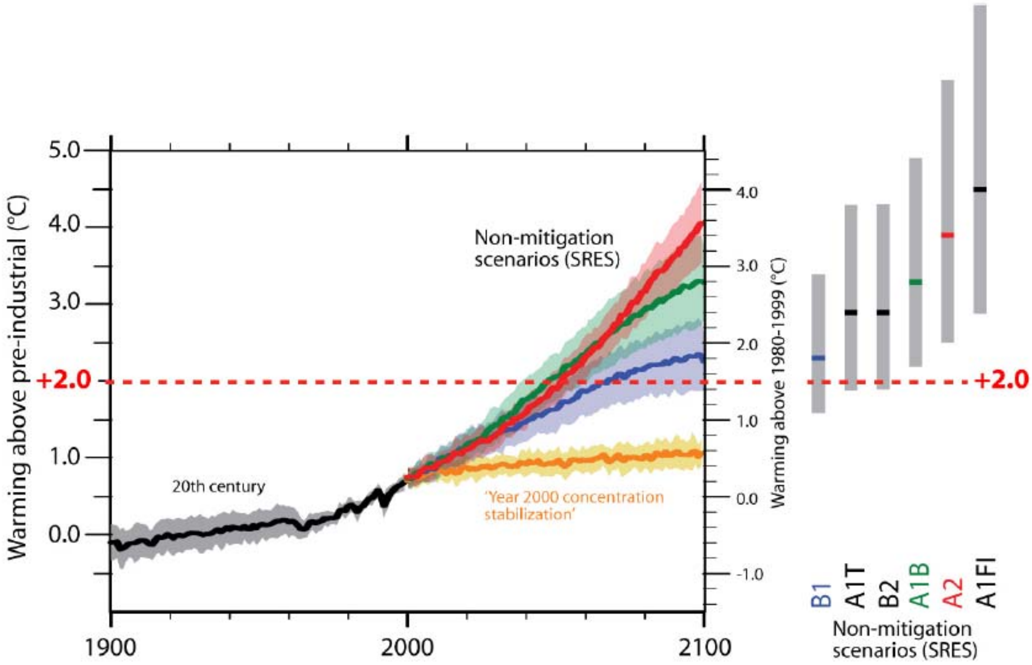
In the Communication and the Staff Working Documents the importance of reaching the 2°C target to avoid dangerous climate change is reconfirmed.

IPCC Report 2007 illustrates high uncertainties

The Fourth IPCC Assessment Report (AR4) 2007 predicts the rise in mean global temperature if GHG emissions will not be reduced and uses lower and higher non-mitigation scenarios to take account of the uncertainties involved. The IPCC indicates that for the lower non-mitigation emission scenarios global temperature may increase by 2.3° C (“likely” range between 1.6° C and 3.4° C) by the end of this century and for the higher non-mitigation emission scenarios by 4.5° C (2.9° C to 6.9° C) respectively. (Figure 5-1)

The temperature response to GHG emissions involves uncertainties. The IPCC Report 2007 estimates that the atmospheric CO_2e concentration has to be stabilized at 440ppm or lower to achieve the 2°Ctarget with at least a 50% probability

Figure 5-1: Projections of global mean surface temperatures for three SRES non-mitigation scenarios



Source: EU Climate Change Expert Group 'EG Science' (2008)

High uncertainties involved

The maximum greenhouse gas concentrations corresponding to a specific maximum warming involve uncertainties in the carbon cycle and the climate sensitivity and are therefore not completely understood. To account for these uncertainties Meinshausen et al. (2009) focus on emission budgets (cumulative emissions to stay below a certain warming level) and the probabilistic implications for the climate using pioneering mitigation studies. They build on the Fourth IPCC Assessment Report (AR4) and more recent research on future climate projections.

The high correlation between maximum warming and cumulative emissions and consequently the cumulative emissions up to 2050 and emissions levels in 2050 are robust indicators for the probability whether the 21st century warming will or will not exceed 2°C relative to preindustrial temperatures.

High risk of exceeding the 2°C target

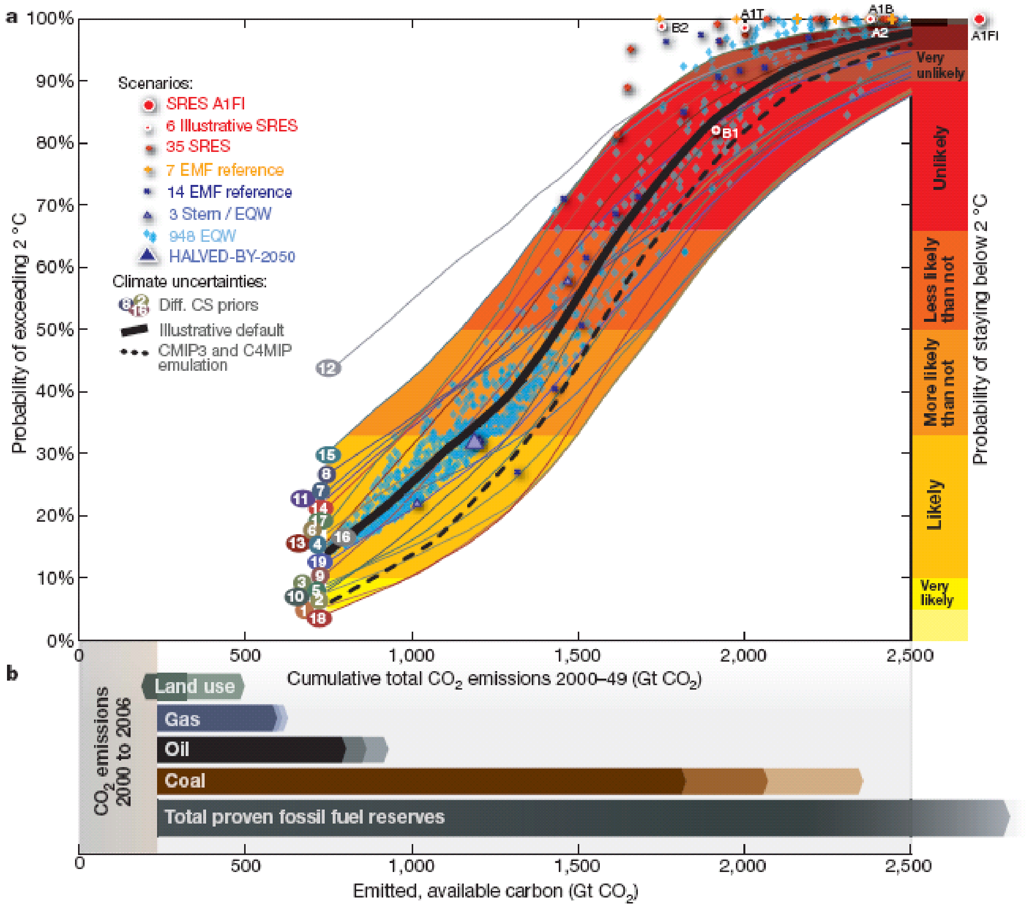
Figure 5-2 shows the probability of exceeding 2°C for different cumulative total CO_2 emissions between 2000 and 2049 and 18 different climate sensitivity distributions. If the 2000-2049 cumulative CO_2 emissions from fossil fuels and land use change can be kept below 1.000 Gt CO_2 the probability of exceeding 2°C can be limited to below 25%. For 1.400 Gt CO_2 the probability of exceeding 2°Ccan be limited to 50%, respectively. On the other hand if the cumulative CO_2 emissions exceed 2.050 Gt CO_2 it is unlikely that the global mean temperature increase stays below 2°C. The basis for the Annex-I reduction needs in the EU communication is the limitation to a 2°C temperature increase.

Basis for EU calculations is to limit the probability of exceeding the 2°C to 50%.

In Figure 5-2 only CO_2 emissions have been taken into account since the dominant anthropogenic warming contribution results from CO_2 emissions. Nonetheless Non-CO_2 GHG emissions contribute to the risk of exceeding warming thresholds.

The grey area in Figure 5-2 shows the total CO_2 emissions already emitted between 2000 and 2006 while the bars show the consequences of burning all proven fossil fuel reserves and land use change between 2006 and 2049. Emitting all proven fossil fuel reserves will greatly increase the risk of exceeding a temperature increase of 2° C.

Figure 5-2: The probability of exceeding 2°C warming versus CO_2 emitted in the first half of the twenty-first century



Source: Meinshausen et al. (2009)

Specified double function of the 2°C target

The 2°C target essentially serves two purposes:

- *Political perspective:* a symbol and a point of orientation for an ambitious, global climate agenda
- *Scientific perspective:* the point of departure for complex calculations that are used in particular to determine the emissions reduction pathways that need to be followed in order to comply, with a sufficient degree of probability, with the 2°C target.

These two functions have been supporting each other but the longer a reversal in global emission trends takes, the less compatible the political and symbolic dimension of the 2°C target becomes with the scientific research findings.

The budget approach

An alternative to the 2°Ctarget in the climate science community is the budget approach. Unlike the 2°C target where the focal point are reduction targets for 2050, like a 50% worldwide emission reduction, the budget approach calculates the maximum quantities of GHGs that can still be emitted until the year 2050 from which implications for the path of emission curves over the medium term can be deducted (Geden 2010).

2°C target after the Copenhagen Accord

While European politicians recognized the mentioning of the target in the Copenhagen Accord as a positive signal and that the summit was a step in the right direction, climate scientists stressed that the national self-commitments agreed on were far from sufficient to meet the 2°C target. (COM (2010) 265)

It is very likely that the quantities of GHGs emitted so far will raise temperature levels by 2.5 C. According to calculations by The United Nations Environmental Programme (UNEP) the peak in global emissions must be reached between 2015 and 2021 at latest. Thus major political actions would be necessary to meet the 2°C target. The UNFCCC discusses to tighten the global goal to 1.5°C.

Recommended change in the target category

When implementing a new global benchmark it would be advisable that a change in the ambitiousness of targets is also accompanied by a change in the target category, e.g. from global mean temperature towards atmospheric concentration of GHGs. Then instead of having a new global target of 2.5°C it is more likely that the new target will be 500 ppm of CO_2e. Such a target can be calculated with less scientific uncertainties than a temperature increase target.

5.1.2 Compatible trajectories

25% to 40% reductions by 2020 for achieving a 450 ppm goal

Based on the 450 ppm goal, the IPCC suggests a reduction of emissions of 25% to 40% below 1990 levels by 2020 and 80% to 95% by 2050. Developing countries would need to reduce at least 15% compared to business as usual by 2020.

Current pledges in the Copenhagen accordare not in line with the 2°C target

There is a clear discrepancy between agreements for reductions in emissions by 2050 (50% globally and some 80% to 95% for developed countries) as outlined in the Copenhagen Accord, and the comparatively weaker targets committed for 2020 (OECD, 2010). The higher end of the reduction pledges by Annex I countries amount to -17% in emissions compared to

1990 levels; for non-Annex I to -7% compared to BAU emissions in 2020 (OECD, 2010). The endeavour to reduce emissions will be much greater in the post 2020 period. Future generations will need to take deep year-by-year reductions in emissions in the years 2020 to 2050 if a stabilization of atmospheric concentrations is to be achieved and global warming is to be limited to a 2°C increase.

Looking at 2020 targets from a 2050 perspective

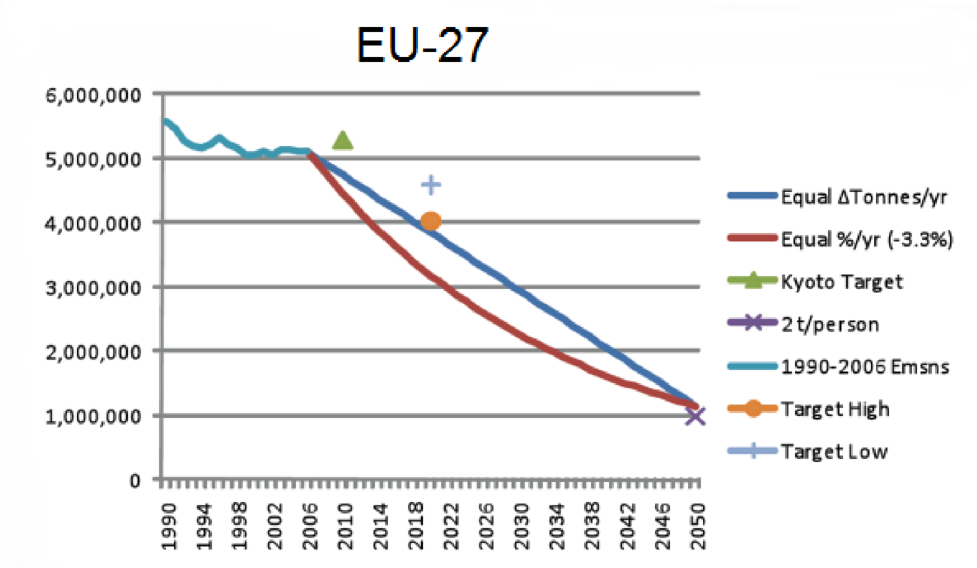
The EU has to reduce its emissions at least by 80% compared to 1990 levels in order to be in line with the 2°C target. To be consistent with this target the short term structural change triggered by the 2020 target is seen as a first step for the EU in order to reach its long-term objective in a cost efficient way.

