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Impact on activity and employment of climate change and greenhouse gas mitigation policies in the enlarged Europe

Final Country Report – Germany

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- According to preliminary estimates, greenhouse gas (GHG) emissions in Germany have decreased by 19.2%, CO_2 emissions by 16.0% between 1990 and 2005. This has to be compared to the original target of the German Federal Government, i.e. to lower GHG emissions by 25% between 1990 and 2005, and to the burden sharing within the EU in the context of the Kyoto protocol, i.e. to lower Germany's GHG emissions by 21% between 1990 and 2008/2012. For the post-2012 period until 2020, the Federal Government has announced to set a 40% GHG emission reduction target, if the EU as a whole agrees to a 30% reduction. On the European level, a 60 – 80% reduction by 2050 is discussed which is supported by the German Federal Government.
- In Germany, a comprehensive mix of climate mitigation policies and measures has been implemented; further measures are already planned on different levels. The existing climate mitigation policies and measures reach from ecological tax reform, over support for renewable energies, co-generation and energy-efficiency on the demand- side to emission trading. However, several stakeholders interviewed question the efficiency and effectiveness of this mix as a whole or of single policy instruments within the mix and ask for optimisation or even suggest the abolishment of several measures. On the other hand, it is not questioned that additional effort and policy support will be needed to achieve the German GHG and CO_2 emission reduction goals, particularly in the medium term to long term.
- While „Climate protection“ is a high priority topic in German politics and media, employment impacts are discussed mainly when it comes to any possible burden expected for industry or consumers by climate mitigation policy instruments, and the economic consequences of this burden compared to other countries which have less effective climate protection policies. A central question, raised by some of the interviewees was: „In how far can Germany (Europe) afford to implement further additional climate mitigation policies and measures?“
- Furthermore, there has been some controversial discussion about the gross and net employment impacts of the German Renewable Energy Act and of the nuclear phase out. While several studies show a net positive employment benefit of increasing the share of renewable energies, few studies come to a negative net impact on

employment. Similarily, the opinions and scientific results with regard to the impact of nuclear phase-out on employment are mixed.

- Recently, the discussion about the positive net impacts on energy security, economic activity and employment of strengthening energy efficiency on the demand-side has increased. A study financed by the Hans Boeckler Foundation, and carried out by Wuppertal Institute and its partners, developed a detailed technical, financial, organisational and legal concept for an Energy Saving Fund in Germany. In total, the 12 programmes designed for the Energy Saving Fund could save 75 TWh/year electricity and 102 TWh/year heat until 2015, thereby leading to energy cost savings of about 9 billion Euro/year and a net impact on employment amounting to up to 75.000 person-years in 2015, and more than 1 million person-years over the duration of the 12 programmes assumed.
- There are no consistent approaches looking at the total net impact of the whole current mix of climate-mitigation policies and measures in Germany on employment. Only older studies are available, which show a net positive impact of climate protection measures on employment, as well as studies for single policy instruments or specific branches. Input-output and bottom-up analysis of national employment impacts based on energy system scenarios show, that the structural transition process towards a sustainable (low-carbon) energy system while at the same time phasing-out nuclear power will not lead to negative employment effects, but will rather have noticeable positive effects on employment, while at the same time contributing to other important societal goals. Also many stakeholders believe that, in total, climate protection policies and measures will have a positive impact on employment. Nevertheless, the structural change towards low-carbon technologies causes winners and loosers, with respective employment impacts. Therefore, as other structural changes, this process has to be carefully designed and accompanied by measures like social dialogue, education and training.
- In the past, employment losses in several branches in Germany have been substantial. However, this is hardly due to climate protection policies, but mainly caused by technical and economic restructuring, and other influencing economic factors, and by developments in the financial markets.
- When looking at employment impacts in the energy-intensive industries, it has to be distinguished between energy-related emissions where there might be still some substantial emission reduction potentials, and emissions related to the industrial (chemical, non-combustion related) processes which are already carried out at the efficiency frontier in many cases (if only existing available technology is regarded and not possible future technology development). Furthermore, it has to be carefully differentiated between small or medium-sized companies which do not have any flexibility to shift emission rights between production sites within or even between countries, and large corporate groups which – at the same time – are much better equipped with personell being able to deal with all the environmental regulation. Finally, it has to be distinguished between the degrees of competitive "pres-

sure" companies perceive in the globalised markets, and possibilities to outsource production processes with intensive emissions.

- In the case of energy-intensive industrial processes already reaching the efficiency frontier (if only existing available technology is regarded and not possible future technology development), and with companies perceiving competitive "pressure" in the globalised market, carbon leakage effects with accompanying job losses (at least compared to BAU development) could be a consequence of existing and further intensified climate protection policies and measures. However, the size of such effects is unknown. Furthermore, border-tax-adjustments or similar measures might help to avoid such problems in the future, in case a global approach to climate protection cannot be implemented (e. g. global sectoral benchmarks or similar measures). Finally, while corporate groups have the flexibility to deal with such developments and can easily switch production between sites and countries, thereby following, among others, the availability of emission allowances, small and medium sized companies can only react by reducing production, and, in worst case, employment.
- For the "winner branches" of climate mitigation policies and measures, like building construction and refurbishment or electrical equipment and machinery, exchange of experience, preparation for future developments, education and training becomes more and more important. There is a general risk – not only in the area of climate mitigation policies and measures, but also in other businesses like in the ICT sector - that jobs for newly developed services and products in new companies will be lower paid, and working conditions will be less secured than in established branches. This is, e. g., valid in some renewable energy companies or energy service companies.
- Against this background, trade unions should closely accompany this process of structural change due to climate mitigation policies and measures, thereby balancing the different sustainability dimensions, particularly employment and environment. Furthermore, stakeholders interviewed demand to intensify exchange on experiences and know how on impacts of climate mitigation policy on economic activitiy and employment among the trade unions at the European level in a cross-country and cross-sectional learning process. Within such a European learning process, the discussion should increasingly focus on the net impact of the whole climate mitigation policy mix (including the framework conditions), on its chances and risks, and on its links to other policy fields on employment, instead of just discussing only the impacts of single policy instruments.
- Cost-efficient technologies for effective climate mitigation policies and measures are already available today, several interviewees pointed out, while the cost-efficiency and impacts on economy and employment of possible future technologies in the energy sector like carbon capture and storage, hydrogen technologies/fuel cells, new types of nuclear power plants or even nuclear fusion can hardly be estimated. Already available technologies particularly mentioned in this context

are, in particular, energy efficiency technologies, renewable energy technologies, co-generation, more efficient fossil power plants and fossil heating systems. However, what would be missing is a broad implementation of these technologies supported by an ambitious policy-mix neutral to global competition. What should be noted in this context is the importance of not looking at single technologies and their contribution to climate change mitigation, economic development and employment, but to look at the combined effects of possible target-oriented technology-mixes like it is done in the mitigation scenarios presented in this report.

1 Introduction and overview

This country report by the Wuppertal Institute is part of the broader study „Impact on the activity and employment of climate change and greenhouse gas mitigation policies in the enlarged EU“ (N° 07-0402/2005/420169/SUB/C2), co-ordinated by the European Trade Union Confederation / Social Development Agency on behalf of the European Commission (DG ENV). Its general aim is to summarise

- the opinions and expectations of 24 stakeholders in politics, ministries and other public administrations, employers organisations, trade unions, selected industry associations and single companies as well as in NGO, collected by the Wuppertal Institute within face-to-face or telephone interviews, or in writing (cf. Appendix)
- published results from scientific studies, official reports and further sources (internet, literature, company reports)
- and own analysis by the Wuppertal Institute

with regard to the question in how far climate mitigation policies affect employment in Germany.

Wuppertal Institute would like to thank all the interviewees who provided data and information to this study, or presented their views on this central topic, or cross-read a draft version of this report. The employers organisation BDI (Association of German Industry) even forwarded the questionnaire to its member associations and companies.

Most of the stakeholders approached were willing to provide information, at least within a short interview. Several stakeholders provided additional written information or even filled in the questionnaire (interview guideline) on which the interviews were based.

This country report is structured as follows:

- In chapter 2, the report focuses on the development of CO_2 emissions in Germany in general and by sector and describes national emission projections for Germany.
- In order to achieve the national emission reduction targets, policies and measures have been developed on different levels which are summarised in chapter 3. Besides giving an overview about implemented and planned measures, the strategies and positions of stakeholders in different sectors with regard to different types of mitigation policies and measures are presented.
- Chapter 4 deals with the impact of mitigation policies and measures on employment in the economy as a whole and in the different sectors and branches.
- Measures to foster a social dialogue on this topic, measures to help transition for workers in the losing sectors as well as measures to support growth of winning sectors are topic in chapter 5.
- Finally, the main conclusions with regard to the question in how far climate mitigation policies affect employment in Germany are presented in the last chapter 6.

2 CO_2 emissions and emission reduction targets

2.1 National emission reduction targets

Within the EU burden sharing, Germany has agreed to a GHG emission reduction target of 21% by 2008/2012 compared to 1990 level, which can be achieved by additional efforts made, and with the help of additional policy instruments implemented. However, the original target of the Federal Government to reduce GHG emissions between 1990 and 2005 by 25% could not be reached by far. For the post-2012 period until 2020, the Federal Government will set a 40% GHG emission reduction target, if the EU as a whole agrees to a 30% reduction. On the European level, a 60 – 80% reduction by 2050 is discussed which is supported by the German Federal Government.

2.2 Overall development of CO_2 emissions

According to preliminary estimates, between 1990 and 2005, greenhouse gas (GHG) emissions in Germany have decreased by 19.2%, CO_2 emissions by 16.0%. In 2005, total greenhouse gas emissions amounted to 993.6 million t CO_2 equivalent, CO_2 emissions to 865.4 milllion t (Ziesing 2006). However, a main part of this reduction is due to se so called „wall fall effect“: As a consequence of Germany's reunification in 1990, a restructuring process started in East Germany which led to closure of industries and changes in energy supply. This is also the main argument for the high target set.

Table 1: Development of CO_2 emissions

Year	CO_2 emissions (Gg) excluding net CO_2 from LUCF	Compared to 1990
1990	1,015,031	100%
1991	976,937	-3.8
1992	929,451	-8.4
1993	920,046	-9.4
1994	905,626	-10.8
1995	902,213	-11.1
1996	924,908	-8.9
1997	893,529	-12.0
1998	885,201	-12.8
1999	857,419	-15.5
2000	860,091	-15.3
2001	873,862	-13.9
2002	863,877	-14.9
2003	865,367	-14.7

Source:Umweltbundesamt 2006

Table 2: Overview of CO_2 emissions per capita in some chosen EU countries

CO_2/ Per Capita	**Czech Republic**	**Germany**	**Hungary**	**Slovenia**
1990	14.84	12.18	6.81	6.26
1995	11.72	10.71	5.71	6.55
2000	11.50	10.15	5.44	7.26
2003	11.47	10.35	5.70	7.64

Source: IEA 2005a

The EEA (2006) expects GHG emissions in Germany to reach 1,000.9 million t CO_2 equivalent by 2010 with existing policies and measures, and 985.7 million t CO_2 equivalent with additional policies and measures, not yet reaching the Kyoto target of 971.7 million t CO_2 equivalent (compared to 1,230.0 million t CO_2 equivalent in the base year).

2.3 Sectoral developments and targets

The following table shows the sectoral breakdown of CO_2 emissions in Germany between 1990 and 2004.

Table 3: Sectoral development of CO_2 emissions in Germany

	1990	1998	2000	2002	2004
	(Gg CO_2)	(Gg CO_2)	(Gg CO_2)	(Gg CO_2)	(Gg CO_2)
Total Energy (Fuel Combustion)	**945,723.63**	**825,974.35**	**803,364.33**	**808,248.01**	**805,254.40**
1. Energy Industries	413,994.02	346,784.87	347,487.94	360,691.12	363,824.11
2. Manufacturing Industries and Construction	153,104.36	103,036.22	100,502.06	95,004.18	99,479.66
- thereof lime industry	*n.a*	*1,301.31*	*1,472.39*	*1,315.65*	*1,454.87*
- thereof cement industry	*n.a.*	*10,646.12*	*10,115.59*	*7,756.48*	*7,807.39*
- thereof Iron and steel industry	*12,589.83*	*12,921.42*	*11,849.13*	*9,362.94*	*11,209.08*
- thereof non-ferrous industry	*n.a.*	*1,060.66*	*992.33*	*935.11*	*936.26*
3. Transport	162,486.47	180,546.31	182,430.05	176,346.62	171,185.86
4. other sources - Residential	129,446.04	132,034.91	116,811.47	120,088.94	115,629.69
Total Industrial Processes	**84,507.68**	**80,697.61**	**82,893.92**	**78,232.29**	**80,699.83**
1. Lime Production	6,136.69	5,704.06	5,819.69	5,503.06	5,529.36
2. Cement Production	15,145.81	15,390.66	15,101.06	12,695.69	13,929.05
3. Iron and Steel Production	48,271.02	44,127.60	45,511.34	43,740.59	44,290.51
4. Aluminium Production	1,011.02	836.72	880.07	894.70	914.30

Source: UNFCCC

The sectoral emissions budgets formulated in the German NAPs are as it can be seen from the following table. On 24 November 2006, the Federal Minister for Environment announced a reduction of the budget for 2008-2012 for plants subject to the emissions trading scheme to 465 millon tonnes CO_2 per year, following a review by the European Commission.