2020 target is not consistent from a 2050 perspective

Figure 5-3 shows the realm of consistent emission reduction pathways as described in Guerin (2010). The indicator is built drawing two lines from a country's current emissions (in 2006) to the end point in 2050 which represents the EU's 2050 target. The first (straight) line is for equal absolute reductions in 'tonnes' per annum; the second (concave) line is for equal percent reductions per year. The difference between the two lines is that the former implies lower percent reductions in early years but increasing percent reductions in later years assuming that mitigation costs are cheaper earlier than later. In between the two lines, there is a portfolio of possible consistent pathways that reflect different choices and have different risk profiles.

According to Guerin (2010) it is evident that the 2020 target is not consistent from a 2050 perspective. Thus, between 2020 and 2050 emission reductions need to be very high in order to reach the 2050 target, involving high costs or the possibility of missing the 2050 target.

Figure 5-3: Trajectory indicator for the EU-27



Source: Ward, Grubb (2010)

Risk profile of the emission pathway

Another option is to analyze the risk profile of the emission pathway by technology. Long-term emissions reduction scenarios all revolve around a small number of key technologies as CCS or renewable energies. The reliance in these scenarios on a small number of key technologies has some risks.

These risks can be tackled in two ways:

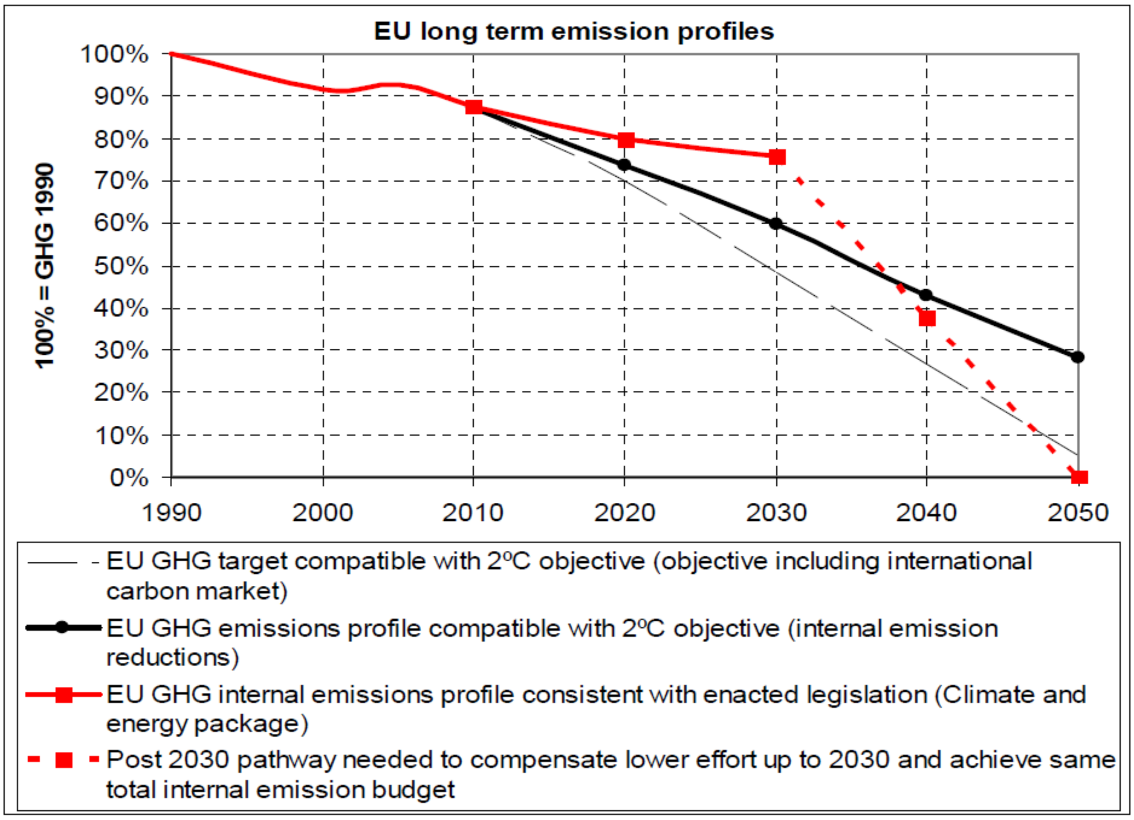
- Establishment of the right (significant and predictable) carbon price and specific support schemes so that technologies can be deployed at time and at large enough scale.
- Policies and measures need to consider the risk that these technologies eventually cannot be deployed at time and/or at scale.

Suggested reduction path% until 2050

According to the scenario chosen by the European Commission, in 2050 internal reductions in developed countries' energy and industrial sectors could be in the order of 76% compared to 1990 levels.

For the EU this would translate into a domestic reduction of GHG (both CO_2 and non-CO_2) from energy and the industrial sectors of 26% by 2020, of 41% by 2030, and 75% by 2050 (Figure 5-4). (SEC (2010) 650)

Figure 5-4: Long term emission profiles of the EU



Source: EC, SEC(2010) 650

The decisive role of emerging economies

Even if China keeps its promise to reduce carbon emissions per unit of gross domestic product (GDP) by 40 to 45% by 2020 as pledged under the Copenhagen Accord, and if the expected economic growth is 8%, its greenhouse gas output could still double.

If DCs don't take action the questions of a 30 % target vs. 20 % has little relevance for the climate

China's emissions rose between 1990 and 2005 from 4 to 8 $GtCO_2e$ and are expected to rise to 12 to 14 $GtCO_2e$ in 2020 under business as usual conditions. While the emission intensity target does not change this range significantly, the package of China's Copenhagen targets reduces this range to 11 to 13 $GtCO_2e$ (Climate Action Tracker, 2010).

Probabilities for achieving a 2°C target

The long-term emission profiles of the EU suggest that a 30% reduction target until 2020 is in line with the EU 2050 targets. Guerin, (2010), however, argues that the 30% reduction target is just the least ambitious target to reach the 2°C target in 2050. In order to reach a higher probability than 50% to stay beyond a 2° temperature increase the GHG emissions would have to be reduced, e.g. by 40%.

5.2 The analytical tools

The arguments of the Communication are based on a number of analytical tools: (SEC (2010) 650 Part II p.112-113). In order to evaluate the model results, this section discusses the models used and assesses and compares model assumptions and results with other models.

5.2.1 The analytical tools

The modelling tools used

These are the main analytical tools used for the Communication:

- PRIMES simulates the response of energy consumers and the energy supply system to different pathways of economic development and exogenous constraints.
- The POLES (Prospective Outlook for the Long term Energy System) model is a global sectoral simulation model for the development of energy scenarios until 2050. The dynamics of the model are based on a recursive (year by year) simulation process of energy demand and supply with lagged adjustments to prices and a feedback loop through international energy price.
- The GAINS (Greenhouse Gas and Air Pollution Interactions and Synergies) model explores cost-effective multi-pollutant emission control strategies that meet environmental objectives on air quality impacts (on human health and ecosystems) and greenhouse gases.

5.2.2 The new baseline in the EU Communication

Changed economic conditions

The Impact Assessment from January 2008 based its projections to a large extent on the 2007 PRIMES baseline. The latest projections take into account the effects of the economic crises as well as higher oil and gas price assumptions and include of a range of energy efficiency measures agreed and based on legislation in the EU during 2008 and 2009.

The new 2009 baseline scenario

The new baseline 2009 is based on the PRIMES energy system model for CO_2 emissions and the GAINS emission model for non-CO_2 emissions (supported by the CAPRI – Common Agricultural Policy Regional Impact – model) and projects CO_2 and non-CO_2 GHG emissions from 2005 to 2030 at EU-27 and Member State level.

It builds on macro projections of exogenous GDP and population It reflects the recent economic downturn, followed by sustained economic growth resuming after 2010. It is assumed that the recent economic crisis has long lasting effects leading to a permanent loss in GDP but economic recovery leads to higher productivity gains and higher growth rates from 2013 to 2015.

Uncertainty concerning the medium-term economic development prevails. In the new baseline scenario, population projections for the EU-27 are higher compared to the 2007 PRIMES baseline due to different migration assumptions. Oil, gas and coal prices are significantly higher than in the 2007 baseline (Table 5-1). It reflects effectively implemented policy measures at EU and national levels

Table 5-1: Comparison of macro assumptions of 2007 and 2009 baselines

Relevant EU 27 drivers	2005	2020 Baseline 2009	2020 Baseline 2007
Population	489.2 million	513.8 million	496.4 million
Gross Domestic Product	11,687 billion €2008	14,963 billion €2008	16,572 billion €2008
Crude oil import price	59.4 $08/barrel	88.4 $08/barrel	66 $08/barrel
Coal EU import price	14.0 $08/boe	25.8 $08/boe	16 $08/boe
Gas EU import prices	39.7 $08/boe	62.1 $08/boe	50 $08/boe

Source: EC, SEC(2010) 650

Comparison of 2007 and 2009 baselines

Table 5-1 shows the differences in the assumptions between the two baseline scenarios. In the new Baseline from the year 2009 population estimates for 2020 are slightly higher due to changes in migration assumptions while estimates for gross domestic product are lower due to the economic crisis. (SEC (2010) 650 Part II p.29)

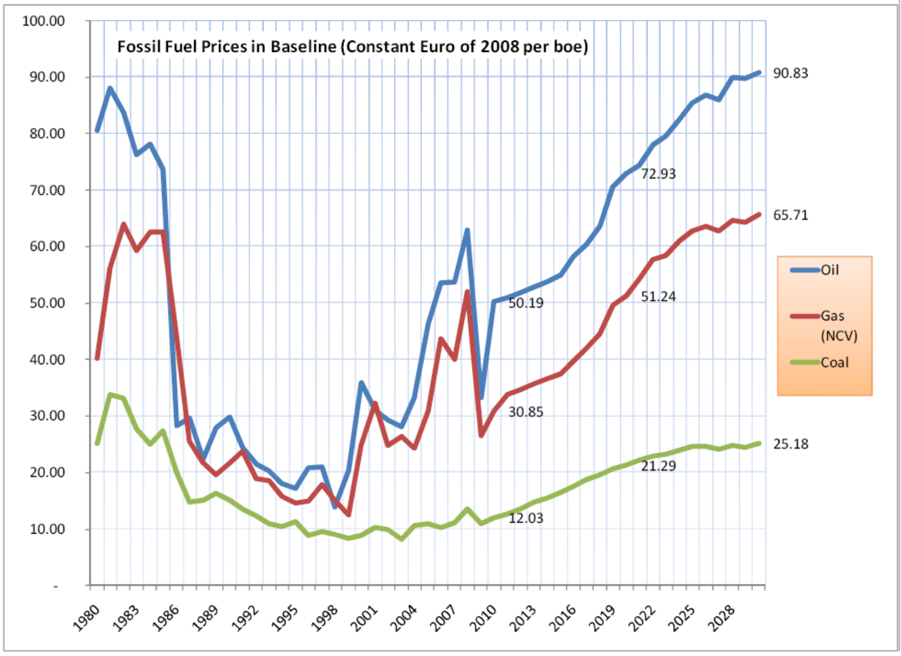
Higher fossil fuel price assumptions in baseline 2009

Assumed oil, gas and coal prices are significantly higher than in the 2007 Baseline, reaching $88, $62 and $26 (2008 prices) per barrel oil equivalent by 2020 instead of $66, $50 and $16. These assumptions are based on the stochastic PROMETHEUS world energy market model and are comparable with the assumptions of the IEA World Energy Outlook 2009.

Assumptions of higher oil prices increase the profitability of low-carbon technologies

Persistently higher fossil fuel prices are now expected than in the Commission's 2007 Impact Assessment of the energy and climate package. In turn, this increases the expected profitability of low-carbon technologies and energy-saving measures. Largely as a result of the economic recession and expected higher fossil fuel prices, in 2010 the costs of the 20% target are modelled by the Commission to be some 30% lower than was estimated in 2007. (COM (2010) 265)

Figure 5-5: Historic and assumed future prices of fossil fuels in the Communication



Source: Amann (2010)

New measures

The main new measures considered compared to 2007 baseline are:

- Improvement and extension of the EU ETS
- Regulation on CO_2 emissions for new passenger cars
- Implementation of the Eco-Design and Labeling Directives (e.g. energy services, stand-by, lighting)
- CCS demonstration plants which are part of the European Energy Programme for Recovery (EEPR)
- The 2008 "Health Check" of the Common Agricultural Policy

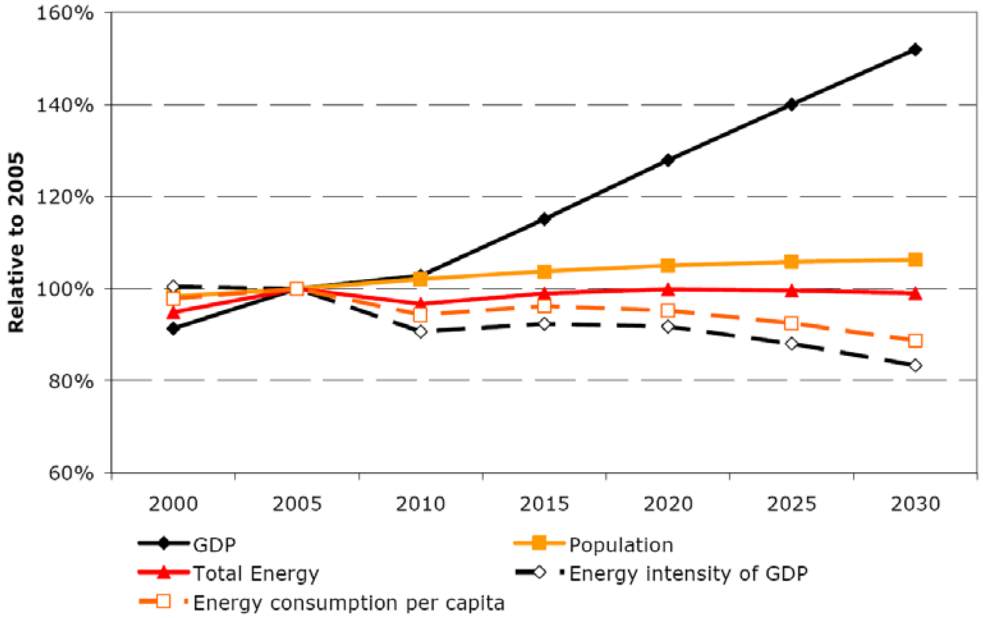
Main differences of the baselines

In the new baseline scenario existing policy measures lead to a EU GHG emission reduction in 2020 of 7.1% (compared to the 2005 level) or 13.8% (compared to 1990). Compared to the 2007 baseline which estimated a GHG emission reduction of 1.5% in 2020 (compared to 1990) the new baseline shows a much stronger decrease since the combined effects of the economic crisis, higher oil prices, reviewed ETS and efficiency measures avoid a further increase of total primary energy use between 2005 and 2020.

The increase in gross electricity generation is 10% lower and the energy and carbon intensity of the economy significantly decreases by annually 1.7%

and 2.5% respectively. The share of renewable energy in gross final energy consumption in 2020 is 15% compared to 8.5% in 2005 while in the 2007 Baseline this share was estimated to be 12.5%.

Figure 5-6: Baseline trends in energy consumption, its key drivers GDP and population and energy intensities for the EU-27 between 2000 and 2030



Source: Amann (2010)

PRIMES projects a de-coupling of GDP growth and energy consumption from 2010 onwards

Figure 5-6 shows the baseline trends in energy consumption. Based on the assumptions on economic development, international fuel prices and energy policies the PRIMES model estimates total energy consumption in the EU-27 in 2010 about 3% below the 2005 level. Despite the assumption of a GDP increase of 50% until 2030 total energy consumption will be reduced compared to the 2005 level by 2015 and remains at this level.

This clear decoupling between GDP growth and primary energy consumption is based on the economic restructuring towards less energy-intensive sectors, autonomous technological progress and dedicated energy policies that promote energy efficiency improvements, as argued by Amann (2010).

5.2.3 Assessing and comparing model assumptions and results

In order to obtain some indication about the range of potential uncertainty of the results based on the analytical tools used for the Communication we provide comparisons with other model based results.

Table 5-2: Comparison of model assumption between EU Communication and Deutsche Bank

	EU Communication May 2010	**Deutsche Bank** August 2010
Amount of carry-over	A build up of potential international credits and banked allowances by 2013 worth more than 2.30 Gt CO_2-eq. Between 2013 and 2020 and despite the linear reduction of the ETS cap, no absolute emission reductions in the ETS need to take place due to the availability of a large buffer of allowances from the period 2008 to 2012 and unused international credits. Nevertheless, by 2020 there is still a large amount of unused allowances and international credits in the system, worth a bit less than 1.6 Gt CO_2-eq.	Phase-2 surplus of 1.07Gt CO_2-eq. Aggregate residual abatement requirement in the ETS over 2008-20 of 378 Mt. Phase-3 deficit of 1.443Gt
Expected Carbon Price by 2020 in the 20% case	The ETS emissions profile changes considerably, given that the renewable energy targets induces actors to reduce emissions already by 2020 even when ETS carbon prices actually reduce in comparison with the baseline. Instead of a carbon price of €25 by 2020 (as in the baseline), the carbon price reduces to around €16 in 2020.	Carbon price rises to €30/t by 2020
Expected Carbon Price by 2020 in the 30% case	€30/t by 2020	Carbon price rises to €37/t by 2020
Qualitative and quantitative restrictions of international credits	Carbon price rises to €55/t by 2020 in the 30% case (no international credits at all)	Carbon price rises to €37/t by 2020 in the 20% case Carbon price rises to €67/t by 2020 in the 30% case

Carbon price issues

Significant differences in the expected future carbon prices

Table 5-2 shows significant differences in expected future carbon prices in the Communication and in model runs by the Deutsche Bank (DB).

The main differences between the EU Communication and the research of DB is that DB

- expects a lower cap,
- lower carry-over (e.g. as they do not expect the full New Entrants Reserve (NER) to come to the market) and

- includes a low availability of international credits also in the 20% case (quality restrictions are being discussed at the moment).

Cost issues

Cost estimates of the Communication

Based on model runs the Communication concludes that compared to an earlier assessment in 2008 the absolute costs of meeting the 20% target have decreased from €70 billion to €48 billion (0.32% of GDP) per year by 2020. (COM (2010) 265)

Significanty different cost estimates by other models

ZEW carried out a cost assessment for the 20% case with three models different from those used by the EC for its impact assessment.

ZEW concludes that if implemented at the lowest possible cost, the 20% emissions reduction would lead to a welfare loss of 0.5 to 2.0% by 2020. Second-best policies would significantly increase the costs.

A policy with two carbon prices (one for the ETS, one for the non-ETS) rather than one could increase costs by 50%. A policy with 28 carbon prices (one for the ETS, one for each Member State), could increase costs by another 40%. The renewables standard could raise the costs of emissions reduction by 90%. (ZEW 2009)

Comparing the differences

Comparing the ZEW results to those of the Impact Assessment of the European Commission (Capros et al. 2008), for the 20% case shows that the marginal, total and excess costs reported here are far higher. In some cases, the estimates of the European Commission are in the lower end of the range of the ZEW assessment; in other cases, the European Commission's are below the lowest numbers.

5.2.4 Assessing carbon leakage

Facts on carbon leakage

The incentives for geographical shifts of production

In general carbon leakage relates to the fact that emissions are shifted from one territory to other world regions due to the implementation of a stronger environmental policy.

This could occur either through increased imports from, or a relocation of trade-exposed, energy intensive industries to countries that do not face equivalent carbon constraints, e.g. carbon pricing. A driver for carbon leakage from these sectoral activities is international competition.

Depending on the scale of carbon costs faced by the sector considered, carbon pricing could lead to competitive distortions in the international markets. In the context of the EU Emissions Trading Scheme (EU ETS), this would mean some production activities moving to non-EU-countries if firms cannot pass on their additional carbon costs to consumers. Production and the associated emissions in these non-EU regions would increase. Thus, the risk of leakage is of significant concern from both an environmental and economic viewpoint.

A threat to environmental integrity

From a global environmental perspective, carbon leakage contradicts the goal of global emissions reduction underlying the implementation of carbon pricing and therefore reduces the environmental integrity of a carbon pricing scheme like the EU ETS.

Environmental and economic effectiveness of measures addressing carbon leakage

Given that carbon leakage occurs in specific industries, the question is whether trade related measures could help to offset the additional costs. Opportunities to prevent carbon leakage as free allocation, subsidies or border adjustment measures are difficult to implement and it is doubtful that they bring the desired effect of eliminating the competitive differences between the international industries or countries. Obviously the best solution in this context would be a global agreement imposing similar carbon costs to all emitters.

Industries which are most exposed to carbon leakage are obviously cement, steel, aluminium, paper and basic chemicals.

Estimates about carbon leakage rates

Estimates of carbon leakage rates differs largely among sectors and industries and are summarised in

Impacts of the implementation of a 30% target are under particular circumstances limited	The Communication emphasizes that the impacts the EU's 30% target when others implement their lo long as the above mentioned measures stay in pla 30% reduction target would lead to extra productio ferrous and non-ferrous metals, chemical prod intensive industries. Clearly, the risk of carbon leakage is lower, the mo ners implement their high-end pledges.

Table 5-3**.**

Assessing the risk of carbon leakage in the EU

Carbon leakage in the Communication

The risk of carbon leakage is a major issue of the Communication. The Energy and Climate Package of the EU sets legally binding targets for each Member State to lower GHG emissions.

Carbon leakage if international trading partners do not set similar legally binding targets

If international trading partners of the European Union do not set similar legally binding environmental standards or implement measures to reduce their GHG emissions the EU has a competitive disadvantage and is at risk of carbon leakage. Therefore the implementation of the Copenhagen Accord's targets, where the key competitors for the EU's energy-intensive industries have pronounced to undertake action to reduce emissions, would help to cope with carbon leakage.

When other countries implement their low pledges of the Copenhagen Accord the overall impacts of EU's 20% target are estimated according to the Communication to be less than 1% (COM (2010) 265). The sector which would face the highest production losses is the sector "other chemicals" where the impacts amount to 2.4%.

Free allocation and international credits to avoid carbon leakage

If the EU implements the 20% target unilaterally, some energy-intensive sectors would even be in a slightly better position, while for others it would make no difference at all. But the actual implementation of the Copenhagen Accord involves large uncertainties, thus, the European Commission considers the already implemented measures to address carbon leakage for energy-intensive industries (free allocation and international credits) as justified (COM (2010) 265).

Impacts of the imple-

The Communication emphasizes that the impacts of the implementation of

mentation of a 30 % target are under particular circumstances limited

the EU's 30% target when others implement their low pledges are limited, as long as the above mentioned measures stay in place. Moving from a 20% to 30% reduction target would lead to extra production losses of around 1% in ferrous and non-ferrous metals, chemical products and other energy-intensive industries.

Clearly, the risk of carbon leakage is lower, the more the major trading partners implement their high-end pledges.

Table 5-3: Estimates of leakage rates

	Sector	Region where the climate policy applies	Findings	Other findings
OECD (2003)	Iron & Steel	OECD-wide carbon tax	The tax applies equally to the steel sector and on the production of electricity used in the steel sector. At a $25/tCO_2$ tax, the leakage rate is about 45%. Unilateral climate policies with the same CO2 tax level would trigger a leakage rate about 60% on average.	Both BOF steel and EAF steel are treated as similar products, but steel products form different regions are treated as imperfect substitutes.
Demailly and Quirion (2008a)	Iron & Steel	EU-27	At a CO_2 price of €20, the leakage rate varies from 0.5% to 25%, with a median value of 6%. It is dependent to the choice of the paramters (incl. allocation mode)..	Steel from BOF or from EAF are not differentiated. Effects on both production routes are not distinguished. The leakage rate is more sensitive to assumptions on pass through rates and rules of allocation.
Demailly and Quirion (2006)	Cement	EU-27	At a CO_2 price of €20, the leakage reaches about 40%	Pass through rates are high for inland producuers and low for producers situated in costal areas.
Demailly and Quirion (2008b)	Cement	Annex B countries except the US, Australia and New-Zealand	At a €15/tCO_2 tax, they find a lower leakage ratio of about 20%	
Ponssard and Walker (2008)	Cement	EU-27	At a €20/tCO_2 price, leakage rate of about 70%. AT €50/tCO_2, the leakage rate reaches 73%	The model predicts a larger increase in imports into the coastal region. The authors admit that leakage rates may be over-estimated.