Table 4: Sectoral emission budgets in the German NAP

SECTOR	**2005-2007**	**2008-2012 (30 June 2006)**	**2008 – 2012 (24 November 2006)**
Energy and Industry sector	503 Mt CO_2 per year	517.5 Mt CO_2 per year	
Of which are allocated to the plants subject to the emission trading scheme - of which are allocated to existing plants - additional new plants - reserve - can be covered by JI/CDM Total reduction for the energy and industry sector		482 Mt CO2 per year 454 Mt CO2 per year 11 Mt CO2 per year 17 Mt CO2 per year ca. 60 Mt CO2 per year 2 Mt CO2 per year	465 Mt CO2 per year 434 Mt CO2 per year 14 Mt CO2 per year 17 Mt CO2 per year ca. 60 Mt CO2 per year 26.5 Mt CO2 per year
Other sectors (trade/commerce/services, transport and households	356 Mt CO_2 per year	334 Mt CO_2 per year	

Source: BMU 2006, 2006a

3 Climate protection scenarios, strategies, policies and measures

3.1 National climate protection plan

In Germany, a comprehensive mix of climate mitigation policies and measures has been implemented on the federal, the state („Länder“) and the regional or local level; further measures are already planned on different levels.

The existing climate mitigation policies and measures in 2006 on the federal level consist mainly of the following elements (cf. Bundesregierung 2005, but also Markewitz and Ziesing 2004):

- Ecological tax reform (additional green tax on fuels and electricity)
- Motorway charge on HGVs
- Energy Saving Ordinance (building regulation)
- Ordinance addressing the refurbishment of boilers
- Voluntary agreements with the German industry
- Self-binding target of the Federal Government to reduce CO_2 emissions in its own premises; and financial budgets for such measures
- Labelling of appliances (Implementation of EU Directive)
- Labelling of fuel consumption and CO_2 emisssions of cars
- Campaigns, information and advice programmes (e. g., „Initiative Energieeffizienz“, ecodriving campaigns)
- Reform of the rail transport system
- Promotion of public transport and bicycle traffic
- Change in legislative framework for spatial planning
- Development of a national fuel strategy 2020
- Laws and ordinances on co-generation and renewables leading to a support of these measures financed by surcharges on the electricity price to be paid by all customers (Renewable Energy Act, Co-generation Act)
- Direct financial support for renewable energies („Marktanreizprogramm“)
- Financial support for on-site audits
- Financial support for demonstration measures (old and new buildings)
- Cheap credits by KfW for energy savings in buildings, and for industry and commerce
- EMAS (Eco Management and Audit Scheme)

- Promotion of research and development.

However, several stakeholders interviewed questioned the efficiency and effectiveness of this mix as a whole or of single policy instruments within the mix and ask for optimisation or even suggest the abolishment of several measures. However, it was not questioned at all, that additional effort and policy support will be needed to achieve the German GHG and CO_2 emission reduction goals, particularly in the medium term to long term.

According to EEA (2006), GHG emission reduction by existing policies and measures would sum up to 247.4 million t CO_2 equivalent, while additional 15.3 million t CO_2 equivalent could be contributed by additional measures by 2010. In how far the emission trading has already had an impact on emissions in 2005 cannot be said yet.

At the German Energy Summit in October 2006, it was decided to formulate a national energy strategy by mid-2007. A German transport strategy until 2020 already exists, which is part of the national climate protection programme.

3.2 Attitudes and positions of stakeholders

3.2.1 Attitude of stakeholders towards mitigation scenarios

Interviewees were asked what kind of scenario would match best to their institution's expectation, opinion or attitude. They could choose between **three alternative scenarios for the development of Europe's energy and emissions until 2020/2030:**

Table 5: Short description of three different scenarios for the development of Europe's energy and emissions until 2020/2030

BAU/PRIMES-Scenario (Business As Usual) (Mantzos et al. 2003)	Continuation of the current policy including with its policies and measures; no focus on an active climate or energy policy, the European emission targets are not reached.
WWF/WI Policies & Measures Scenario (Lechtenböhmer et al. 2005)	Active climate policy: first priority are energy efficiency/energy saving measures; an enforced emissions trading system, a better market penetration of renewable and combined heat and power-technologies; completion of the exit from nuclear energy that was begun in some countries; no new nuclear power plants; special focus on the transport sector; a Europe-wide eco-tax and a reform of the subsidies policy.
LCEP-Nuclear-Scenario (EEA 2005)	The climate protection targets can only be reached through substantial reduction of GHG outside of Europe; within Europe, energy efficiency is given first priority; a further change of the fuel-mix is only relevant on a long-term basis; intensification of emissions trading; 40-50 new nuclear power plants and re-evaluation of the nuclear-exit strategies already decided upon; fixed target quota for renewable energy; reform of the current subsidies policy; enforced promotion of research & development; increased awareness for ecological issues.

Table 6 shows a summary of the preferences of scenarios as stated by the interviewees:

Table 6: Overview of Scenario Preferences

	BAU-Scenario	WWF/WI-Scenario	Nuclear Scenario	Other or own scenarios	No overall preference or no answer
Public Authorities		XX			X
Trade Unions		XXXX		X	
Employers' organisations					X
Environmental NGOs					X
Steel / Aluminium companies	X*				
Cement / Building materials companies					XX
Electrical equipment					X
Building construction and refurbishment					X
Power, Gas				XX	
Oil, Gas			X	X	
Transport				X	
Others				X	

* The interviewee estimated that climate protection targets would also be achieved in BAU development, because several instruments would be implemented already (e. g. nuclear energy, voluntary agreements), which would contribute to reaching the targets set.

Source: Interviews carried out by Wuppertal Institute

While most of the representatives of the trade unions and part of the public authorities support the WWF/WI scenario and expect that this policies & measures scenario will achieve emission reduction at lowest societal costs, stakeholders from industry either

- think that the BAU scenario would be the most feasible one (steel industry),
- have their own scenarios or support different scenarios,
- against their background, would only like to comment on some aspects within the scenarios, or,
- do not have an opinion on this matter at all (in this context, it has to be noted that the scenarios focus on the energy and transport sector and neglect the industrial processes with the process-related emissions, which might explain some of the answers of the interviewees).

3.2.2 Mitigation scenarios and the vulnerability of the energy and transport system

The climate system and the energy and transport system are deeply interlinked. Therefore the discussion about risks the energy and transport system are exposed to has to incorporate the vulnerability and resilience of both the climate and the energy and transport system. Climate change is mainly caused by energy and transport system related GHG emissions. Climate change means temperature and precipitation change, rising sea levels and altered occurrence of natural disasters, all of which affect the energy and transport system in Europe, with consequent rebound effects of the interdependent systems.

Technological issues contribute to the vulnerability and exposure of the European energy sector in several aspects (Luhmann 2004). With reference to the three mitigation scenarios described in Table 5, the following risks incorporated in particular in the electricity infrastructure can be analysed:

- The proportion of high-risk potential technology such as nuclear energy increases in the BAU and in the EEA scenario. Conversely, the WI-WWF scenario includes a nuclear moratorium and therefore a decreasing nuclear risk;
- Power plants and the electric grid have a long lifetime and therefore require long-term investment. This brings a lack of flexibility in adapting to changing requirements (e.g. environment, demand, resources prices) as well as financial exposure. A high share of decentralised CHP and RES electricity generation limits this risk considerably;
- Furthermore the general risks of centralized energy systems where technological failures and cascading effects are concerned decreases as a result of decentralised generation with CHP and RES plants;
- The technical and financial feasibility of future technology is unknown to a large extent and only predicted in scientific analysis. Sound research, development and testing of prototypes over years deliver the feasibility of new concepts. The R&D process itself contains risks, but focussing the whole R&D on single technology bears even greater risks concerning economic feasibility and the time horizon of market entry. For example, a strong support for carbon capture and sequestration technology hoping that this will develop to the future key CO_2 emission reduction technology seems risky, because of a variety of uncertainties, no proven storage concept and no running prototype plant until now. A similar risks arises out of the time horizon of the development of hydrogen generation, storage and use technology. The WI-WWF scenario highlights GHG emission reductions without focusing on single future technology. To a wide extend emission reductions are gained with energy efficiency measures and RES with practically proven technology;

- In addition, material constraints for the market introduction of new technology (e. g. fuel cells) might be a risk in the future (cf. Krewitt et al. 2004).

In the BAU and EEA-‚Nuclear Accelerated' scenarios, the vulnerability and exposure of the European energy and transport infrastructure is higher than in the WI-WWF scenario. The resilience is strengthened in the WI-WWF scenario by renewable and decentralised electricity generation technology, a decreasing import dependency, and energy efficiency measures. This in turn decreases employment risks, too.

3.2.3 Positions of stakeholders with regard to existing and future policies and measures

Interviewees were asked which policies and measures would be the most suitable ones to achieve the ambitious emission reduction goals set by the Council of European Ministers in 2005. The median values of the results are shown in Table 7.

Table 7: Median value of expectations by interviewees with regard to the effectiveness of different types of emission reduction measures (Range from 1 = not suitable over 2 = suitable to 3 = particularly suitable to contribute to achieving the target set by the Council of European Ministers in 2005) (n = number of interviewees having given a value to the respective cell in the table; total number of interviewees: 24)

Measures for reducing emissions	**until 2012**	**until 2020/2030**	**until 2050**
Emissions target, set by the Council of European Ministers (2005)	*- 8 %*	*- 30 %*	*- 60 bis - 80 %*
aa) Investments in technical measures for energy efficiency	2 (n = 9)	2 (n = 8)	1 - 2 (n = 6)
ab) Organisational (incl. behavioural) measurers to improve energy efficiency	2 (n = 8)	2 (n = 6)	1 - 2 (n = 5)
b) Conversion of production (products and processes)	1 (n = 7)	2 (n = 8)	2 (n = 7)
c) Closing oder reducing of capacities and/or production sites	1 (n = 7)	1 (n = 7)	1 (n = 6)
d) Important technological breakthrough	1 (n = 8)	1 (n = 7)	1 - 2 (n = 5)
e) Instruments of the Kyoto protocol: Emissions trading, JI, CDM	2 (n = 8)	2 (n = 7)	2 (n = 6)
f) Other measures: fuel switch/biofuels, RES, Clean Coal, Transport measures (e. g., standards), Energy tax increase	2 – 3 (n = 3)	3 (n = 3)	3 (n = 3)

Source: Interviews carried out by Wuppertal Institute

Energy efficiency measures are particularly seen as suitable to contribute to CO_2 reductions until 2020/2030, while conversion of production (including CCS measures in the energy sector) are seen as suitable in the medium term to long term. The interviewees do not have much hope that there will be any major technological break through in the long term achieving substantial CO_2 reductions. Some interviewees stressed the importance of nuclear energy for reaching ambitious emission reduction targets, while others focused more on extending support for renewable energies, e. g., in the renewable heat sector.

Several interviewees stated that the transport sector would be the most difficult one with regard to emission reduction actitivities. A further increase in emissions could only be avoided by additional policies and measures, e. g., increased fuel tax, standards for cars, including the transport sector or parts of it into emissions trading, or a mix of measures aiming at changing the modal split including fair framework conditions for public transport in comparison to the aviation industry and road traffic. However, there are, of course, different opinions on the policy-mix to be chosen for the transport sector, depending on the position of the respective stakeholder interviewed. The ecological tax reform (green tax) has particularly had a significant impact on the transport sector and has led to reduced fuel consumption (cf. also Umweltbundesamt 2004), complemented by further measures like promotion of research and development of alternative fuels and drive technology, promotion of public transport, and implementation of a motorway charge on HGVs.