Source: Reinaud (2008)

Impacts of the package

To what extent the energy and climate package affects the emissions patterns of energy-intensive industries is inconclusive. On the one hand, the emissions of the energy-intensive sectors have significantly declined over the last years and unused free allowances have been monetized. On the other hand, overall productivity in energy-intensive sectors has been strengthened through investment in low-carbon technologies in these sectors.

Different ways to eliminate the competitive difference between EU and third countries

The European Commission is currently analysing different ways to eliminate the competitive difference between the EU and third countries, thus tackling carbon leakage, e.g.:

- Giving further support to energy-intensive industries through continued free allowances
- Adding to the costs of imports to compensate for the advantage of avoiding low-carbon policies eg. with border adjustment measures (BAM)
- Including imports into the ETS. That would imply that allowances would have to be bought on the market to cover the emissions of certain imported goods.
- Taking measures to bring the rest of the world closer to EU effort levels.

Options to measure the carbon content

Border adjustment measures based on carbon contents of products

One decisive issue in the context of border adjustment measures (BAMs) is proper calculation of their level. The aim of border tax adjustment measures is to balance the competitive differences internationally, thus carbon emissions must be treated equal for both EU products and non-EU products, i.e. EU imports. Therefore it is necessary to base BAM on the carbon embedded in the production of imported goods.

Different calculation methods

Many ways of different calculation methods have been proposed and they differ considerably in detail but have one common feature: all of them exclude manufactured goods, although the inclusion of manufactured goods would enhance the environmental impact of BAM.

The calculation of the carbon content is difficult, especially if all emissions, from the resource extraction to selling the final product, are taken into account. The fact that "variations in the type of energy used and the efficiency with which it is consumed can create dramatically different carbon footprints for goods that appear identical at the border" further complicates the identification of carbon content, as Meyer-Ohlendorf and Gerstetter (2009) have stressed.

Lack of data

Most producers, especially in developing countries would be in lack of the required data to ascertain the carbon content in their products and additionally it is unlikely that the national authorities in those countries would rush to establish requirements that would make the missing data available (Cosbey 2008).

Benchmarks or default values as alternative

Therefore one alternative is benchmarks or default values. A relevant benchmark for calculating the carbon content could be best available techniques (BAT). The use of BAT as a border adjustment measure could take the following form: "Whenever a product is imported into Europe, the importer has to pay a tax corresponding to the costs the most efficient producer in Europe incurs for emission certificates" (Meyer-Ohlendorf and Gerstetter 2009).

Problems when using BAT as benchmark

There are a number of problems when using BAT as benchmark:

- The identification of a best available technique is complicated since it is a moving target.
- Best available techniques benchmarks will probably reduce the ability to reduce carbon leakage. Problems about how to deal with imports cleaner than BAT would arise if a BAT as benchmark is implemented since the benchmark level usually has to be generous to meet WTO rules. This in turn weakens the ability for the BAM to prevent carbon leakage.

Average value for products from a specific country

Another alternative which was also proposed by the US Lieberman-Warner Climate Security Act of 2008 is to calculate an average value for products from a specific country.

This proposal would require that importers of primary goods (e.g. iron, steel, cement, aluminium, glass, pulp, paper, chemicals and industrial ceramics) and probably manufactured goods have to purchase "international reserve allowances" to cover all emissions that the production of the product involves.

In addition an "International Climate Change Commission" would be established which determines which countries have taken "comparable action" and which manufactured goods should be included in the system. The exact specification on how these embedded carbon contents should be calculated is missing in the proposal.

5.3 International carbon markets

Boom in international carbon markets

While the EU-ETS is the only comprehensive cap & trade system in operation in several other countries, such as Australia and the US, cap-and-trade systems are emerging. Furthermore, there was a boom of CDM projects, one of the Kyoto flexible mechanisms, in the last years. However, the future of the Kyoto mechanisms is unclear. Uncertainty remains with respect to the future of assigned amount units (AAU) trading, a mechanism that allows trade of emissions rights between governments. If no Kyoto successor protocol is ratified AAUs will lose value after 2012.

5.3.1 Performance of carbon markets

Kyoto Protocol as basis for carbon markets

The Kyoto Protocol, that includes emissions trading as part of its aim to provide flexibility and minimize implementation costs, has given rise to a number of national emissions trading schemes, most of them however are still in the design phase.

EU ETS is characterized

The EU ETS has been so far characterized by high CO_2 price volatility, un-

by high CO_2 price volatility, uncertainty and over-allocation

certainty and over-allocation. In the US and other regions that are discussing the implementation of cap & trade a major issue is to give business more certainty regarding the expected CO_2 price: for example by including price caps and floors or allowance reserves into the scheme design. Also alternative instruments, such as CO_2 taxes, are increasingly being discussed in the US and given the ambivalent experiences made in Europe cap & trade is increasingly being questioned.

Copenhagen architecture is decreasing importance of carbon markets

The Copenhagen conference can be seen as an important step for a broader discussion of possible instruments to meet longer term emissions stabilization pathways, including e.g. direct technology strategies and technology agreements. Contrary to Kyoto that focuses on targets and timetables, the development and deployment of green technologies is now seen as a key to meet the 2°C target and to avoid the most adverse damages of climate change. It is likely that a new agreement is more technology-based than on targets and timetables.

Little evidence that EU ETS has triggered investments in low-carbon technologies

In the EU so far there is little evidence that the EU ETS has induced investments in low-carbon technologies. However, there is the urgent need to know to what extent and under what conditions the EU ETS and company-based emissions trading in general is able to contribute to low-carbon investments, in order to improve the system. Price floors for auctioned credits have been discussed since 2009 (Climate Strategies, 2009). The idea of a minimum value for carbon credits has been discussed in response to concerns about lower CO_2 emission during in the recession. While the European Commission currently opposes price floors, the EU ETS could also be influenced by the way other cap & trade schemes develop, especially in the US.

Economic rationale for carbon pricing often does not match the organizational reality of companies

The economic rationale for carbon pricing is that investment in low-carbon technologies occurs if the investment costs are lower than the costs for paying for emissions allowances. However, actual decision making in companies is often quite different: There may be

- no continuous monitoring of all cost-saving possibilities,
- financial constraints and limited cognitive resources,
- no knowledge of probability distributions under uncertainty,
- volatility / uncertainty of energy and carbon prices,
- too short payback periods and too high returns on investment are required (no investment in expensive low-carbon technologies), and
- grandfathering (if opportunity costs of selling the allowances are not taken into account).

Transmission of market factors into reduction decisions is likely to be imperfect

Hence, the transmission of market factors into reduction decisions is likely to be imperfect. Also, there may be differences across sectors and technologies and by decision structures of companies. Incumbent companies might be too slow to shift to low-carbon strategies because of institutional inertia or attempts to protect assets and technological advantages in existing carbon-intensive activities. Exposing the risks of their carbon ignorant strategies can trigger withdrawal of assets by long-term investors like pension funds and encourages shareholders to push for a shift to low-carbon strategies (Neuhoff and Vieider 2010).

5.3.2 The role of the carbon price

Estimation of CO_2 price involves high uncertainties

In earlier analyses the EU estimated a carbon price of some €32 (2008 prices) in the EU ETS if the measures for reaching the 20% target are fully implemented. The economic crisis will have consequences lasting several years. New projections show a carbon price of €16 in 2020. The EU argues that a lower carbon price is a less powerful incentive for change and innovation. In order to achieve a 30% reduction it is estimated that the carbon price would amount to some €30 per tonne of CO_2 (COM (2010) 265).

Estimations of future carbon price involve a huge degree of uncertainty since the CO_2 price under the EU ETS depends on several factors, as cited in IEA (2007).

The overall stringency of caps imposed on installations

The overall stringency of caps imposed on installations depends on the initial allocation and the economic environment of the underlying activities.

External supply of project-based mechanisms

An abundant supply of project-based credits (i.e. certified emission reductions – CERs – and emission reduction units – ERUs) could have a dampening effect on the price, as project-based reductions are generally expected to cost less than EUAs (EU Allowance Unit of one tonne of CO_2).

Relative fuel prices

For some industries, especially for power generation, the price of gas relative to the price of coal affects operating choices. A relatively high gas price encourages more use of coal, which should drive up demand for CO_2 allowances, all other things equal, as coal emits twice the CO_2 content of natural gas. If such a phenomenon is sustained and EUA supply becomes tighter, CO_2 prices may reach a level that allows gas, a cleaner fuel, to be more competitive again (Reinaud, 2007).

Weather (temperature, rainfall, cloudiness)

Power generation represents the majority of the total EUA allocation. Hence, factors that affect power generation are bound to affect the supply and demand of EUAs. A dry year is likely to trigger the demand from fossil-based generators and increase emissions but it is less clear how day-to-day temperature variations should impact on CO_2 prices.

Regulatory features

Several national allocation plans (NAPs) specify that EUAs that are yet to be allocated will be lost upon closure of a plant. Therefore there is just a minimal possibility to sell unused allowances due to plant closures and as a consequence, it is less likely that such measures will be used to reduce emissions. This should, in a tight market, put upward pressure on prices.

Policy uncertainty

Climate change is a long-term, high uncertainties involving challenge. Political systems prioritize more immediate concerns, thus few governments are well prepared to consider and adopt long-term action against long-term risks. The fact that there will be ongoing new allocations and targets means that investors will only have a short (3 to 5 years for the first and second commitment periods) foresight into ETS (which will be the potentially most important value driver) when they commit themselves to a 20 to 30 year investment. Therefore there is a risk that irreversible investment decisions will be based on pre-implementation expectations of climate change policy, and that the actual marginal cost of abatement may differ from those expectations. Uncertainty may therefore lead to a delay in investment, thus impacting the overall level of CO_2 allowance prices (Reinaud 2007).

Pass through of CO_2 costs

Opportunity costs of CO_2 emission allowances

Since CO_2 allowances are scarce goods companies which own a certain amount of carbon allowances have two options:

- using these allowances to cover the emissions resulting from the production process or
- selling the allowances on the market to other participants who need additional allowances.

Thus using emission allowances represents an opportunity cost, no matter whether the allowances have been allocated for free or auctioned. Consistent with economic theory, companies aim at profit maximization, and therefore they pass through these opportunity costs of CO_2 emission allowances into their price bids on the electricity wholesale market, even if the allowances are granted for free (Sijm et al 2005, 2006). Since the level of generated CO_2 emissions differs between generation technologies the opportunity costs of CO_2 emissions per unit of power produced differ as well.

CO_2 price pass through is determined by market structure

If it is assumed that the power generator maximizes profit, whether there is full competition or the market structure is oligopolistic or monopolistic, the pass through rate (the extent to which carbon costs are ultimately passed on to electricity prices on the wholesale market) will also be 100%, as cited in Sijm et al (2005). But this fact does not imply that power prices will increase by the same amount. In general, the more concentrated the market, the smaller will be the total increase in prices. Overall power prices will be higher under monopoly, but the rise in prices due to the pass through should be lower. Empirically Sijm et al. (2006) ascertain that under monopolistic conditions 50% of the pass through is absorbed by a lowering of the monopolistic price markup.

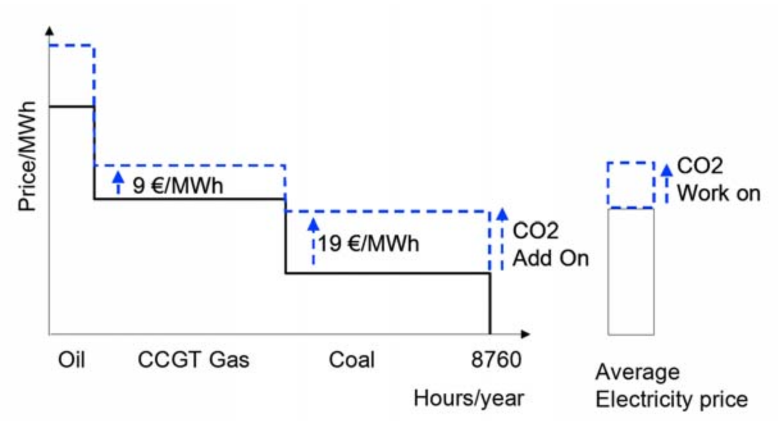
Determinants of the CO_2 price pass through rate

The CO_2 pass through rate and the impact of CO_2 emissions trading on the power sector and in particular on electricity prices depends on several factors:

- the price of a CO_2 emission allowance,
- the carbon intensity of the power sector, especially of the generation technologies setting the electricity price at different levels of power demand,
- the structure of the power market, including the level of market concentration or competitiveness, the shape of the power demand and supply curves including carbon price induced changes in the merit order to the supply curve, and the level of market liberalization versus regulation and
- the allocation system (auctioning vs. free allocation).