As it can be seen from the above table, instruments of the Kyoto protocol are generally seen as suitable measures, although some stakeholders think that other measures would be even more suitable. Several interviewees expressed their disappointment with regard to the effectiveness and efficiency of the current emissions trading system. However, most of them still expect emissions trading to develop more effectively in the future. Some interviewees argued that an increase in green tax or CO_2 emission standards would lead to similar emission reductions, but with less side-effects.

In general, there are different opinions about the effectiveness of so-called market-driven or market-oriented policy instruments, and the need for additional policy instruments. Interviewees from energy industry and energy-intensive industry believe that market-driven instruments like emission trading would be sufficient and best suitable to induce emission reductions, at least if implemented globally and only including larger emission producers (i. e. also that to address the other emission producers other instruments should be implemented). In contrast, other interviewees have the opinion that the so-called market-oriented policy instruments like certificate trading but also energy or green tax setting a price signal to the market and internalising external effects, would not be sufficient to initiate the broad implementation of emission reducing measures. Price signals in the markets would matter, but might not be sufficient to overcome the various barriers and obstacles existing in the markets. Interviewees supporting this argument, suggest a mix of additional policy instruments to overcome the existing barriers, including standards or mandatory targets, labels, information, education and training, research and development, financial incentives (e. g., by via programmes of an energy saving fund), public procurement and a step-by-step foreseeable energy or green tax increase.

4 Impact of mitigation policies and measures on economy and employment

4.1 General developments and overall impact

While „Climate protection“ is a high priority topic in German politics and media, employment impacts are discussed mainly when it comes to any possible burden expected for industry or consumers by climate mitigation policy instruments, and the economic consequences of this burden compared to other countries which have less effective climate protection policies. A central question, risen by some of the interviewees was:

> *„In how far can Germany (Europe) afford to implement further additional climate mitigation policies and measures?“*

A study recently commissioned by German ministries shall give more insights in how far climate mitigation policies beyond 2012 might lead to negative economic and carbon leakage effects. One discussion in this context asks, how the policy-mix could be designed to avoid such negative developments, particularly, in how far global climate protection instruments will be needed and could be implemented, or in how far measures like border-tax adjustment can avoid that climate protection affects global competitiveness of German industry (e. g., energy-intensive industry, aviation industry), in case a global approach to climate protection cannot be implemented.

Table 8: Basic economic indicators in Germany

	2003	2004	2005
Population	82,600,000	82,501,000	82,438,000
GDP (billion Euro)	2161.50	2207.20	2241.00
GDP (growth in %)	0.9	2.1	1.5
Net inflation (%)	1.1	1.6	2.0
Number of wage earners	35,734,000	35,209,000	n.a.
Unemployment rate (%)	10.5	10.5	11.7

Source: German Statistical Office

In the past, employment losses in several branches in Germany have been substantial which explains the relative high unemployment rate. However, this is hardly due to climate protection policies, but mainly caused by technical and economic restructuring, and other influencing economic factors, and by developments in the financial markets.

There are currently no consistent approaches looking at the total net impact of the whole mix of climate-mitigation policies and measures currently in place in Germany on employment. However, some older studies are available, as well as studies for single policy instruments or specific branches.

A study by Scheelhaase et al. (PROGNOS 2000c) on behalf of the German Federal Environmental Agency came to the conclusion that climate protection and nuclear phase-out will lead to 194,000 additional person-years of employment until 2020, assuming policies and measures leading to a 25% reduction in CO_2 by 2005 vs. 1990, and a 40% reduction by 2020. The highest positive employment effects would be reached in building construction and refurbishment, and in industry producing efficient machinery and equipment. The study did neither take into account possible additional export of clean technologies, a possible increase in fossil fuel prices, nor an additional support for co-generation, which would even lead to higher positive employment impacts.

In addition, a macroeconomic study predicting the impact of the German ecotax (additional fuel and electricity tax) on employment comes to similar results: up to 250,000 jobs have been created since 1999 due to reduced labour costs (income of tax is used to reduce social conributions). Compared to BAU development, the green tax has increased employment by 0.76% until 2003, and is expected to lead to an overall increase in employment of 0.46% by 2010 (Kohlhaas 2005 ;cf. also Schleich et al. 2006).

Eonomic models can hardly deliver reliable projections for a time horizon longer than 10 to 15 years. Therefore, in the course of this study looking also at the medium term to long term, stakeholders were asked about their expectations with regard to economic including employment effects of climate protection policies and measures. Many of them expect a positive net impact on employment from mitigation policies and measures compared to BAU development. However, this positive net impact would not necessarily mean an absolute increase in employment in Germany due to other influences. The contribution of climate change mitigation policies and measures to reducing unemployment would only be small, if any.

NGO and trade union representatives argued that an effective environmental policy leading to high standards in practice could induce the development of innovative technologies that can be highly competitive in the global market, having a positive impact on economic activity and employment in the end. This could be seen, e.g., in the car industry, where Japanese manufacturers are currently particularly successful on the European market, the NGO representative added. However, it should be noted in this context, that not for all such innovative products a successful market introduction and transformation process will necessarily happen, and that the success depends on a variety of factors on the supply-side and on the demand-side.

Table 9: Median value of expectations by interviewees with regard to the impact of different types of emission reduction measures on employment (Range from 1 = lower over 2 = unchanged to 3 = higher) (n = number of interviewees having given a value to the respective cell in the table; total number of interviewees: 24)

Measures to reduce emissions	**Number of safeguaded or created jobs**	**Number of job losses**	**Qualification structure**	**Working conditions**	**Level of salary**
aa) Investments in technical measures for energy efficiency	3 (n = 8)	2 (n = 3)	2 - 3 (n = 2)	2 - 3 (n = 2)	2 (n = 2)
ab) organisational (incl. behavioural) measurers to improve energy efficiency	2 - 3 (n = 8)	2 (n = 3)	2 - 3 (n = 2)	2 (n = 2)	2 (n = 2)
b) Conversion of production(products and processes)	2 (n = 8)	2 (n = 3)	2 (n = 1)	2 (n = 2)	2 (n = 2)
c) Closing oder redu-cing of capacities and/or production sites	1 (n = 8)	3 (n = 3)	1 - 2 (n = 2)	1 - 2 (n = 2)	1 - 2 (n = 2)
d) important techno-logical breakthrough	2 - 3 (n = 7)	2 (n = 2)	3 (n = 1)	2 (n = 1)	2 (n = 1)
e) instruments of the Kyoto protocol: Emis-sions trading, JI, CDM	2 (n = 7)	3 (n = 3)	2 - 3 (n = 2)	2 - 3 (n = 2)	2 - 3 (n = 2)
f) other measures: fuel switch/biofuels, RES, Clean Coal, Transport measures (e. g., standards), Energy tax increase	3 (n = 3)				

Source: Interviews carried out by Wuppertal Institute

Table 9 shows the median value of the expectations by interviewees with regard to the different types of emission reduction measures on employment. According to the median of interviewees' expectations, energy efficiency measures, important technological breakthroughs and other measures (like fuel switch in agriculture, RES measures, clean coal, transport measures, e. g., standards, and energy tax increase) will have a positive impact on the number of jobs, while it is feared that the instruments of the Kyoto protocol (in particular, emissions trading) will lead to job losses.

The interviewees agree on the fact that, on the one hand, the need for more and more highly educated employees increases while, on the other hand, the number of jobs for less educated people will decrease. This is a general development in the economy, but valid for, e. g., energy efficiency measures, for the implementation of the Kyoto instruments, and, of course, for new technological developments, too. Working conditions and the level of wages/salaries will be hardly affected by climate mitigation measures, the interviewees expect.

4.2 Sector-specific effects

4.2.1 Energy sector

4.2.1.1 Overall development of employment in German energy industry and the influence by climate mitigation policies and measures

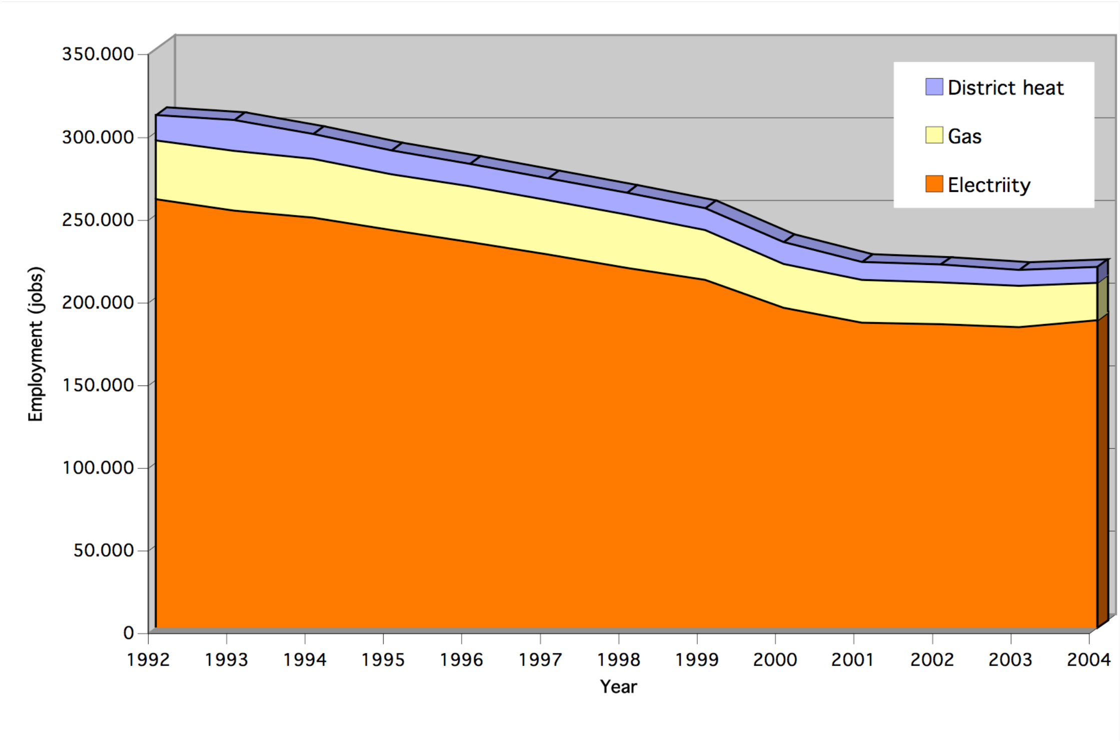
In the past, employment losses in the grid-based energy industry have been substantial. However, this is hardly due to climate protection policies, but mainly caused by cost pressure from liberalisation and re-regulation, technical restructuring and developments on the side of the shareholders (municipalities; global financial markets)

Table 10: Gross value added at factor costs for electricity, gas and district heating [million Euro]

	2000	**2001**	**2002**	**2003**
Electricity	25,264.2	24,020.5	25,212.8	24,601.0
Gas	3,836.7	5,018.6	5,057.9	5,752.0
District Heating	749.1	1,551.3	1,139.8	845.7

Source: Eurostat

Figure 1: Development of jobs in German energy industry 1992 – 2004



Source: German Federal Statistical Office

While some studies in Germany fear negative net employment impacts of nuclear phase-out while at the same time aiming to fulfil climate protection targets, other scientific input-output and bottom-up analysis of national employment impacts based on energy system scenarios show, that the structural transition process towards a sustainable (low-carbon) energy system while at the same time phasing-out nuclear power will not lead to large negative net economic effects in Germany, and might even have noticeable positive net effects on economy and employment, while at the same time contributing to other important societal goals (cf., e.g., Hohmeyer/Menges/Schweiger 2000; Wuppertal Institut/Öko-Institut 2000; DIW/bei/WI/IAT 2004; Fahl/Ellersdorfer 2004).

Although the total net impact on economic activity and employment might be slightly positive in the end, depending on the design of the policy-mix, the structural change of the energy system towards low-carbon technologies causes winners and loosers. The following two subchapters look into this in more detail.

4.2.1.2 Impact of climate change mitigation policies and measures on the fossil fuels-based energy industry

The fossil fuels-based energy industry is, of course, a clear looser of further strengthened climate protection activities, which aim at reducing the use of fossil fuels for energy and transport services by substituting fossil fuels by renewables and strengthened e-nergy efficiency. For example, with additional policies and measures to increase energy efficiency on the demand-side like it is assumed in a proposal for an energy saving fund in Germany by Irrek/Thomas/et al. (2006), leading to a reduction in energy end-use of 75 TWh electricity/year and 102 TWh heat/year by 2015, employment in the energy industry would be further reduced, in this case by about 409,000 person-years in total by 2029, i.e. about 17,000 full-time jobs on average.