Figure 5-7 presents a marginal cost (price) duration curve which illustrates that for a certain load period the competitive electricity price is only affected by the price increase of the marginal production unit. The abscissa presents the 8,760 hours of a year while the ordinate illustrates the marginal costs of the marginal generation unit. The competitive electricity price in any one hour is affected by the cap & trade system through the price increase of the marginal unit. Thus the amount at which the power price increases due to the pass through may differ per hour load period considered. Therefore the CO_2 pass through is defined as: "the average increase in power price over a certain period due to the increase in the CO_2 price of an emission allowance", as cited in Sijm et al. (2006).

Figure 5-7: Pass through of CO_2 opportunity costs for different load periods (at a price of 20 €/tCO_2)



Source: Sijm et al. (2006)

Add-on rate vs. work-on rate

As shown in Figure 5-7, Sijm et al. (2006) distinguish between the behaviour of individual power generators and the impact on the price system as a whole.

- "Add-on" rate: the extent to which individual power generators pass on CO_2 costs into their bidding prices (usually 100%).
- "Work-on" rate: the rate that is effectively passed-on to the power prices on the market (usually less than 100% due to various reasons e.g. market response).

Obsereved pass through of CO_2 costs

Recent studies show a strong correlation between CO_2 prices and electricity prices in several European countries. This was especially visible in May 2006 when CO_2 prices dropped on the day-ahead prices. Carbon prices dropped by more than 50% in mid-May 2006 due to the fact that emissions of several countries have been much lower than expected. As a consequence, power prices on the European market exchanges fell. According to an IEA information paper of Reinaud (2007) a fall in the price of EU allowances by €10 per tonne CO_2 was immediately followed by a drop in electricity prices of at least €5-10 per MWh in Europe.

Risk of carbon leakage in sectors where the pass through of carbon price increases is difficult

The degree of the pass through of carbon price increases is also an important topic in the Communication. In sectors, where the pass through of the cost of allowances into prices is difficult, the risk of carbon leakage occurs if installations competing in the same market are not confronted with the same carbon constraints as in the EU. This could lead to a loss of market share to installations outside the EU, thus increasing the GHG emissions which undermine the environmental integrity of actions by the EU. Thus the energy and climate package contains provisions to prevent the risk of carbon leakage as does the Communication (COM (2010) 265, SEC(2010) 650 Part II).

5.3.3 The future of AAU trading

Russia and Ukraine have the largest share of AAUs

The amount of AAUs that countries would like to offer is far below the total AAU surplus of central and eastern Europe (CEE) countries which is estimated between 8 and 12 billion (Société Générale 2009, Point Carbon 2009). Most of these AAUs are owned by Russia and Ukraine. Russia is limiting its possible AAUs sales to 200 Mt by 2012.

Most public buyers choose seller countries carefully

As the supply of AAUs is much larger than the demand the impact of green investment scheme (GIS) initiatives on the market will depend on purchaser requirements, particularly requirements for credibility of GIS. Most public buyers chose seller countries carefully, buying only AAUs, which will be greened in a clear and transparent way.

Some large buyers are purchasing AAUs with unclear greening

Large AAU buyers, including in particular Japanese companies, however, concluded deals also in countries where there is a lack of clarity regarding important elements of a credible GIS. Such transactions, however, have led to reputational consequences for both buyer and seller. As a result, most sellers have made significant efforts to increase credibility.

Copenhagen conference increased uncertainty in the AAU market

The Copenhagen conference increased uncertainty in the AAU market by opening the possibility that international AAU trading will end after 2012, with the consequences that AAUs will have no value after 2012 or banking will be restricted. This situation has increased the pressure to sell AAUs prior to 2012, leading in turn to increased pressure on CEE countries to sell as many of their AAUs as quickly as possible (Tuerk et al., 2010).

Limited demand for AAUs

The consequence is increased temptation to sell GIS of lower credibility and at lower prices. Currently the demand for AAUs is limited and could further decrease.

Currently now significant impact on CER and ERU prices

Due to a possible lower price of AAUs than CERs and ERUs they may influence these markets with consequences for project development and implementation as well as credit prices. Nevertheless, the current situation does not yet indicate an obvious impact of offered AAUs on the entire carbon market. The traded AAU volumes are small compared to the CDM market. They are generally limited by a buyer orientation of the market through which sellers need to address the demand for greened AAUs. However, not in all of the deals concluded so far greening activities were defined in detail. If the CDM market fails to deliver, since upcoming decision of the Executive Board (EB) may limit the supply of CERs, more AAUs may come to the market.

Possible supply of AAUs up to 1.9 Gt by 2012

The amount that countries would like to sell by 2012 is roughly 1.9 billion AAUs (Tuerk et al, 2010). Most of the CEE EU Member States would like to sell their total surplus, as banking of AAUs is likely to be impossible for EU states.

Barriers of greening limit supply also after 2012

If credibility continues to play an important factor in purchases, limitations on CEE countries to design and implement credible GIS may limit the supply of GIS-backed AAUs. Experiences so far have shown that a number of barriers have emerged when implementing greening activities.

Lack of funds to co-finance credible GIS has been a problem for CEE countries, particularly in the current economic crisis. Limited implementation capacity of host countries constitutes another barrier. Therefore, the supply of credible GIS-back AAUs may be significantly limited in the short term.

However, if credibility fails to be a critical issue for significant numbers of buyers, very inexpensive GIS-backed AAUs could be brought onto the market, depressing prices (Tuerk et al., 2010).

AAU trading after 2012

The supply of AAUs will be potentially higher than 12 Gt. However the future of AAU trading is completely open. If no Kyoto successor protocol is ratified AAUs will have no value after 2012.

Table 5-4: AAU trading in the EU (million tons of CO_2e)

	Total amount aimed to be sold by governments 2008-2012	Amount already sold (summer 2010)
Hungary	50	11
Latvia	40	18.5
Czech Rep.	100	71
Romania	200	0
Bulgaria	200	0
Poland	500	2.5
Lithuania	50	0
Estonia	85	0
-+Ukraine	400	47
Russia	200	0
Slovakia	50	15
Total	**1,875**	**165**

Source: Tuerk et al, (2010)

5.3.4 The future role of international credits

Imposing qualitative restrictions on the CDM

In the Communication the Commission suggested that qualitative restrictions on the use of CERs/ERUs in the ETS beyond 2012 should be considered (regarding CERs from industrial projects), and Commissioner Hedegaard followed this by stating that DG (Directorates-General) Climate Action would present formal proposals in this regard.

HFC-23 projects under review by the EB

In summer 2010 the CDM Executive Board commissioned reviews of the requests for CER issuance made by three HFC-23 (fluoroform) projects, and since then several other HFC-23 projects requesting CER issuance have also had their requests subjected to review.

Reviews will be vital to market expectations

HFC-23 projects currently account for over 50% of the total issued volume of CERs. Given that it now seems inevitable that CER issuance from all HFC-23 projects will be subject to review, and given the proportion of CERs accounted for by HFC-23 credits, the outcome of these reviews will be vital to market expectations of CER supply and hence to CER and EUA prices.

CER prices likely to rise

Estimates for 2020 CER prices range between €10 and €30 per tonne, with a higher level being more likely. The amount of supply of CERs is uncertain and depends on the demand of a possible US ETS and possible qualitative restriction imposed e.g. by the EU.

JI may continue without a Kyoto successor

The amended EU ETS legislation allows to work together with interested developed and developing countries both bilaterally and multilaterally, even in case of no international agreement, to set up sectoral mechanisms, whose credits could then be recognized for use in the EU ETS and under the EU's Effort Sharing Decision containing Member State reduction commitments for the non-ETS.

Negotiations on bilateral agreements with the EU have started

Japan has recently started to negotiate with China on bilateral CDM agreements. Also Ukraine has started negotiations on bilateral agreements with the EU and also Russian investors push for a bilateral deal with the EU.

Focus on sectoral crediting

Besides the continuation of the CDM in certain sectors in Least Developed Countries the Communication focuses on sectoral crediting based on ambitious crediting thresholds. Sectoral crediting would target emission reductions in a whole sector e.g. the Mexican cement sector or the Chinese steel sector. In case no international agreement is reached the EU plans to establish bilateral agreements with numerous third countries. The Communication emphasizes in supporting a pilot for an EU/China sectoral crediting agreement on steel.

Convergence with US position

Sectoral crediting plays a major role in all US proposals for a US-wide cap & trade scheme, while the US is against the CDM, given its experiences. The EU recently stated it would be in principle possible to develop common standards for sectoral credits together with the US, even outside of the UN.

Who will administer the CDM?

In case there is no Kyoto-style international agreement after 2012, the EU and other countries that are interested in using CDM credits could continue using the UNFCCC structures for generating these credits. The CDM is self-financed by a certain share of proceed of CDM credits. The UNFCCC recently said it could also administer an EU-wide offset scheme.

6 Reflecting on a more ambitious GHG reduction target

This chapter emphasizes the role of technology for meeting a higher reduction target. It illustrates that the costs for meeting long term targets will significantly rise if ambitious reductions and investments in low-carbon technologies are not taken in the near future.

6.1 Sharing the effort between ETS and non-ETS sectors

6.1.1 Dealing with effort sharing

The Communication aims to keep the current effort sharing between ETS and non ETS sectors

The ETS Directive 2009/29/EC and the Effort Sharing Decision. 406/2009/EC split the overall reduction target between the EU-ETS sectors and the non ETS sectors. The Communication states that the overall mitigation potential compared to 2005 remains lower in the non-ETS compared to the ETS. In order to meet the 30% target cost efficiently as under the 20% target the ETS should continue to provide about the double percentage point reduction compared to 2005 compared to the non-ETS sector. The cost efficiency of emission reductions was assessed with the PRIMES and GAINS models.

Compared to 2005, a 34% reduction compared to 2005 should be provided by the ETS sectors (including aviation), and 16% compared to 2005 should be provided by the non-ETS sectors. In the non-ETS sectors, reduction potentials compared to current effort sharing targets continue to be higher in the poorer Member States.

Trading between Member States

The effort sharing decision introduced emission targets for Member States in a range of areas not covered by the EU ETS. A degree of flexibility is introduced by allowing Member States to trade up to 5% of their annual emission allocation among them (Article 3.4 and 3.5 Effort Sharing Decision). Transfers under Article 3.4 are possible at all times but the total transferred quantity shall be less than 5% of the Annual Emission Allocation of the transferring Member State.

Domestic offsets

Moreover, countries will be allowed to use credits resulting from Article 24a projects (domestic offsets) without any limitations. Article 24a of the ETS directive is a fallback option in case the Kyoto mechanism JI does not continue after 2012. According to article 24a, a project will need the approval of a Member State to be recognized in its offsetting function and, as explicitly mentioned in this article, a Member State can unilaterally refuse certain project types for its territory.

6.1.2 Evaluating the Communication's targets

Analyses with the TIAM model

The impacts of the EU emission targets were analyzed with the global TIMES Integrated Assessment Model (TIAM) (Loulou and Labriet, 2008; Loulou, 2008), developed under the Energy Technology Systems Analysis Program (ETSAP) of the International Energy Agency (IEA). The results indicate that with the current targets, the marginal costs in the non-ETS are likely to be slightly higher than in the ETS in 2020.

Flexibility for non-ETS sectors recommended

In the case that the additional reduction resulting from the 30% target are allocated to the ETS and non-ETS sectors proportionally to the sectors' current reduction targets the marginal cost in the non-ETS sector increases considerably in particular if no or only limited trading between member states is allowed.

Without this flexibility the cost level in the non-ETS sector will be remarkably higher than the level in the ETS, except in eastern Europe, and the allocation of emission targets is far from efficient. At the same time the non-ETS targets in eastern Europe would be ineffective, if there are no transfers (trades) in non-ETS allocations between Member states. The transfers in non-ETS allocations therefore play a crucial role in levelling the marginal costs between Member States.