Energy industry can, however, at least partly profit from the introduction of specific low-carbon technologies like they are described in the following subchapter.

4.2.1.3 Impact of (policy support for) specific low-carbon technologies

Several experts believe that in the period 2020 to 2030, a break with current technology might take place in the energy and transport market. Besides futher development of energy efficiency technology, renewable energy and co-generation technology, new technology like hydrogen technology, fuel cells, carbon capture and storage, new types of energy storage, or the fourth generation of nuclear power plants might enter into the market on a larger scale, after prototypes and demonstration plants will have already been installed, tested and further developed in the decades before. Plasma confinement technology for nuclear fusion might come into the market about one to two decades later. In how far this will happen, will largely depend on the success of further research and development, policy support and framework conditions, and the development of material prices and labour costs.

Until now, the state of new technology development is not promising for every type of new technology. In the following, the different technology which are under discussion today are analysed a bit more in detail taking employment aspects into account as far as possible. Some of these technologies are already available today and cost-efficient, while the possible development and impact of others can hardly be estimated today. What should be noted in this context is the importance of not looking at single technologies and their contribution to climate change mitigation, economic development and employment, but to look at the combined effects of possible target-oriented technology-mixes like it is done in the scenarios presented.

Energy efficiency technology and organisational and behavioural solutions

Various energy efficiency technology and organisation solutions (e.g., energy management) are already available, practically proven and economical. Their techno-economic potentials are large. However, in many cases, due to diverse barriers and obstacles, the market transformation process has not been fully successful. For an increase of energy efficiency in industrial production experts point out that further improvements must rely on energy-efficient innovations, because many large-scale production processes are already (at least partly) optimised (EurEnDel 2004, 19).

Recently, in Germany, the discussion about the positive net impacts on energy security, economic activity and employment of strengthening energy efficiency on the demand-side has increased. A study financed by the Hans Boeckler Foundation, and carried out by Wuppertal Institute and its partners, developed a detailed technical, financial, organisational and legal concept for an Energy Saving Fund in Germany (Irrek/Thomas/et al. 2006). In total, the 12 programmes designed for the Energy Saving Fund could save 75 TWh/year electricity and 102 TWh/year heat until 2015, thereby leading to energy cost savings of about 9 billion Euro/year and a net impact on employment amounting to up to 75.000 person-years in 2015, and more than 1 million person-years over the duration of the 12 programmes assumed (cf. Appendix 3 of this report). The results confirm a rule of thumb by Jochem and Schön (1994), which says that the net employment impact of energy saving measures is about 100 person-years/PJ saved end-use energy. The calculations were done taking structural changes and multiplier effects into account. The positive net impact on employment is mainly due to the reduction in energy imports. The branches benefiting most are craftsmen (+300,000 person-years between 2006 and 2029 caused by the 12 programmes of an Energy Saving Fund), particularly in the area of building construction and refurbishment, but also in other areas, and machinery (+125,000 person-years within this period).

Several municipalities or regions in Germany use support for climate protection activities to develop their regional economy and to attract investors. In this sense, they try to bridge possible gaps between ecology and economy. This is, e. g., true for the Region of Hannover, the City of Freiburg i.Br., and the City of München. In the City of München, in 2005, specific support measures for heat saving measures induced gross employment at the size of more than 200 person-years (Landeshauptstadt München 2006).

None of the interviewees questioned the expected substantial positive net impact of increasing energy efficiency. However, most of them thought that the largest part of the efficiency gains will be reached in the short term to medium term, and that other technologies will become more important in the long term.

Manufacturers of energy-efficient technology pointed out in interviews within this and other projects of the Wuppertal Institute (cf., e.g., Irrek/Thomas/et al. 2006), that the number of jobs in their companies will not depend on the energy-efficiency of their technology, and that production would follow the markets. However, if they produce innovative (energy-efficient) technology, this will secure competitiveness of the company in the medium term to long term, and therefore will indirectly secure jobs.

Energy efficiency services

Energy efficiency services (e. g., energy audits and energy performance contracting) are offered in the market to assist end-users in taking advantage of the huge energy efficiency potentials. There are different estimates of potentials for energy performance contracting and possible market development in Germany. According to information by the Berlin energy agency, in the public sector alone, about 2 billion Euro could be yearly invested in the course of energy performance contracting projects, leading to energy savings of more than 350 million Euro per year. According to information by the energy service company (ESCO) association “Contracting-Forum im ZVEI”, the potential for different kinds of contracting projects in Germany in general would be 26.5 billion Euro per year. However, not only for specific energy saving technologies, but also for services like energy performance contracting or energy audits, there are diverse barriers and obstacles, and the market transformation process has not been fully successful. Nevertheless, recently, due to increased energy prices, there has been an increased interest in such services. While within the years after the start of the liberalisation process, energy performance contracting was mostly just a small part of projects on the supply-side implemented by third parties, more ‘pure’ energy performance contracting projects are implemented now. According to information by the German newspaper “Handelsblatt” of 5 December 2005, there were about 50,000 contracts that ESCOs had concluded with customers in Germany at this time. There are about 500 firms (ESCOs) offering energy performance contracting (Frommann 2006). They are partly part or daughter companies of energy companies, partly independent from them. Three associations of ESCOs exist. Unfortunately, employment figures and estimates of future development of employment in this field could not be gained in the course of this study.

Renewable energies

There are more and less mature renewable energy technology. However, most of them rely heavily on public support by fiscal and regulatory policy for their growth, and thus for the employment impacts. The immature technology as, e.g., ocean energy systems, for which market support is currently irrelevant, still need substantial R & D support. Technology in intermediate stages of development, such as photovoltaic systems, require both R & D support and market support. Relatively mature technology, such as biomass for heating, need less R & D support, but public support for their dissemination.

Although it is obvious that the increased use of renewable energy technology has lead to many new jobs (e. g., about 157,000 jobs in Germany by 2004 according to Staiß et al. 2006; about 170,000 by 2005 according to the Federal Renewable Energy Association), the net employment impact of renewables is controversially discussed among experts. However, most studies like the recent study by Staiß et al. 2006 for Germany estimate a slightly positive net employment impact of renewables. Eurofores et al. (2004) even expect a much larger net national employment growth by advanced renewable strategies. Staiß et al. (2006) expect that jobs in the renewable energy industry will increase to 300,000 in 2020, and a net employment effect of about +70,000 person-years in 2020 compared to the reference scenario (BAU development), depending mainly on the development of energy prices and foreign demand. Other stud-

ies like Pfaffenberger/Nguyen/Gabriel 2003 expect a negative net impact on employment (cf. also Häder/Schulz 2005). The results largely depend on the model used, the system boundaries set, and the model input factors assumed.
In the region of Freiburg i. Br., called the "solar region" of Germany, early support for research and development of solar energies has finally led to the creation of 80 companies with 640 employees being active in the solar business in the Freiburg region in 2004, about half of it being employed in a research and development company (Lutzky/Seitz-Schüle/Künze 2004). Another example of several in municipalities is the City of München, which in 2005, supported specific measures for thermal solar plants and biomass of about 900,000 Euro in total, that induced gross employment at the size of 44 person-years (Landeshauptstadt München 2006).

CHP / micro-CHP

Co-generation technology powered by fossil fuels or renewables (biomass) often are a technically and economically feasible emissions reduction option which increases the overall efficiency of electricity and heat supply.
In Germany, the technical-economic potential for heat produced by co-generation is 328 TWh heat per year, which is about 32% of today's used heat. At the same time, 351 TWh electricity per year would be produced, which is about 57% of today's gross electricity generation. Furthermore, 173 TWh primary energy and 54 million t CO_2 would be saved (Eikmeier et al. 2006; cf. also Krewitt et al. 2006). The results are valid for a price of 10 Euro/t CO_2, and the potentials would be even higher at higher prices.
CHP plants are usually located close to where the heat can be consumed. Today new CHP plants are often gas-fired, but also other fuels and renewable energies (biomass) are used. Employment impacts are more or less the same as for other thermal power plants (cf., e.g., the discussion of employment impacts of coal-fired power plants below). Additional positive and negative employment impacts come from the construction and operation of district heating systems. An integrated analysis of employment effects of co-generation should cover employment at the co-generation plant, jobs connected to the district heat grid, and employment effects of reduced revenues from selling fuels, e. g., natural gas. In 2000, the trade union ver.di estimated employment in municipal co-generation plants at 20,000 person-years. One interviewee argued that expansion of co-generation could mitigate negative employment effects caused by liberalisation and nuclear-phase out in the energy sector. Another interviewee mentioned that CHP would still need some public support in Germany, and thus employment impacts would depend on state interventions.

Coal-fired power plants with high efficiency

New types of coal-fired power plants with high efficiency up to 50% will be available from 2010 onwards. Although they are highly efficient, they still have high CO_2 emissions due to the use of coal (cf. "CO_2 capture and storage" in the following for a possibility of further reducing this impact on climate). Nevertheless, such plants are needed in the transition period to a sustainable energy system at least in some countries to fill the gap between supply and demand. In general, the operation of new thermal power plants often needs only half or even one third of the employees of the old thermal power plant they replace. For the 3-years construction period of a specific type of coal-fired power plants currently discussed in Germany ("Referenzkraftwerk NRW"; cf. VGB PowerTech e.V. et al. 2003), about 6,200 person-years of direct employment are estimated (gross impact). Climate protection considerations would support the construction of new efficient power plants, and thus would lead to growth and positive employment effects at least during the construction phase, an interviewee of one energy company argued. An interviewee from another energy company focused on the way highly efficient gas-fired or coal-fired contribute to securing employment: Such innovative technology would mean a comparative advantage with respect to know-how, which in turn would secure competitiveness and stabilise employment in the liberalised market for the energy company as well as for the technology suppliers.

CO_2 capture and storage

CO_2 capture and storage might have a role as a transition technology helping to move towards a lower-carbon energy system. IEA modelling results suggest a potential of 400 to 800 Mt of CO_2 capture in Europe by 2030 (EEA 2005, 52). However, as already mentioned before, the current strong support for carbon capture and storage technology hoping that it will develop to the future key CO_2 emission reduction technology in the future seems risky, because of a variety of uncertainties, no proven storage concept and no running prototype plant until now. There might be even insurmountable technical obstacles towards a sustainable storage concept (EurEnDel 2004, 27). Furthermore, the infrastructure costs as well as the energy input needed to capture, compress, transport and inject CO_2 are high, which makes carbon capture and storage less favourable than many other CO_2 reduction options. While IEA projections estimate net costs of carbon capture and storage solutions to develop in a range between -40 and 100 US$/t CO_2 globally, including costs of CO_2 capture, compression, transportation and injection as well as CO_2 revenues of up to 55 US$/t CO_2 mainly due to EOR projects, own estimates by Wuppertal Institute assumes that costs of about 50 Euro/t CO_2 at the moment and of about 30 Euro/t CO_2 in the future will be realistic. Furthermore, while such technology will not be broadly available before 2020, at this time, renewable energy technology might already have nearly reached the break-even point and will be the substantially cheaper option to reduce emissions. The possible employment impacts of CO_2 capture and storage are not known yet. However, if the technology remains a costly one, net employment impacts will probably be negative. Until today, there are only pilot projects starting with only little employment effects.

Hydrogen technology / fuel cells

In how far a hydrogen economy with stationary and non-stationary fuel cells will be established and in how far fuel cells will be using predominantly natural gas in the course of the next 20 to 50 years, is controversially discussed among experts. Establishing a hydrogen fuel cycle would need large investment in new infrastructure and technology for production, transport, storage and use. Furthermore, a central question in judging the technological, market and social impact is the origin of the hydrogen fuel: production from renewable energy sources, nuclear, or fossil fuels. A sustainable energy system can only be achieved with hydrogen production from renewable energy sources. However, the potential of renewable sources to be used for hydrogen production is limited in the EU. For example, for Germany, this might be an option only slightly starting not before 2025. Until then, there are more efficient and less costly alternatives to bridge the possible gap between supply and demand.

There are no reliable estimates of the employment impacts of fuel cells and other technologies and infrastructures of the hydrogen chain yet. What is known today, are e.g. the production expansion plans of manufacturers. For example, Sulzer Hexis in Germany plans to increase the number of employees from currently 35 to 200 persons in the course of the coming years, Siemens Westinghouse in Pittsburgh (USA) from 150 to 450-500 employees, i. e. about one person-year per 200 kW_{el} of production capacity.

Nuclear Fission

The economics of nuclear power largely depend on the national framework conditions and policy support given. Taking all explicit and implicit subsidies into account, nuclear power is probably the most expensive electricity generation option today. In fact, there would be no commercial use of nuclear power without implicit subsidisation. The highest implicit subsidy are the limited liabilities of nuclear power plant operators. The risks associated with the use of nuclear energy (accidents, 'regular' operation, waste impacts, transport, proliferation, terrorism) are socialized because the producers are practically not fully liable for the damage and risks caused by their activities. Furthermore, there are still the world-widely unsolved problem of waste management and the risks from political instability, terrorism and war (proliferation). Nevertheless, plans to construct new reactors exist in many countries in the world. Where nuclear phase-out agreements exist, they are re-discussed. The interviewees from the energy company RWE confirmed that they would like to use nuclear technology in the future, which would have positive impacts on growth and employment.

It should be noticed that reactor types like the EPR are just slightly adapted versions of the Generation III reactors (Generation III+). In 2000, the Generation IV International Forum (GIF) was established, representing 10 countries. Two years later they announced the selection of six reactor technologies suitable for deployment between 2010 and 2030. Three technologies are fast reactor designs and all operate at higher temperature as the present ones. For example, an international prototype of the planned gas-cooled fast reactor (GFR) is expected by 2025. The commercial use for the six reactor types will probably not start before 2030. For both Generation III+ and IV reactors it is questionable that they will be less risky and less costly than the present

reactor types.
With regard to employment aspects, it can be said from experience with present German commercial nuclear power plants, that during operation on average about 350 people are directly employed by the operator at the nuclear power plant site, further 150 person-years are needed of personnel from other firms steadily working at the nuclear power plant site (e.g., security), further 100 person-years are needed of personnel from other firms partly working at the nuclear power plant site (e.g., for revision and maintenance), and 450 to 500 person-years are further indirect gross employment impacts (cf. also Irrek 2005).

Nuclear Fusion

Nuclear fusion has received a very large share of public R&D support since about five decades and longer. However, until now the results are disappointing. It is very questionable that nuclear fusion will once become a technically and economically feasible energy source (cf. EurEnDel 2004, 26). Furthermore, this would not happen before 2050. With regard to the many cost-effective technology options in the energy and transport sector already available today, it cannot be understood why nuclear fusion still receives such a large support. Positive employment impacts cannot be expected from this type of large-scale technology.

New types of energy storage technology

In general, it has to be differentiated between seasonal and short-term storage. In the electricity sector, short-term storage technology such as pumped storage have been in use over many decades. While they were previously used in combination with large centralised power plants (e.g., nuclear), in the future, they will more and more be installed to absorb excess power by wind power plants or other renewable energy technology. This is also the expectation of the interviewee from the trade union ver.di. New storage technology might become important in the medium to long term in specific applications like, e.g., Redox flow batteries, fly wheels, super capacitors, hydrogen storage, electrochemical storage, or storage technology based on organic and silicate chemistry (EurEnDel 2004, 21). Innovations in storage technology are seen to be particularly crucial for the development of power systems with a large share of distributed generation (renewables, micro-CHP, fuel cells, etc.). The possible impact of new types of energy storage technology on employment is not known.

4.2.2 Energy-intensive industry

4.2.2.1 Overview

When looking at employment impacts in the energy-intensive industries, it has to be distinguished between energy-related emissions where there might be still some substantial emission reduction potentials, and emissions related to the industrial (chemical, non-combustion related) processes which are already carried out at the efficiency frontier in many cases (if only existing available technology is regarded and not possible future technology development). Furthermore, it has to be carefully differentiated between small or medium-sized companies which do not have any flexibility to shift emission rights between production sites within or even between countries, and large corporate groups which – at the same time – are much better equipped with personell being able to deal with all the environmental regulation. Finally, it has to be distinguished between the degrees of perceived competitive “pressure” companies experience in the globalised markets, and possibilities to outsource production processes with intensive emissions.

In the case of energy-intensive industrial processes already reaching the efficiency frontier (if only existing available technology is regarded and not possible future technology development), and with companies perceiving competitive “pressure” in the globalised market, carbon leakage effects with accompanying job losses (at least compared to the trend) could be a consequence of existing and further intensified climate protection policies and measures. This has been stressed by interviewees from energy-intensive industry, an employers’ association, and energy companies. However, the size of such effects is unknown. Furthermore, border-tax-adjustments or similar measures might help to avoid such problems in the future, in case a global approach to climate protection cannot be implemented (e. g. global sectoral benchmarks or similar measures). Finally, while corporate groups have the flexibility to deal with such developments and can easily switch production between sites and countries, thereby following, among others, the availability of emission allowances, small and medium sized companies can only react by reducing production, and, in worst case, employment.

Table 11: Gross value added at factor costs for different sectors [million Euro]

	2000	2001	2002	2003	2004
Manufacture of basic metals and fabricated metal products	16,218.8	15,953.9	15,915.7	16,365.2	18,186.3
Of which is Aluminium	*2,207.4*	*2,195.6*	*2,299.5*	*2,243.3*	*2,386.1*
Manufacture of cement, lime and plaster	1,391.9	1,333.9	1,004.2	720.0	877.1
Manufacturing of electrical machinery and apparatus n.e.c.	30,611.3	26,992.6	26,771.4	27,546.2	29,611.7

Source: Eurostat, German Statistical Office

Table 12: Employment in the German industry

	2000	2001	2002	2003	2004
Manufacture of basic metals and fabricated metal products	257,447	258,985	259,588	250,109	247,657
Of which is aluminium	*31,494*	*31,637*	*32,859*	*30,760*	*31,027*
Manufacture of other non-metallic mineral products (Building materials)	248,079	233,709	220,799	211,921	205,401
Manufacture of cement, lime and plaster	14,770	14,423	12,342	12,649	11,904
Manufacturing of electrical machinery and apparatus n.e.c.	492,209	500,657	487,028	465,295	469,681

Source: Eurostat, German Statistical Office

Table 13: Income per sector [million Euro]

	2000	2001	2002	2003	2004
Manufacture of basic metals and fabricated metal products	9,399.1	9,677.3	9,924.8	9,885.5	10,165.0
Of which is Aluminium	*1,202.5*	*1,231.9*	*1,297.3*	*1,277.6*	*1,287.4*
Manufacture of other non-metallic mineral products (Building materials)	8,807.0	8,381.5	8,190.2	1,928.9	7,746.1
Manufacture of cement/ lime/plaster	573.6	596.7	534.5	534.1	499.1
Manufacturing of electrical machinery and apparatus n.e.c.	20,238.4	20,280.3	20,658.8	20,119.2	21,138.6

Source: Eurostat

The development of employment in the German manufacturing industry is depicted in Table 12. Employment losses are hardly due to climate protection policies, but mainly caused by technical and economic restructuring, and other influencing economic factors, and by developments in the financial markets.

A study by Schleich et al. (2006) concentrating on the energy-intensive industry comes to the conclusion that climate change mitigation policies and measures like, e. g., a CO_2-tax increasing from 5 Euro in 2005 to 20 Euro per t CO_2 in 2010, and then remaining at this level, would have only a negligible impact on production (GDP), and would have a net positive impact on employment (+ 231,000 in 2020). However, Schleich et al. assumed a global tax design. They state with respect to their specific results for the steel industry (and this statement can be transferred to other branches of the energy-intensive industry, too)(Schleich et al. 2006, 42): „Of course, this minor effect is the result of the global tax design. Thus, under a Kyoto-type regime, ... the effects ... may be more severe, since some major competitors [outside Germany or the EU-25] are not levied with additional costs“.

4.2.2.2 Lime industry

Employment in German lime industry has experienced a strong decrease in recent years. CO_2 emissions in lime industry amounted to 2.3 million t CO_2 in 2003. Use of secondary fuels amounted to 180,000 t CO_2 in 2003. In general, the lime industry supports global and domestic efforts to reduce emissions like they have been agreed on in the Kyoto protocol. In a voluntary agreement, the German lime industry had committed itself to reduce CO_2 emissions of lime production by 15% until 2005. However, according to the lime industry, the possibilities to further reduce emissions would be limited. This is examplarily shown in the following example of a small producer of lime products. It cannot be said in how far this example is a typical one, and in how far the results could be generalised. However, the example shows the specific problems a company in this industry can face with regard to emission trading in Germany.

Table 14: Employment in the German lime industry

	2002	2003	2004	2005
LIme industry	4,259	3,971	3,640	3,316

Source: Bundesverband der Deutschen Kalkindustrie e.V., 2006

Table 15: Secondary fuels in the lime industry in 2003

Type of secondary fuel	ZSE-abbreviation (ID)	Value in TJ
Used oil	AÖ	1,490
Other commercial waste	GEWABFS	657
Meat and bone meal and fat from animals	TMUF	258
Total		**2,405**

Source: Lechtenböhmer et al. 2006, according to data from Bundesverband der Deutschen Kalkindustrie

One of the interviewees is the co-owner of a small family-owned company in the lime industry with only one production site and 87 employees in total. The plant is subject to emission trading, and thus has to reduce CO_2 emissions by 1.25% compared to the baseline. However, this affects competitiveness and employment of the company in four ways, as it has been stated by the interviewee:

- First, since 2/3 of the emissions in the lime industry are process-related emissions due to the resources used as input to the production processes which cannot be avoided, the remaining emissions from fuel combustion, which can be influenced in principle, would have to be reduced by about 4%. However, efficiency frontiers would have been reached already (if only existing available technology is regarded and not possible future technology development, which cannot be foreseen yet): a fuel switch was already implemented several years ago, and the possibilities for the use of secondary fuels (cf. Table 15) are limited (in 2003, use of secondary fuels amounted to about 8% of total fuel use in lime industry; cf. Lechtenböhmer et al. 2006); plant efficiency has already reached 85%, and can hardly be further increased.
- Second, the years for which data was collected to set the baseline for the emission target were years with relatively low production. Recently, demand has increased,

partly due to environmental policies and measures in the water and building sector. However, due to the limitations by emission trading, the company has decided not to increase production, because this would lead to the additional costs mentioned above which would not be paid by the market. In total, the interviewee estimated that, because of current high demand, the company would produce 20% below what it could produce today if there were no emissions trading scheme. Furthermore, specific products which would need other fuel input, cannot be produced, because a fuel switch back to solid fuels would increase emissions.

- Third, the second national allocation plan foresees a maximum utilisation time of of the plants in the lime industry of 7,500 hours/year, while, in fact, the processes cannot be interrupted for more than 6 hours, and therefore, real production time approximates 8,760 hours/year.
- Fourth, the company is a family-owned one. In total, the brothers managing the firm and one further employee had to work about nine person-months in total to understand and fulfill all the bureaucratic requirements imposed by the emissions trading scheme with respect to NAP I.

This situation for this company would mean that for every additional t lime produced, additional certificates for 1.2 t CO_2 would have to be bought, the interviewee claimed. If a price for lime products of roughly 70 Euro per tonne and a price for CO_2 certificates of 15 Euro per tonne were assumed, the additional certificates would mean an increase in price for lime products of more than 25%. However, the higher price would not be (fully) paid by the customers and therefore cannot be pushed through in the market because of three reasons:

- long term contracts exist with some customers which limit the possibility to change the price in the short term;
- competition in the market for lime products is severe, and at some price level, imports from other European countries are profitable;
- for some of the customers, besides labour, lime products are the only domestic input factor. Since other input factors have to be imported or – like electricity – can be supplied in other countries for a similar or even lower price, a strong increase in price of lime products could lead customers to shift their production and thus their demand for lime products to other countries.

Because of possible over-allocation of some of the company's competitors (for example, with sufficient allocation in some of the new Member States – cf. the respective country reports, with allocation of certificates to plants which had not implemented fuel switching strategies in the past, but now realised such an investment, or for plants which were shortly closed after start of emissions trading) and the possibility for larger competitors to switch production between different sites within Europe depending on the allocation received, the starting point in emissions trading and thus the impact on competitiveness in the lime market is different for the small company of the interviewee compared to its competitors.

The interviewee estimates that at prices for emission certificates above 2 Euro / t CO_2, it would be more profitable for the company to reduce production below what could be produced according to the increasing demand from the markets than to buy additional emission certificates. This situation would limit employment perspectives, and could lead to job losses and carbon leakage (transport / supply from other countries with lower efficiency standards) in the end. According to a calculation by the interviewee, the additional costs induced by the emissions trading scheme on an employee in the lime industry would some up to 1,600 to 6,000 Euro. This would have to be compared to an average monthly salary of 2,900 Euro.