East-West difference regarding mitigation potentials

Several of the new Member States are projected to overachieve their 2020 targets for emissions from the non-ETS sectors without additional efforts beyond business as usual. This means a significant emissions reduction potential remains untapped, even after implementation of the climate and energy package.

The Communication emphasizes that it will be necessary to mobilize the public and private financial resources to enhance emission reduction without jeopardizing economic growth and mentions the EU's cohesion policy as an important instrument in this regard. It is questionable whether this should be the only mechanism to benefit from poorer Member States higher emission reduction potential.

Flexibility significantly reduces compliance costs

Also a paper by ZEW (2009) concludes that a policy with two carbon prices (one for the ETS, one for the non-ETS), in case there are no or limited offset opportunities for the EU-ETS sector in the non EU-ETS sector could increase costs by 50%. A policy with 28 carbon prices (one for the ETS, one each for each Member State), in case there is only limited trading between Member States, as foreseen in the effort sharing decision could increase costs by another 40% compared to a non-trading scenario.

6.1.3 More flexibility in the 30% case

Efficient allocation of costs would require that the marginal costs are equal in the ETS and non-ETS sectors

An economically efficient allocation of costs would require that the marginal costs of emission reductions are equal in the ETS and non-ETS sectors in all Member States. Equalizing the marginal costs between these two sectors, would indeed require a flexibility mechanism between the ETS and non-ETS sectors.

More flexibility for the non-ETS sectors

As the emission allocations in both of the sectors are already transferable – either between actors in the ETS or Member States – a possible mechanism would e.g. enable transfers between the EUA credits of the ETS and national non-ETS allocations, such as in the form of domestic offsets. Such mechanisms have been called for already previously, as also have been free transfers in the non-ETS allocations between the Member States.

European offset scheme currently no priority

The European Commission so far has not advocated an EU-wide domestic offset scheme and leaves this up to the Member States. Currently several EU Member States, including France, Bulgaria and Denmark, have teamed up to coordinate post 2012 offset activities.

Additional flexibility needed in the 30 % case via domestic offsets

The European Commission has so far argued that an EU-wide domestic offset scheme is no priority as neither the EU-ETS nor the Non-EU ETS sectors would necessarily need additional offset credits to meet the 2020 targets. In case of moving to a -30% target this position should be reassessed. Recalibrating the ETS cap as mentioned in the Communication should also go hand in hand with providing more flexibility for companies. Also countries may benefit from purchasing offset credits from other EU Member States, comparable to currently buying JI credits within the EU. An EU-wide domestic offset scheme may significantly reduce transaction costs compared to individual Member States effort.

6.2 Drivers for the diffusion of energy-saving technologies and current EU strategies

6.2.1 Technological perspectives for achieving the long term target of 2050

For an 80 % reduction in 2050 a new energy system is needed

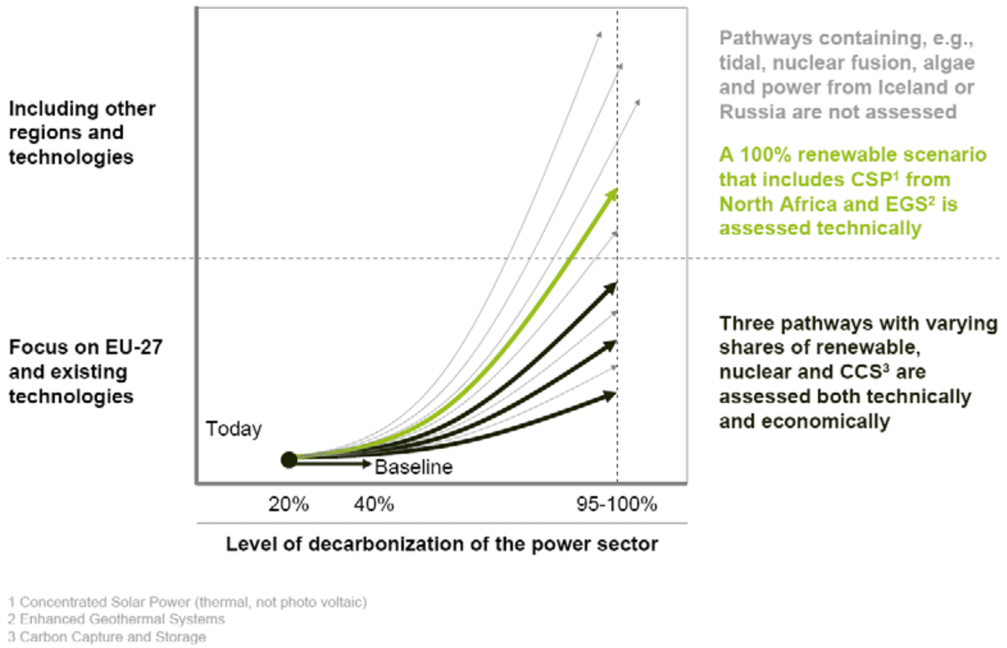
To achieve the long term target of the EU, a GHG emission target of 80% in 2050, a new energy system has to be developed, both in the way energy is used and provided. This implies a transformation across all energy related sectors and moving capital into new sectors (e.g. low-carbon energy generation, smart grids, electric vehicles, heat pumps). Investing in these technologies will result in lower operating costs compared to the baseline.

To implement this new energy system substantial changes as shifts in regulation funding mechanisms and public support are required. But this shift would yield economic and sustainability benefits in the power sector and additionally increase the security and stability of Europe’s energy supply considerably.

Roadmap 2050 of the European Climate foundation

As shown in Figure 6-1, with a full implementation of all available existing technologies in the EU-27 a GHG emission reduction of 80% until 2050 (compared to 1990 levels) is technically possible with a combination of efficiency, near full decarbonisation of the power sector and fuel shift in transport and buildings, according to the European Climate Foundation (2010).

Figure 6-1: Possible pathways to achieve the long term target



Source: European Climate Foundation (2010)

Delaying investment in low-carbon technology would yield in higher costs

To realize this dramatic transition investments have to start within the next five years, otherwise it will be hard to achieve the targets. Delaying investments in clean technologies would place a higher burden on the economy and the construction industry and in addition, delaying would increase the challenges in transforming policies, regulation, planning and permitting.

6.2.1 The Communication emphasizes incentives for technological change

Technological change – the ultimate target

The Communication emphasises the central role of technological change in the EU for achieving Europe's long term energy and emissions targets. To meet the long-term target and become a low carbon economy the EU has to use its energy in a more efficient and sustainable manner. The implementation of technologies and practices that increase firms' and households' energy efficiency are thus crucial to meet this target and maintain the high level of standard of industrialized countries.

Research on the drivers for technological change

Much research has been done regarding the driving forces of the diffusion of ready-to use energy efficient technologies among firms. The R&D and innovation stage needs to be examined but also the actual diffusion of technologies among final users since especially the diffusion of green technologies within and across firms is a very slow and heterogeneous process, as cited in Battisti (2008).

Swiss experiences

A recent Swiss study analyzed the factors determining the adoption of energy-saving technologies in 2324 Swiss firms from all fields of activity and size classes (Arvanitis and Ley 2010).

Evidence from IEA

Based on information of the International Energy Agency (see IEA 2008) a distinction is made between four groups of energy-saving technology applications:

- Electromechanical and electronic applications (e.g., energy-saving in machines either by substitution for more energy efficient machines or by modification of already installed machines towards more energy efficiency)
- Applications specific to motor vehicles and traffic engineering
- Applications in building construction
- Applications in power generating processes

The authors distinguish between inter- and intra-firm diffusion, the first is measured by the variable "adoption of at least one energy-saving technology application in one of the mentioned technology fields" while the latter is measured by the number of technology applications of a certain technology field by the firm in a certain point of time.

6.2.2 Empirical evidence of technology diffusion

Swiss experiences

A recent Swiss study analyzed the factors determining the adoption of energy-saving technologies in 2324 Swiss firms from all fields of activity and size classes (Arvanitis and Ley, 2010).

More than 50% of all responding firms reported at least one energy-saving technology application. The most frequently reported applications were related to building construction which can be explained by the fact that building-related energy-saving is widely applicable in all sectors of the economy.

Inter-firm diffusion

Firm-specific rank effects

There are several important firm-specific rank effects:

- The likelihood that at least one of the technology applications is adopted is driven by the same firm characteristics independent of the specific technology applications.
- With respect to factor endowment the variable for gross investment per employee and the dummy variable for R&D show the expected positive signs.
- Adopting firms do not use more human capital than non-adopting firms.
- Not the percentage of employees with tertiary-level education but rather the existence of R&D activities constitutes a crucial precondition for adopting such new technologies.

- Firm size shows the expected (non-linear) positive effect.
- Foreign firms seem to be less inclined than domestic firms to adopt energy-saving technologies in buildings and energy-generating processes.
- Export activities do not appear to be a specific trait of adopting firms.

Rank effects of market environment

The Swiss study discovered that competitive pressures are relevant for at least two technology groups, electromechanical and electronic applications and energy-generating processes and seem to have some influence on the propensity to adopt energy-saving technologies, particularly for firms with substantial energy costs that use machinery intensively and/or generate their own power (electricity or heat). But the expected demand seems to be of minor importance (except for building-related technologies).

Stock, order and epidemic effects

Inter-firm epidemic (learning) and network effects seem to outweigh negative effects of stock and order effects leading to positive net effects that enhance the inter-firm adoption rate of energy-saving technologies

Relevant for the introduction of energy-saving technologies is the experience of first use of such technologies in other firms and in most cases not the intensity of usage.

Adoption costs

There are some potential barriers that could increase adoption costs considered as the lack of compatibility with current product program or current production technology seems to be the main barrier for firms that hinder them from adopting any kind of energy-saving technologies. Financing obstacles and information and knowledge barriers show positive effects which means that non-adopting firms seem to anticipate these two types of obstacles less as a problem than adopting firms. Organizational and managerial impediments do not seem to have an influence on the adoption rate.

Intra-firm diffusion

Limited intra-firm acceptance of energy-saving technologies

Furthermore the Arvanitis and Ley (2010) results show that the acceptation of energy-saving technologies either in production processes or in products is rather limited. A possible explanation for this could be that most firms do not have integrated strategies of energy-saving (see, e.g., Santos da Silva and Amaral, 2009).

Drivers of intra-firm diffusion of energy-saving technologies

Some factors which are important for the inter-firm adoption rate are a minor concern for the intra-firm adoption rate. E.g. factor endowment in the form of gross investment per employee and R&D showed no effect on the rate of intra-firm adoption while firm size showed a positive effect.

Foreign firms are less inclined than domestic firms to more intensive use of energy-saving technologies and when it comes to competitive pressures it is shown that non-price competition appears to be more effective than price competition in the case of intra-firm adoption. More intensive usage of new technologies requests higher technological capabilities that are available mostly to firms that are stronger exposed to non-price competition with respect to qualitative and technological product characteristics

Table 6-1: Comparison of different studies dealing with the diffusion of energy-saving technologies

	Object of investigation	Research target	Factors enhancing the adoption of energy- saving technologies	Barriers for the adoption of energy- saving-technologies
Pizer et al. (2002)	285 larger US companies in 4 energy-intensive industries (pulp and paper, plastics, petroleum, steel) in 1991-1994	Examination of the factors that influence the adoption of new energy-saving technologies by US manufacturing plants	Plant size Financial health Energy prices (to a smaller extent)	
De Groot et al. (2001)	135 Dutch companies in the nine most energy-intensive sectors in 1998	Investigation of barriers to the adoption of readily available energy-efficient technologies	Economic potential for cost saving Increase in energy taxes High energy intensity	Lack of compatibility with existing technologies Organizational problems Lack of internal financing Lack of public subsidies No need for further increase of energy efficiency
Velthuijsen (1993)	110 Dutch companies	Examination of the incentives for investment in energy efficiency		Limited financial means Lack of information No need to renew existing equipment Lack of interest due to the fact that energy-saving does not belong to firms' core business
Sardianou (2008)	50 Greek industrial firms in 2004/05	Investigation of the main determinants of industrial decision-making process with respect to energy efficiency investments	Highly educated employees Investment in human capital	Lack of fund Slow rate of return of energy saving investment High investment costs Existence of other investment opportunities Uncertainty about the future energy prices Managerial deficiencies Bureaucratic procedures to get punlic financial support

Source: Arvanitis and Ley (2010), De Groot (2001), Pizer (2002), Sardianou (2008), Velthuijsen (1993)

Barriers to private green innovations activities

Environmental externalities: The greatest benefits from green technologies are public rather than private (a reduction of the environmental externality). As a consequence, the private willingness to pay for green innovation will be low unless there is a clear and appropriate price put on the externality.