Finally, the interviewee estimated, that he would make a higher profit from closing the firm and selling the emission certificates on the market than from continuing his business.

4.2.2.3 Cement industry

Employment in German cement industry has decreased due to general economic developments and increased competition on prices in the cement industry. In 2001, 38 cement companies produced approximately 32 million tons of cement in 64 plants. Most of the cement klinker is produced in dry kilns with preheater and precalciner. According to the association of German cement industry, Germany is probably the country in Europe which has performed most emission reducing measures in the cement industry.

Table 16: Employment in the German Lime/cement/plaster industry

	2000	2001	2002	2003	2004
Lime/Cement/plaster industry	14,770	14,423	12,342	12,649	11,904

Source: German Statistical Office

The shares of the individual production steps in the cement industry in total electricity consumption are as follows: raw meal preparation: 35%; burning of the cement clinker: 22%; grinding of cement: 38%; others: 5% (Schleich et al. 2006, 30, according to Sozialpolitische Arbeitsgemeinschaft der Deutschen Zementindustrie). On average, specific fuel consumption for the production of clinker decreased by about 0.5% between 1980 and 2000. CO_2 emissions arise from the calcinations of the raw materials and from the combustion of fossil fuels, and amount to about 0.53 t CO_2/t cement clinker. Today, average specific fuel use amounts to around 3,500 MJ/t clinker (including secondary fuels). Since 1988, specific electricity use in the German cement industry has been decreasing and average values now lie around 102 kWh per t cement (Schleich et al. 2006).

Table 17: CO_2 emissions in 2004 and thermal fuel use in the German cement industry in 2005

Emissions fuel combustion	**Gg**	**7,807.39**
Emissions industrial processes	**Gg**	**13,929.05**
Black coal	Million GJ/a	8.7
Brown coal	Million GJ/a	29.1
Petroleum coke	Million GJ/a	4.2
Fuel Oil	Million GJ/a	2.4
Gas	Million GJ/a	0.5
Other fossil fuels	Million GJ/a	0.5
Derived fuels	Million GJ/a	43.3
Total thermal energy consumption	**Million GJ/a**	**88.7**

Source: UNFCCC, AG Energiebilanzen

With regard to the impact of mitigation policies and measures on the German cement industry, the situation is partly similar compared to the lime industry, but more flexible solutions seem to be possible, which might even lead to some cement companies making a profit out of emissions trading. In the last year, some companies like Heidelberg Cement could make a profit out of emissions trading, because they received emission certificates for plants they had to close due to excess capacities. In the NAP II, specific benchmarks for cement industry have been set differentiating between different types of plants and products.

Like in the lime industry, only 1/3 of emissions are energy-related ones, 2/3 are process-related. Possibilities to reduce emissions in cement industry are:

- Use of secondary fuels. Between 1980 and 2000, the German cement industry substantially increased the share of secondary raw materials and energy carriers (waste processing) in order to lower production costs. At the beginning of the 1980s, secondary fuels such as tyres, rubber, industrial waste or solvents were hardly used. By 2000, they accounted for about a quarter of the entire thermal fuel use in the cement industry. The technical-economic upper limit for the use of secondary fuels is around 60% (Schleich et al. 2006). Heidelberg Cement was able to increase the input of alternative fuels from 22% in 2000 to 44% in 2005.
- Production of blended cement, with reduced use of burnt cement clincer and substitution by interground additives (22.4% share in 2000; technical upper limit for the share of these additives in cement production is about 50%; cf. Schleich et al. 2006).
- Use of renewable energies. For example, Heidelberg Cement has increased use of biomass from 0% in 2000 to 4% in 2005, and plans a further increase in the future.

- More efficient logistics.

New, further emission-reducing technologies are not expected to be invented in the near future.

The interviewees from the cement industry fear a reduction in domestic production and employment caused by mitigation policies and measures within the emissions trading regime until 2012 and its successors. Carbon leakage effects would be a consequence. For example, in spite of increasing demand in Spain, new capacities have been built in the north of Africa, due to, among others, the restrictions set by European emissions trading, one interviewee claimed. Imports of cement products would increase. Particularly smaller cement companies would experience problems, while on the other hand, the German electricity companies would even make windfall profits out of the emissions trading scheme.

According to Schleich et al. (2006), a CO_2-tax increasing from 5 Euro in 2005 to 20 Euro per t CO_2 in 2010, and then remaining at this level (or mitigation policy instruments with similar effects), would lead to an increase in production costs of 8% in the cement industry.

The cement industry has proposed a global sectorial approach to emission reductions, with global benchmarks and additional CDM and further measures of technology transfer to make it possible also for less-developed countries to improve efficiency and reduce emissions in their cement industry.

4.2.2.4 Iron and steel industry

Germany is the biggest steel producer in the EU: 28% of total EU production in 2003. Employment in German iron and steel industry has decreased. Specific energy use has decreased between 1960 and 2004 from 29.4 to 18.0 GJ/t crude steel production and from 44.9 to 22.3 GJ/t rolled steel production. CO_2 emissions have decreased respectively between 1987 and 2004 from 1,634 kg CO_2/t to 1,360 kg CO_2/t crude steel production and from 2,200 kg CO_2/t to 1,683 kg CO_2/t rolled steel production.Emission allowance certificates received for the period 2005 to 2007 amount to about 155 million t CO_2 compared to 50 million t CO_2 annual emissions counting within the emissions trading scheme.

Table 18: Production and employment in the German iron and steel industry

	2001	2002	2003	2004	2005
Production (1,000 t)					
- hot metal	29,184	29,427	29,481	30,018	28,854
- crude steel	44,803	45,015	44,809	46,374	44,524
- stainless steel	8,897	8,347	8,132	8,658	9,658
- hot rolled steel	37,011	37,763	37,174	39,976	37,771
- flat products	24,483	25,123	24,566	26,357	25,047
- long products	12,527	12,640	12,608	13,619	12,724
Total turnover (billion Euro)	20.9	20.7	22.0	27.1	30.3 (of which 64% is domestic)
Employment (Steel only)	101,327	97,940	94,551	92,193	91,279
Employment (manufacture of basic metals and fabricated metal products incl. steel)	258,985	259,588	250,109	247,657	n.a.

Source: German Statistical Office; Stahl-Zentrum Düsseldorf

Table 19: Qualification structure in the German iron and steel industry

Qualification	**Share**
Clerical workers	28%
Of which are engineers	*6,000*
Manual workers	72%
Of which are foremen/technicians with higher/medium education	*62%*
Total	**100%**

Source: Wirtschaftsvereinigung Stahl, 2006

Table 20: CO_2 emissions and energy consumption in the German iron and steel industry in 2005

Emissions counting for the emissions trading scheme (not including emissions induced by electricity consumption)	Million t CO_2	About 50* (total allowances: 155 for 2005-2007
Emissions (including emissions induced by electricity consumption)	Million t CO_2	60.16
Electricity used	TWh	21.16
- of which was own generation	TWh	8.1
Fuels used		
Natural gas	Billion m^3	2.7
Coke oven gas	Billion m^3	1.1
Blast furnace gas	Billion m^3	3.1
Coal	Millon t	3.9
Coke	Million t	10.4

* The 50 million t CO_2 are estimated emissions in 2005, which was a year, in which – according to the association of the steel industry – emissions were low compared to other years. For example, in 2006, CO_2 emissions will be probably about 2 million tonnes higher.

Source: Wirtschaftsvereinigung Stahl, 2006

A study by Schleich et al. (2006) concentrating on energy-intensive industry comes to the conclusion that climate change mitigation policies and measures like, e. g., a CO_2-tax increasing from 5 Euro in 2005 to 20 Euro per t CO_2 in 2010, and then remaining at this level (the Kyoto regime is assumed to lead to similar developments), will lead to a significant shift in the production from basic oxygen furnaces (BOF)-steel to the less carbon intensive electric arc furnaces (EAF)-steel. According to these results, EAF-steel production share would almost double by 2020 and would reach 46%. However, the interviewee from the association of the steel industry does not share this view. According to the association, production would be limited due to availability of scrap metal, quality requirements for flat products, and electricity prices.

The interviewee from the iron and steel industry, like interviewees from other energy-intensive industry, in a worst case situation, fears a reduction in domestic production and employment caused by mitigation policies and measures within the emissions trading regime until 2012 and its successors. Carbon leakage effects would be a consequence, he claims. Such effects are not expected to place in the short term, but would be plausible in the medium term to long term depending on the design of the future policy-mix, which currently would not take adequately account of global competition aspects. However, a global sectorial approach to emission reductions, with global benchmarks and additional measures, like it has been proposed by the cement industry, would be much more difficult in the iron and steel industry because plants would be less comparable. Nevertheless, in the long run, the steel industry and policy makers should think about such a kind of emission scheme.

Today, the efficiency frontier would have been nearly reached in many cases (if only existing available technology is regarded and not possible future technology development). In how far and when the current research project ULCOS [Ultra Low CO_2 Steelmaking] of 48 European companies and organisations will achieve the planned reduction in specific CO_2 emissions from ore-based steelmaking of 30% is unclear. Broad implementation of new production procedures is not expected to take place before 2030, maybe even not before 2050, the interviewee from the steel association estimates. The plans include the re-use of blast furnace gas after prior CO_2 removal. New technologies for storing CO_2 are being investigated under the research initiative, too. Also under investigation are electrolysis, use of hydrogen, carbon or natural gas with CO_2 being separated and stored in dedicated reactors, or the use of biomass (Information from www.thyssenkrupp-steel.com, 24 May 2006).

4.2.2.5 Aluminium industry

Aluminium is produced or processed in about 600 plants in Germany, with about 73,000 employees. In 2004, turnover was about 13.4 billion Euro. More than two thirds of the turnover was attributable to the producers of raw aluminium and aluminium semi-finished products; companies involved in the further processing of aluminium accounted for some 3 billion Euros in 2004. About 40% of turnover is realised via exports. For the next years, a continuous growth in production and turnover is expected.

Table 21: Production and employment in the German aluminium industry

	2001	2002	2003	2004	2005
Employment according to the German Statistical Office	31,637	32,859	30,760	31,027	
Employment according to the association of producers				73,000	73,000
Number of firms					ca. 600
Production in tonnes of					
- **primary aluminium**	651,600	652,900	660,800	667,800	647,900
- **secondary aluminium**	622,900	666,100	677,900	703,800	718,300
- **semi-finished products**	2,011,500	2,114,900	2,151,200	2,246,700	2,312,100
- **shaped castings**	652,200	660,700	667,100	715,800	727,200
- **further processing**	374,100	384,000	387,600	387,300	384,200
Turnover (billion Euro)		12.7		13.4	13.9

Source: German Statistical Office; Gesamtverband der Aluminiumindustrie e.V.

Energy costs, particularly electricity costs, represent a high proportion of total costs of producing primary aluminium (about 25%, and up to 40% in some plants, of which a large part is due to electrolysis). This leads the producers to having a large interest in reducing energy costs by

- negotiating low electricity prices with electricity suppliers or producing electricity prices at low costs in own plants
- demanding an energy regulation which leads to low prices for access to the grid
- lobbying for low taxes and reduction in other state-induced surcharges on electricity prices
- reducing electricity consumption.

According to the producers' association, since 1950 specific electricity consumption has been reduced by almost 30%. However, according to information from the University of Aachen (RWTH Aachen), there still remains a potential for further optimisation, which can lead to a specific possible value of 12.9 MWh/t aluminium for the electrolysis. There was a voluntary commitment by the German non-ferrous metals industry to reduce specific energy consumption by 22% until 2005 compared to 1990. Furthermore, the German aluminium industry signed an agreement with the federal ministry for environment to reduce emissions of perfluorinated hydrocarbons by at least 50% until 2005 ocmpared to 1997.

However, in public debate in Germany, the main focus has been always on state-induced increases in electricity costs that would affect competitiveness of the German aluminium industry. There was the argument by the aluminium industry, that plants like one which was closed in Stade near Hamburg would have to close because of the burden put on the electricity price by the state. However, the fact that there was an offer by another aluminium company to buy the plant in Stade showed that the electricity price and the state-induced surcharges on it, which only partly have to be paid by the aluminium industry, could not be the most important reason for closing the plant. Furthermore, since the aluminium plants were provided with electricity also during every audit and refurbishment of the nuclear power plant in Stade without any problems, the closure of the nuclear power plant (due to economic reasons) cannot be an argument for closing the aluminium plant (DIW/bei/WI/IAT 2004).

Nevertheless, it has to be stated, that – ceteris paribus - due to the high share of energy costs in total costs, any increase in electricity price for the aluminium industry, e.g. caused by climate protection policies and measures, might affect competitiveness of the aluminium industry. How far this will be the case depends, among others, on how far such policies and measures are implemented globally, or how far their impacts on competition are mitigated or fully reduced by border-tax adjustments or similar regulation.

4.2.3 Transport sector

Employment in German transport sector has increased in most of the sectors. While in all other sectors, CO_2 emissions were reduced between 1990 and 2000, CO_2 emissions in the transport sector increased by 14%. In 2000, 28% of total CO_2 emissions in Germany were related to the transport sector, of which 84% were related to road traffic. However, since 1999, the emissions from the transport sector have decreased, which is due to the ecological tax reform (additional green tax on fuels and electricity), promotion of research and development of alternative fuels and drive technology, promotion of public transport, and implementation of a motorway charge on HGVs.

Table 22: Employment in the German transport sector

	2000	2001	2002	2003	2004
Land	607,959	677,942	698,155	642,998	656,594
Water	20,026	26,258	28,777	26,123	26,679
Air	37,578	40,958	46,960	51,472	53,005
Road cargo	503,420	463,476	n.a.	n.a.	n.a.

Source: German Statistical Office

Table 23: CO_2 emissions in 2004, fuel and electricity use in the transport sector in 2005

Emissions fuel combustion	**Gg**	**171,185.86**

Electricity	**PJ**	**58**

Black coal	PJ	0
Petroleum	PJ	2487
Other mineral oils	PJ	0
Gas	PJ	3
Others	PJ	80
Total fuel use	**PJ**	**2570**

Source: UNFCCC, AG Energiebilanzen

The possible impact of increased use of hydrogen on economy and employment have been already discussed in the chapter on the energy sector. Besides different possibilities to increase efficiency of vehicles already today, fuel cell driven cars might play a siginificant role in the long term, and are predicted to have a major market share already before a hydrogen economy is established. “Thus flexibility of design with the option to use natural gas as a transition fuel will be crucial in the development path of fuel cells for transportation” (EurEnDel 2004, 20). However employment impacts of a possible switch to fuel cells can hardly be estimated yet, as well as for other new fuels like advanced biofuels or natural gas, or for new highly efficient engines.

Employment impacts of changes in the modal split, and in spatial planning and further measures influencing the demand for transport technology and services might be quite substantial. If framework conditions and price ratios between the different means of transport change due to general economic development and/or climate change mitigation policies and measures, this directly affects competitiveness of the respective means of transport, and therefore employment. This is probably the most important employment effect to be considered in the transport sector.

An effect that is already measurable today is the impact of the emissions trading scheme on the electric rail traffic. According to a position paper by the largest German railway company Deutsche Bahn AG (2006), total taxes and other surcharges on energy to be paid by Deutsche Bahn AG amounted to about 380 million Euro in 2005. The company has already taken efforts to reduce specific energy consumption and, according to its position paper, decreased specific CO_2 emissions by 25% between 1990 and 2002, and by further 5.5% until 2005 as part of its climate protection programme 2020. However, in its position paper, the Deutsche Bahn AG sees the energy taxation, and particularly the electricity taxation, as a clear disadvantage compared to other transport modes. While air and domestic water transport do not have to pay energy taxes, and while road and air transport are not included in the emissions trading scheme, the electric rail traffic is affected by both. This would influence competitiveness, and thus employment.

Another part of the transport sector that might be affected by mitigation policies and measures in the future is the aviation industry. The aviation industry expects net negative impacts of possible future mitigation policies and measures on their business which might affect employment. On the one hand, mitigation policies and measures have already induced companies like FRAPORT to increase efficiency and reduce emissions in several fields (e. g., by energy management, improved modal split of passengers and employees, optimised air traffic, more efficient planes, vehicles and machinery). On the other hand, policies and measures like the inclusion of the aviation industry into emissions trading or a kerosene tax would increase costs, would affect competitiveness and therefore employment. However, studies estimating the possible employment effects have not been carried out yet. Furthermore, other factors like the influence by financial markets might have a substantially higher impact on employment than climate change mitigation policies and measures.

4.2.4 Building sector

Employment in German construction material sector and handcraft sector has decreased due to general economic development.

Table 24: Employment in the German building materials and handcraft sector

	2000	2001	2002	2003	2004
Manufacture of other non metallic mineral products (bulding materials)	248,079	233,709	220,799	211,921	205,401
Handcraft	5,899,000	5,307,000	n.a.	n.a.	n.a.

Source: German Statistical Office, website Zentralverband des Handwerks: Data downloaded at 31.10.2006

The possible impact of additional energy efficiency measures in existing buildings and new energy-efficient building technologies have been already discussed in the chapter on the energy sector.

Against the tendency described above, producers delivering building materials for energy-efficient construction and refurbishment (e. g., insulation materials) will particularly benefit from additional policies and measures in this field further strengthening energy efficiency of buildings.

5 Social transition

The structural change towards low-carbon technologies causes winners and loosers, with respective employment impacts. Therefore, as other structural transition, this process has to be carefully designed and accompanied by additional measures like social dialogue, information, motivation, education and training. However, information and dialogue on climate protection activities should not be separated from normal business matters, but instead closely linked to them. Otherwise, facing the complex information available, employers and employees will hardly be able to follow them.

Stakeholder dialogues initiated by German ministries, the German sustainability council and other important committees and working groups on the federal level, which discuss mitigation policies and measures, always involve, among others, employers' organisations and trade unions. Furthermore, there are some direct dialogues between employers' organisations and trade unions on the national, regional or sectoral level are. The following examples were identified in the course of this project:

- The employers' confederation BDI and the German trade union confederation DGB (2006) recently issued a common statement on energy policy.
- In 1999, DGB initiated an alliance for employment and environment, which was later integrated into a general alliance for employment. It has focused particularly on energy-efficient building refurbishment and export of renewables.
- In the horticulture sector, a general agreement ("Eckpunktevereinbarung") exists between employers and the trade union IG BAU, which aims at securing employment in times of increasing energy costs by fostering energy cost saving measures.
- There is an agreement on sustainability aspects of cement industry between employers and trade unions.

The representatives of the German trade union confederation DGB and of the trade union IG Metall emphasized the importance of participating and motivating employees in sustainability discussions. In addition, the DGB representative suggested to use the revision of the law on the constitution of Works Council Constitution Law (Betriebsverfassungsgesetz) to implement new rights for the employees in this context. This would be needed in order to take advantage of the innovative potential and knowledge of the employees. The representatives by the trade union IG BCE added, that works councils have made several emission reducing suggestions in the past due to their off-site communication with colleagues from other firms and branches (e.g., on thermal use of waste).

Several interviewees from different companies in different sectors reported about information, education and training of employees with regard to climate change mitigation policies and measures, and how they affect the company's business.

For the "winner branches" of climate mitigation policies and measures, exchange of experience, preparation for future developments, education and training becomes more and more important. Furthermore, there is a general risk – not only in the area of climate mitigation policies and measures, but also in other businesses like in the ICT sector - that jobs for newly developed services and products in new companies will be lower paid, and working conditions will be less secured than in established branches. This is, e. g., valid in some renewable energy companies (cf., e.g., Grundmann 2005 for the wind industry) or energy service companies. Therefore, as two of the interviewees from trade unions argued, it would not only be important to increasingly use domestic sources like renewable energies and energy efficiency to secure or even increase the number of jobs, but to look on the qualitative aspects (characteristics) of these jobs, too.

In "looser branches" like the fossil energy business, framework conditions and impulses have to be set in order to make a socially acceptable development of these markets in transition possible. For example, initiatives to strengthen decentralised technologies and energy services / energy efficiency services should be taken, the representative from the trade union ver.di demanded. In the nuclear industry, due to the nuclear phase-out, decommissioning plans are plans for the medium-term and the long-term. Therefore, an anticipatory, preventative regional and industrial policy (economic policy) for securing employment and creating new jobs would be possible (cf. Appendix 2 for more details).

Education and training is always of high importance for the future competitiveness of German companies, interviewees from trade unions emphasized. However, the interviewee of the Federal organisation representing craftsmen in Germany (ZDH) argued that qualification measures should not ask too much from the usually small companies. Furthermore, it should be noted that education and training of employees in „looser branches", so that they will receive the competences needed for jobs in „winner branches", is not always easy. For example, it is difficult for a person having worked in a nuclear power station for many years to become a worker in a fossil plower plant, as well as to switch from being a locksmith in a fossil fuel plant to an energy service supplier giving advice or carrying out energy audits in households (both examples given by the representative of the trade union ver.di).

A study by Schleich et al. (2006) concentrating on energy-intensive industry comes to the conclusion that climate change mitigation policies and measures like, e. g., a CO_2-tax increasing from 5 Euro in 2005 to 20 Euro per t CO_2 in 2010, and then remaining at this level (the Kyoto regime is assumed to lead to similar developments), will lead to a shift towards jobs with higher (master degree) education and medium (bachelor degree and foremen/technicians) education requirements, but will have no noticeable effect on jobs with the lowest qualification requirements. Furthermore, differences in the effects on job characteristics and working conditions would be barely noticeable.

Against this background, trade unions should closely accompany this process of structural change due to climate mitigation policies and measures, thereby balancing the different sustainability dimensions, particularly employment and environment. Furthermore, stakeholders interviewed demand to intensify exchange on experiences and know how on impacts of climate mitigation policy on economic activitiy and employment among the trade unions at the European level in a cross-country and cross-sectional learning process. Within such a European learning process, the discussion should increasingly focus on the net impact of the whole climate mitigation policy mix (including the framework conditions), on its chances and risks, and on its links to other policy fields on employment, instead of just discussing only the impacts of single policy instruments.

6 Conclusions

Climate protection and employment is a central topic in the context of ecology and e-conomy.

The results indicate that, in total, strengthened climate mitigation policies and measures can lead to overall positive net economic and employment effects in Germany. In some branches or sectors like, e. g., building construction and refurbishment or electrical equipment and machinery, the positive net impacts are quite substantial.

However, policy instruments like emissions trading can lead to reduced economic activity and employment in some other branches where industrial process-related emissions can hardly be further reduced, and companies are subject to global competition. In general, policy instruments and their interaction within the policy-mix have to be carefully designed in order to avoid or mitigate such unwanted negative side-effects in some areas, and to take full advantage of the economic and employment chances incorporated in the structural change towards a low-carbon economy. In particular, it should be considered to revise the policy-mix for those industrial processes in which energy(combustion process)-related emissions build only a (small) part of total emissions.

The process of discussing, designing and evaluation the climate change mitigation policy-mix has to be carefully accompanied by exchange of experience of policy makers and further stakeholders on national and European level, social dialogue and thorough analysis in order to create trust in the possible net benefit of climate protection activities, and to take advantage of the possible employment benefits of low-carbon technology innovation. Furthermore, efforts to achieve further global agreements on additional climate protection activities have to be strengthened. In all discussions and political and legislative procedures, the political fields, in which CO_2 reduction matters, should be linked in a transparent way. This study aims at contributing to this discussion, particularly among European trade union associations and other European stakeholders.

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Appendix

Appendix 1: Overview on contacted stakeholders and interviewees

Table 25: Overview on contacted companies, organisations and public authorities in Germany

Stakeholder group / Sector / Branch	Number of companies/ organisations/ authorities contacted	Number of Interviews conducted	Number of written replys	Negative answers / rejection	Reasons for rejection*
Public Authorities	4	3	0	1	(c) (d)
Trade Unions	5	5	0	0	-
Employers' Organisations	3	1	0	2	(c) (g)
Environmental NGO	1	1	0	0	-
Steel and Aluminium Companies	3	1	0	2	(a) (d)
Cement / Building Materials	4	3	0	1	(a)
Electric Equipment	2	1	0	1	(e)
Building, construction & Refurbishment	3	2	0	1	(g)
Power, Gas	3	2	0	1	(a)
Oil, Gas	3	1	1	1	(a)
Transport	2	2	0	0	-
Others	several companies and associations were contacted via an employers organisation	0	1	0	-
TOTAL	**> 33**	**22**	**2**	**10**	

* Reasons for rejection:
(a) No interest to take part in study
(b) No reply at all
(c) Not responsible for topic
(d) No time for interview/response
(e) No reply after email/phone contact
(f) Company too small
(g) Cannot answer the questionnaire

As it can be seen from the following table, some of the interviewees preferred to remain anonymous.