Appropriation problem: Firms will be reluctant to innovate when they cannot fully appropriate the returns from their innovations. Particularly green innovations are typically complex, cumulative-process innovations, where classic patent protection may need to be complemented with other appropriation mechanisms if it is to be effective.

Access to finance: Financing constraints will be even more limiting for green innovations. Especially the more breakthrough type of green innovation carries a high technical risk/ uncertainty and uncertain market conditions involve commercial risks.

Learming effects: For green technologies that have passed the prototype stage, there are still significant learning effects during the initial stage of marketing. Customers may want to wait to adopt the new technologies until they are at a later stage, when their costs are lower. In the absence of early lead-users, learning effects cannot materialize, preventing these technologies from reaching their most cost-efficient configurations.

Existing technologies: New green technologies face competition from existing dirtier technologies which have an initial installed-base advantage (Arvanitis and Ley 2010).

6.2.3 Modelling endogenous technological change

Deficiencies of current modelling approaches

To define when and how much intervention is needed to tackle climate change economists estimate the trade-off between immediate costs and long-term benefits of fighting climate change. In this context the rate at which we should discount the future is crucial and determines the balance between the two. The assumption of a low discount rate (e.g. Stern) calls for immediate intervention while the assumption of higher discount rates (e.g. Nordhaus) leads to a postponed intervention.

Most current modelling approaches largely disregard the innovation factor and treat technologies to mitigate climate change as given or emerging spontaneously. They ignore the fact that the portfolio of technologies available tomorrow depends on what is done today which can easily lead to a misguided preference for postponing action to later.

The AABH Model

Productivity growth from innovation

The AABH model, developed by Acemoglu, Aghion, Bursztyn and Hemous (2009) is a growth model with environmental constraints and limited resources. In this model, in contrast to the neoclassical DICE model of Nordhaus, productivity growth is not exogenous but instead results from innovation.

Model features

Main features of the model are:

- Production of the same goods is possible using either clean or dirty technologies.

- Entrepreneurs typically select the more profitable one, taking into account the current state of technology in both and the (dis)incentives put in place for either/ both by government.
- If the dirty technology enjoys an initial installed-base advantage, the innovation machine will tend to work in favour of further improving the dirty technology and government has to intervene to induce a takeoff of the clean technology.
- Thus governments have to influence the allocation of production between clean and dirty activities and also the allocation of research and development between clean and dirty innovation.

Two major issues to deal with

The AABH model presents two major issues to deal with: First, there is the environmental externality generated by polluting production activities and the second issue is the fact that past or current technological advances in dirtier technologies make future production and innovation in clean technologies relatively less profitable.

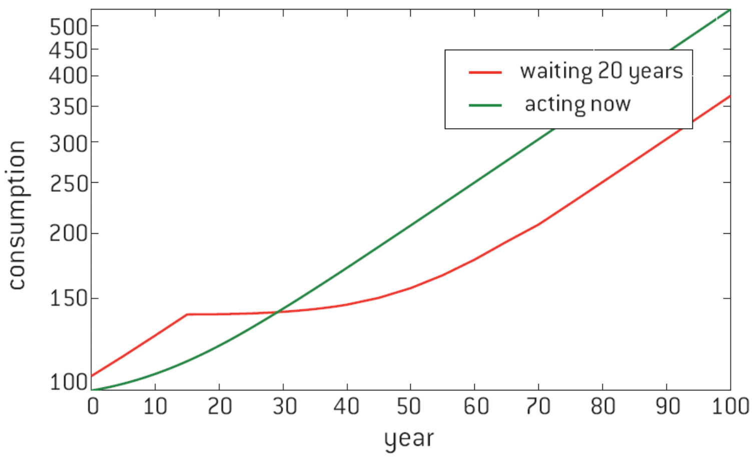
New cost-benefits analysis

Thus such a directed technological change perspective leads to a new cost-benefit analysis to policy intervention. The cost of supporting cleaner technologies is that this may slow down growth in the short run, as cleaner technologies are initially less advanced. But the benefit from supporting cleaner technologies is that it will bring about greener and more sustainable growth.

Impacts of delaying intervention

Delaying intervention with directed technological change leads to a further deterioration of the environment and makes the dirty technology more productive, thus further widening the productivity gap between dirty and clean technologies. This in turn extends the period which is needed for clean technologies to catch up and replace the dirty ones. This catching-up period is characterized by slower growth and slower consumption, (Figure 6-2) and the cost of delaying intervention will accordingly be higher.

Figure 6-2: Loss of consumption if action is delayed with ABHH model



Source: Aghion, Hemous and Veugelers (2009)

Two instrument policy

The AABH model estimates the cost of using only the carbon price instead of a combination of a carbon price and a subsidy to clean R&D. The cost is expressed as the amount of lost consumption in each period which arises when using only the carbon price instead of using optimal policy, which involves:

Optimal policies

With a discount rate of 1% this cost in terms of lost consumption amounts to 1.33% and with a 1.5% discount rate to 1.55% respectively.

The two-instrument policy reduces the short-run costs in terms of foregone consumption and endorses the case for immediate implementation, even for higher discount rates where standard models commend delaying implementation.

The timing of government intervention

Government intervention can be reduced over time as soon as clean technologies have gained sufficient productivity advantage over dirty technologies. Then private innovations are sufficient enough to generate further, even better and more efficient, clean technologies.

With cleaner technologies in place, the environmental damage problem, which the carbon tax is designed to address, gradually abates. However, the longer intervention is delayed, the longer it will need to be maintained.

Multilateral vs. unilateral intervention

Since climate change and thus the benefits of a reduction in CO_2 emissions are global issues, countries may be tempted to free-ride and avoid the costs of intervention. Most of the developing countries can at best imitate or adopt green technologies previously invented in the developed countries. Therefore to tackle climate change developed countries could direct change towards clean technologies and subsequently facilitate the diffusion of new clean technologies to developing countries.

The greater the innovation spillovers from developed to developing countries, the more active the developing countries will be in implementing clean technologies rather than dirty ones. Thus even unilateral policy intervention by developed countries is recommendable.

But unilateral climate change policy can lead to carbon leakage in a free trade world. E.g. taxing dirty technologies can lead to a specialization in the production of dirty goods in countries which have no environmental taxes and an export of those goods to the rest of the world. To avoid such perverse effects Aghion, Hemous and Veugelers (2009) and Aghion et al. (2009) recommend a massive effort to make clean technologies available and affordable to poorer countries. Only if such conditions are given carbon tariffs or a carbon tax on dirty consumption (or the threat of them) should come into play. But such threats should be made credible so they may push others to emulate such policies.

6.3 EU technology initiatives

Motivated by the central role of technological change this section provides an overview of EU technology initiatives, such as the Strategic Energy Technology Plan, which play an important role in the Communication.

6.3.1 Strategic Energy Technology Plan (SET Plan)

Development of the SET Plan

The development and deployment of a diverse portfolio of low carbon technologies is essential to achieve the goals of the energy and climate policy, and to ensure Europe's future competitiveness. Thus the EU has implemented the European Strategic Energy Technology (SET) Plan to accelerate the development and large scale deployment of low carbon technologies.

It is a common approach for research, development and demonstration planning and implementation and is based on the current state of R&D activities and achievements in Europe. The successful implementation of the SET Plan presents a vision that Europe will be the world leader in low-carbon technologies which are affordable, clean and efficient and drives wealth and creates growth and jobs (EC, 2010 Strategic Energy Technology Plan).

Stakeholder involvement

Governance of the SET Plan is characterised by strong stakeholders involvement:

- European Commission (coordinates the SET Plan and connects various interest groups)
- Member States (Steering Group on Strategic Energy Technologies)
- Research capacities of the major European institutes and universities (European Energy Research Alliance – EERA)
- European Industry (technological European Industrial Initiatives – EII)

European Industrial Initiatives (EII)

The industry plays a central part in the implementation of the SET Plan. Technological European Industrial Initiatives (EII) have been established to encourage the industrial participation in energy research and demonstration and boost innovation.

The EII includes the areas of wind, solar energy, bio energy, electricity networks, carbon capture, transport and storage, nuclear fission, fuel cells and hydrogen and the Smart Cities Initiative. Within those sectors working at EU level entails the most benefits since the barriers, the scale of the investment and the risk involved can be better managed collectively.

The European wind initiative

The European wind initiative aims at accelerating the reduction of costs, increasingly moving offshore, resolving the associated grid integration issues and generating up to 20% of EU electricity by 2020 and as much as 33% by 2030. These actions are expected to create more than 250,000 skilled jobs (COM (2007) 723).

To reach these targets it is necessary to develop a better picture of wind resources in Europe through components and build up to 10 demonstration projects of next generation turbines. At least five prototypes of new offshore substructures have to be tested in different environments and new manufacturing processes have to be demonstrated. Also, the viability of new logistics strategies and construction techniques in remote and often hostile weather environments have to be tested and additionally, a comprehensive research program to improve the conversion efficiency of wind turbines has to be implemented. To achieve the targets €6 billion total public and private investment is needed in Europe over the next 10 years.

The solar Europe initiative

The solar Europe initiative aims at gaining mass market appeal and becoming more competitive, reducing the cost and improving the efficiency and generating up to 15% of EU electricity in 2020. This is expected to create 200,000 skilled jobs.

For reaching these targets it is necessary to resolve problems derived from its distributed and variable nature and when talking about concentrated solar production (CSP) to achieve an industrial up-scaling of demonstrated technologies. Another goal is the building of up to ten first-of-a-kind power plants, supported by a research program. Thus, €16 billion total public and private investment is needed in Europe over the next 10 years. (COM (2007) 723).

The European electricity grid initiative

The European electricity grid initiative aims at creating a real internal market, integrating a massive increase of intermittent energy sources and managing complex interactions between suppliers and customers. By 2020, 50% of networks in Europe should achieve the seamless integration of renewables, effectively matching supply and demand and supporting the internal market for the benefit of citizens.

To achieve the above mentioned targets a strongly integrated research and demonstration program, research to develop new technologies to monitor, control and operate networks in normal and emergency conditions and the development of optimal strategies and market designs to provide all actors with the right incentives to contribute to the overall efficiency and cost-effectiveness of the electricity supply chain are necessary. Another componenent to reach the goal is the implementation of up to 20 large scale demonstration projects at real life scale to validate solutions and value their real system benefits before rolling them out across Europe. For this initiative €2 billion total public and private investment is needed in Europe over the next 10 years (COM (2009) 519 final).

The sustainable bio-energy Europe initiative

The sustainable bio-energy Europe initiative aims at permitting large-scale, sustainable production of advanced biofuels and permitting highly efficient combined heat and power from biomass. The initiative should generate up to 14% of the EU energy mix by 2020 and create more than 200,000 local jobs.

For achieving these targets the demonstration of the technology at the appropriate scale (pilot plants, pre-commercial demonstration or full industrial scale) and a longer term research program to support the development of a sustainable bio-energy industry beyond 2020 are necessary. The full implementation of the initiative would require €9 billion total public and private investment in Europe over the next ten years.

The European CO_2 capture, transport and storage initiative

The European CO_2 capture, transport and storage initiative aims at widely commercializing carbon capture and storage (CCS) and reducing the cost of CCS to €30 to €50 per tonne of CO_2 abated by 2020.

For reaching these targets it is necessary to demonstrate the full CCS chain at industrial scale and implement a comprehensive research program to make CCS commercially feasible in fossil fuel power plants. €13 billion total public and private investment is needed in Europe over the next ten years to implement the initiative.

Fuel cells and hydrogen initiative

The joint initiative on fuel cells and hydrogen was established for 2008-2013. It has a budget of €470 million of community funding and the aim is to validate efficient and cost-competitive technologies for the various fuel cells applications.

This joint initiative requires more and larger scale demonstrations and pre-commercial deployment activities for portable, stationary, transport applications and long term research and technology development. Therefore €5 billion additional public and private funding is needed for the period 2013 to 2020.

Smart Cities initiative

The focus of the Smart Cities Initiative is to enhance the energy efficiency in European cities, which is a comparatively cheap option to secure CO_2 reductions.

The initiative aims at enhancing the energy efficiency in transport, buildings and industry into and at initiating the mass market take-up of energy efficiency technologies through the creation of the proper conditions. It wants to support ambitious and pioneer cities which demonstrate transition concepts and strategies to a low carbon economy and the target is that in 2020, 25 to 30 cities should be the leaders in the transition to a low carbon economy.

For achieving this target participating cities and regions shall test and demonstrate the feasibility of going beyond the current EU target of a 20% reduction in GHG emissions and therefore €11 billon total public and private investment is needed in Europe over the next ten years.

Funding of the SET Plan

To implement the SET Plan the related investments have to increase from the current €3 billion per year to around €8 billion per year. This is almost a triplication and should induce an additional private investments.

A risk sharing approach where all relevant public and private actors take on that part of risk corresponding to their own field of activity is the best solution for the investment in low carbon technologies. In general, more public support is needed where the technological uncertainties are higher and regulation can help to prevent market failures.

The biggest part of the funding is required to come from the private sector and from Member States, while the EU contributes towards some parts of it.

Banks and private investors will have to finance and invest heavily in the seminal companies to accelerate the transition to a low carbon economy. In the face of the financial crisis, this is a major challenge since nowadays the investment in new, riskier technologies is not preferred by investors and risk aversion is higher. Therefore the public authorities have to provide the adequate incentives and consistent policy signals and have to have the willingness to rise the public funding of low carbon technology development(COM (2007) 723).

6.3.2 EU research funding

The European Union's main instrument for funding research is the Seventh Framework Programme for research and technological development (FP7). It will last for seven years from 2007 until 2013 and has a total budget of €53.2 billion. This number represents a substantial increase compared with FP6 which had a global budget of €18 billion.

Main strategic objectives

The Framework Programmes for Research have two main strategic objectives:

- to strengthen the scientific and technological base of European industry and

- to encourage its international competitiveness, while promoting research that supports EU policies

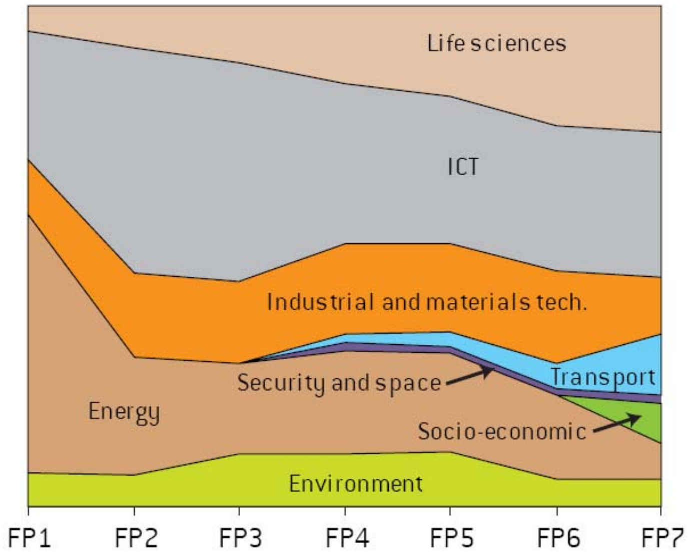
The FP7 budget

These are some key figures of the FP7 budget:

- €2.35 billion is dedicated to energy research
- €1.89 billion to environment (including climate change)
- €2.7 billion for Euratom.

Although the budget has increased substantially, in relative terms the share of energy and environment has decreased over successive FPs (Figure 6-3). The first FP was launched in 1984 and was heavily concentrated on energy but now the FP concentrates more on information and communications technology (ICT) and broader applications in support of industrial competitiveness.

Figure 6-3: EC-FP funding by technological area, a comparison across FPs



Source: Aghion, Veugelers, and Serre (2009)

Types of support

FP7 enhances Europe's position in terms of jobs and competitiveness and helps maintaining leadership in the global knowledge economy. The majority of the money is spent on grants to research actors all over Europe and beyond. The selection is based on calls for proposals and a peer review process and the grants are used to co-finance research, technological development and demonstration projects. The activities funded must have a "European added value". This includes the transnationality of many actions or raising the competition between scientist (Aghion, Veugelers, and Serre 2009).

The Specific Programmes of FP7

The Specific Programmes constitute the five major building blocks of FP7:

Cooperation Programme

The Cooperation Programme is the core of FP7 and enhances collaborative research across Europe and other partner countries through projects by transnational consortia of industry and academia. The program also includes the new Joint Technology Initiatives (JTI), coordination of non-community research programs and the Risk Sharing Finance Facility (RSFF). JTI are industry driven, large-scale multi-financed actions while the coordination of non-community research programs aims at bringing European national and regional research programs closer together.

Ideas Programme (the European Research Council – ERC)

The Ideas Programme funds pure, investigative research at the frontiers of science and technology and independently of thematic priorities. It aims at bringing such research closer to the conceptual source and it is an appreciation of the value of basic research to society's economic and social welfare.

The support of such "frontier research" is solely based on scientific excellence, therefore research may be carried out in any area of science or technology and there is no obligation for cross-border partnerships. The program is implemented by the European Research Council (ERC).

People Programme

The People Programme supports research mobility and career development, both for researchers inside the EU and externally. Its objective is to help researchers build their skills and competences throughout their careers and the program is implemented via a coherent set of Marie Curie actions.

Capacities Programme

The Capacities Programme is designed to help strengthen and optimize the knowledge capacities that Europe needs if it is to become a thriving knowledge-based economy. By strengthening research abilities, innovation capacity and European competitiveness, the program is stimulating Europe's full research potential and knowledge resources.

Nuclear research

The program for nuclear research and training activities consists of two parts

- The first program includes fusion energy research (in particular ITER) and nuclear fission and radiation protection.
- The second program handles some of the activities of the Joint Research Centre (JRC) and focuses on nuclear safety, waste management for nuclear fission facilities and radiation protection (EC Research Directorate-General 2007. FP7).

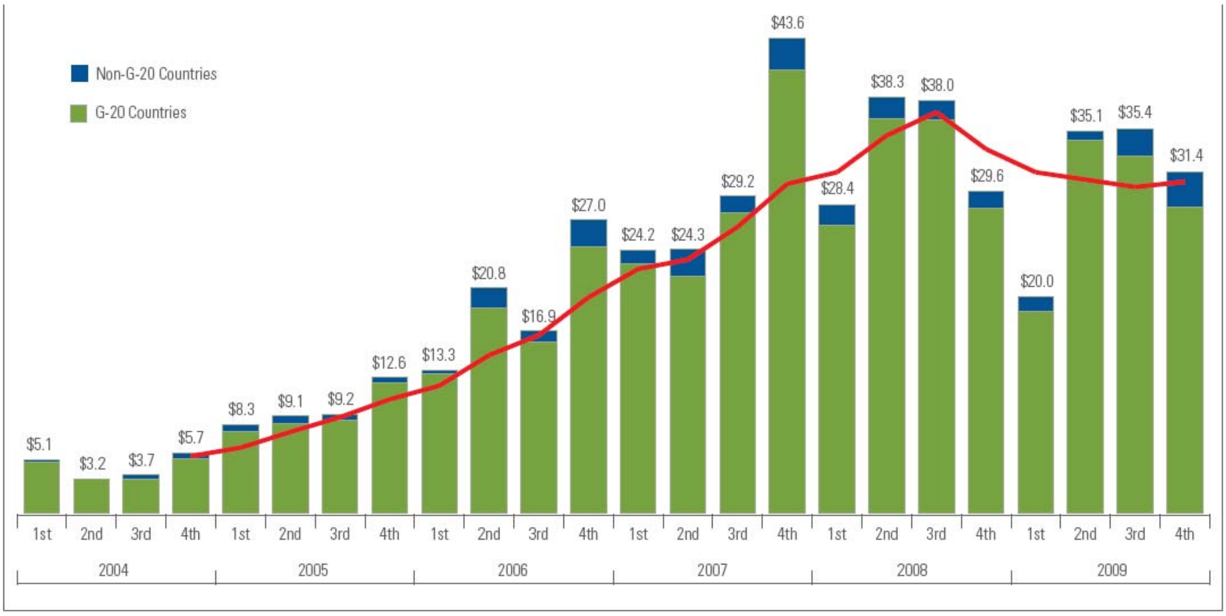
6.4 International developments in the green energy sector

Europe's position in the international low carbon technology market

The Communication emphasizes the critical role of Europe's position in the international low carbon technology market. This section therefore gives an overview of international developments in the green energy sector.

Between 2005 and 2009 overall investment in clean energy grew by 230%. In 2009 global investments were $162 billion declining only 6.6% from the year before. (Figure 6-4)

Figure 6-4: Financial investment in clean energy: global trends by quarter (billions of $)



Source: The Pew Charitable Trusts (2010)

Global stimulus plans prioritize investments in clean energy

One reason for this development is that many governments prioritized clean energy within economic recovery funding, devoting more than $184 billion of public stimulus investments to this sector, to enhance private investment in the green energy technologies. The global stimulus plans are led by the US ($67 billion) and China ($47 billion).

According to The Pew Charitable Trusts (2010), G-20 nations dominate the clean energy landscape since they account for more than 90% of worldwide finance and investment. Overall investment in the clean energy sector in G-20 nations has grown by more than 50% between 2005 and 2009.

Comparison of environmental patents between countries

Reliable indicators for innovation are patent applications. 2.15% of total patents applied for worldwide have been categorized as environmental technologies (2000-2006).

According to

Comparison of public green R&D expenditure between EU-27, US and Japan

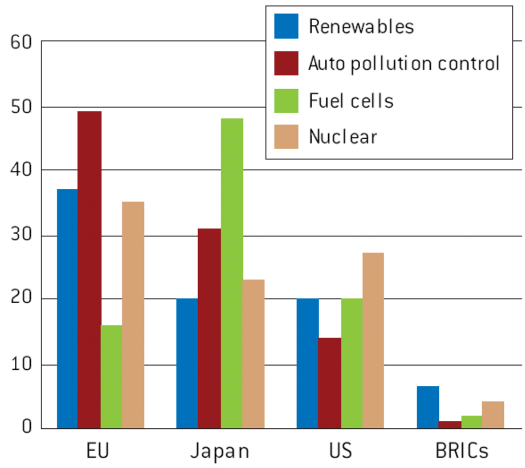
Figure 6-6 compares the size of public green R& financing of R&D by public-sector research organiz private sector R&D.. Compared to total R&D spen of the environment category is insignificant and fu tion in the data that this share is increasing, at l 2005. The EU-27 perform relatively well while th negative annual growth rate of government green I and 2005 (Aghion, Veugelers, and Serre 2009).

Figure 6-5 Japan is the leader since it holds 35% of all environmental patents as it is specialized in environmental patents. US is the least specialized in environmental technologies. Germany is by far the biggest producer of environmental patents in Europe.

Comparison of public green R&D expenditure between EU-27, US and Japan

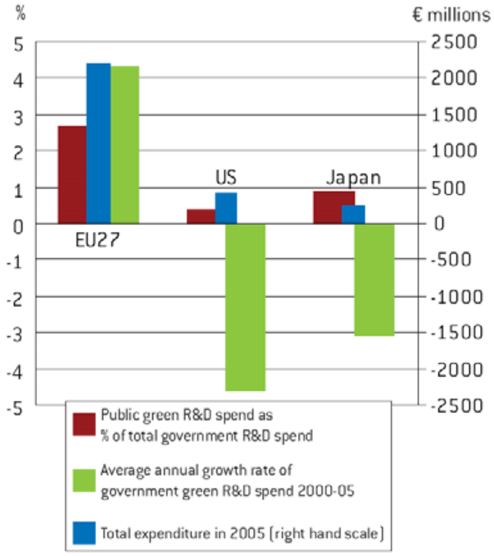
Figure 6-6 compares the size of public green R&D expenditures either by financing of R&D by public-sector research organizations or by subsidizing to private sector R&D.. Compared to total R&D spending the control and care of the environment category is insignificant and further, there is little indication in the data that this share is increasing, at least for the period up to 2005. The EU-27 perform relatively well while the US and Japan have a negative annual growth rate of government green R&D spent between 2000 and 2005 (Aghion, Veugelers, and Serre 2009).

Figure 6-5: Percentage share of world environmental patents by subfields and by country (Share of the country in world environmental patents relative to the share of the country in total world patents)



Source: (Aghion, Veugelers, and Serre 2009)

Figure 6-6: Public R&D expenditure on 'control and care of the environment'



Source: (Aghion, Veugelers, and Serre 2009)

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