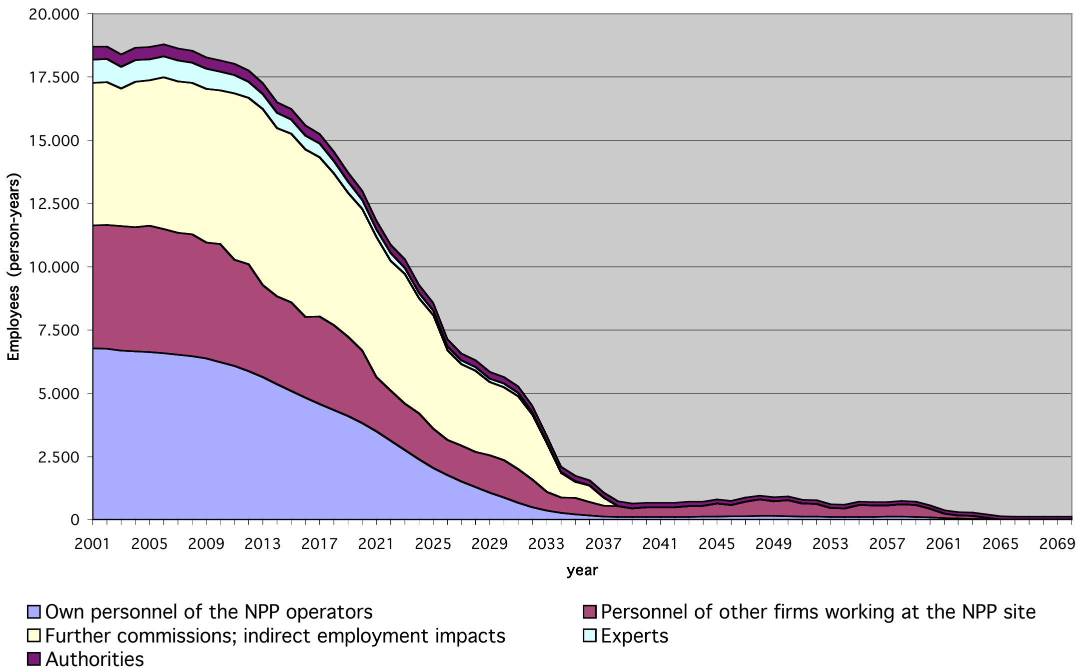
Table 26: List of persons interviewed or having answered the questionnaire in writing

Stakeholder group	Institution	Name of interviewee	Date
Public Authorities	BMWI	Dr. Erich Wallenwein	16 Aug 2006
	BMU	Kai Schlegelmilch	30 Jun 2006
	Stadt Freiburg (via Deutscher Städtetag)	Dr. Dieter Wörner	1 Sep 2006
Trade Unions	DGB	Dr. Horst Heuter	29 Jun 2006
	IG BCE	Roland Gimpel, Dr. Ralf Bartels	11 Oct 2006
	IG BAU	Dr. Sabine Graf	6 Oct 2006
	IG Metall	Angelika Thomas	15 Sep 2006
	Ver.di	Dr. Reinhard Klopfleisch	30 Jun 2006
Employers' Organisations	BDI	Dr. Joachim Hein	20 Oct 2006
Environmental NGO	BUND	Daniel Unsöld	17 Aug 2006
Steel / Aluminium Company	WV Stahl	Roderik Hömann	29 Aug 2006
Cement, Building materials compa-nies	VDZ	Dr. Volker Hoenig	22 Aug 2006
	Heidelberg Cement	Rob van der Meer	23 Aug 2006
	Kalkwerke Oetelshofen	Moritz Iseke	22 Aug 2006
Electric Equipment	Siemens	Dr. Ferdinand Quella	29 Aug 2006
Building construc-tion and refurbish-ment	ZDH	Dr. Peter Weiss	11 Oct 2006
	Universität Göttingen	Dr. Ullrich Komhardt	11 Oct 2006
Power, Gas	E.ON Energie	Stefan Ulreich, Stefan Bockamp	25 Sep 2006
	RWE	Joachim Löchte, Alexander Nolden	30 Aug 2006
Oil, Gas	Anonymous		29 Sep 2006
	Shell	Jörg Adolf	4 Aug 2006
Transport	Anonymous		30 Aug 2006
	Fraport	Dr. Peter Marx	15 Sep 2006
Others	Volkswagen	Daniel-Sascha Roth	4 Sep 2006

Appendix 2: Expected development of employment in the nuclear industry

Figure 1 shows the overall results for the development of jobs in the context of de-commissioning of the 19 NPPs in Germany, which were in operation in the year 2001, plus the NPPs at Würgassen and Mülheim-Kärlich (own personnel of the NPP operators, personnel of other firms, indirect employment effects). In total, there were about 23,250 to 30,000 person-years of work secured by nuclear activities in Germany in the year 2001, of which about 19,000 were within the field of operation and decommissioning of these 21 NPPs (Figure 1).

Figure 2: Rough estimate of the development of jobs in the context of decommissioning of those 19 NPPs in Germany, which were in operation in the year 2001, plus the NPPs at Würgassen and Mülheim-Kärlich (own personnel of the NPP operators, personnel of other firms, indirect employment effects) (direct dismantling assumed):



Source: Irrek 2005

The successive decommissioning according to the agreed nuclear phase-out, which secures the operation of the plants more or less until the end of their technical-economic lifetime, will reduce the number of jobs in these 21 NPPs to less than 1,000 person-years from about the year 2040 onwards. Depending on the decommissioning concept chosen (direct dismantling or temporary safe enclosure), between 2,200 and about 7,000 of the about 19,000 employees, who were working in these 21 NPPs in the year 2001, will be in danger to loose their job before retirement. On the other hand, about 450 skilled persons have to be hired in the course of the next decades to replace employees going into retirement, if an age at entry into retirement of 63 years for women and 65 years for men is assumed.

How could the different stakeholders contribute to securing employment and creating new jobs at the different NPP sites in Germany?

The Federal Government and the operators of the nuclear power plants are particular responsible for those and other employees working at the plants (employees of the operators, but also employees of contractors, suppliers, etc.) and for the economic development of the regions, in which the plants are sited. In chapter 6 of the agreement between the German Federal Government and the biggest electric industry players of 14 June 2000 on a nuclear phase-out, both parties agreed to secure employment in Germany as much as possible by investments in new power generation capacities and in energy services.

Together with the Länder (states), the Federal Government has to secure stable framework conditions for the choice of the decommissioning concept by the NPP operators and for new investments in energy efficiency and new generation capacities. The nuclear phase-out will only become reality, if the generation capacity lost will be compensated by a strong increase in energy-efficiency and investments in CHP, renewable energies and innovative fossil technologies. Furthermore, the Federal Government's labour market policy has to secure a socially acceptable reduction in employed and contracted staff at the NPP sites. In particular, the Federal Government, but also the Länder, together with the regional employment agency (labour administration) should develop regional concepts for securing employment right in advance of a planned decommissioning.

Also the NPP operators have a specific responsibility regarding the employment situation at the NPP sites. Decommissioning concepts should be designed in such a way, that measures to reduce staff are minimised and a socially acceptable reduction in staff in co-operation with the employees' representatives can be stipulated. Furthermore, the NPP operators should contribute to initiiatives and measures aiming at securing employment and creating new jobs in the regions, where the NPPs are sited. Finally, while developing from a supplier of energy carriers to an energy service company, offering the customer best available solutions to its energy service needs, the energy companies should consider alternative business possibilites at the NPP sites in co-operation with the works councils and accompanied by human resources development measures.

Further options to act are open to contractors and suppliers involved in the nuclear business, workers' councils and trade unions, local authorities, other local companies, employees' and employers' associations and employment agencies (labour administrations) in the respective regions.

In the regions where the NPPs are sited, the nuclear phase-out can only be organised without considerable job losses, if all these organisations and the NPP operators, initiated by the Federal Government, bind themselves to closely work together in order to

- provide for the shut-down and the decommissioning of the respective plant with regard to financial and labour aspects,

- avoid the danger of considerable job losses by a concerted action initiated by the regional employment agency, if existing labour market instruments cannot be applied effectively anymore,
- create new possibilities for jobs, education and training on the base of a regional economic development concept including a regional energy policy concept and respective measures.

Appendix 3: Expected employment impacts of a possible EnergySaving-Fund in Germany

Energy policy faces great challenges: energy prices are driving upwards, the reliable supply of energy causes problems and many types of the current energy production contribute to climate change. Renewable energies can be a loophole. What is left aside time and again are the **huge potentials of an efficient energy use**, which can be tapped fast and at low costs:

- Today, the most efficient cooling and freezing devices only use one third of energy as devices used ten years ago.
- Without large extra costs, “low-energy houses” only require 20% of the heating energy of a new traditional building, due to a better insulation and an efficient ventilation and heating system.
- Efficient circulation pumps in heating systems, together with an optimised heating circuit, can save up to 90% of electricity and additionally heat

If efforts to fully use the existing potentials by an **EnergySavingFund** started in 2006, more than **10%** of today’s end-use energy consumption (75 billions kWh electricity and 102 billions kWh heat) and respective energy costs amounting to 73.3 billion Euro could be saved until 2015, thus realising a **profit** for consumers in private households, public administrations, industry and commerce (36.6 billion Euro until 2015) and the national economy. This is a result of a study by the Wuppertal Institute and its partners, financed by Hans Boeckler Foundation, Germany (Irrek/Thomas/et al. 2006; cf. also http://www.wupperinst.org/Projekte/fg2/3216.html).

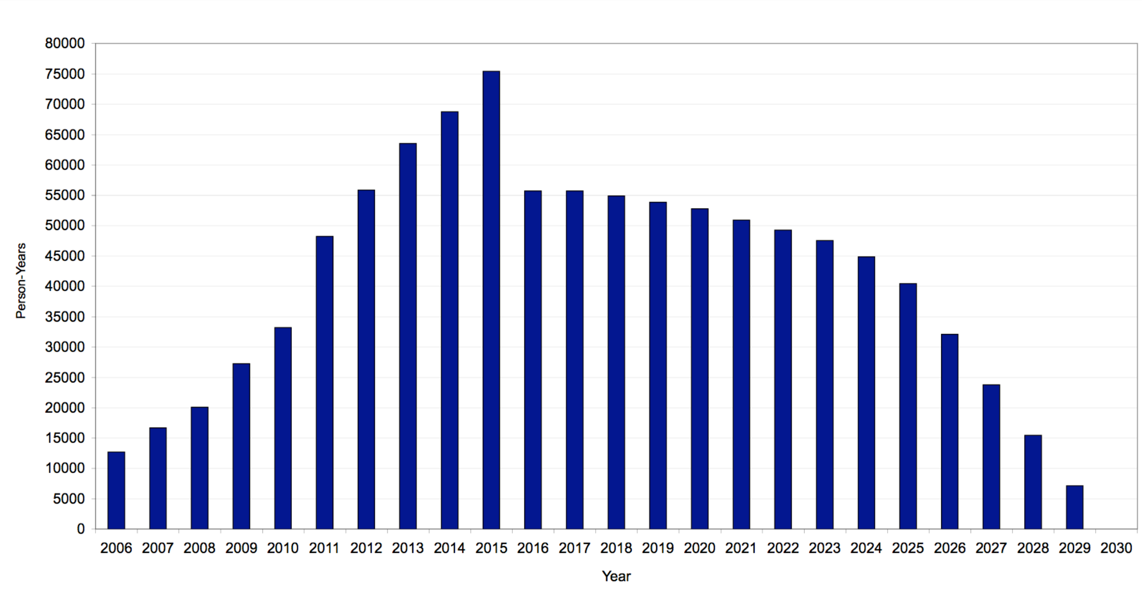
Beyond these pure cost effects, there are further positive effects: increasing investments in efficient technology will provide new jobs, the problems of a reliable energy supply can be reduced and climate protection will benefit as well. This is a classic **win-win-win** situation.

Altogether, the programmes of the EnergySavingFund have a **positive net impact on employment amounting to about 1 Mio person-years until 2030**, with a maximum of **75,000 person-years in 2015**. Thus, these programmes will be able to safeguard or newly create tenthousands of full-time jobs.

Even after expiry of the proposed programmes of the EnergySavingFund, the development of net employment will remain positive in every year of the period under consideration until 2030. The basic reason is that the **import of fossil energy can be significantly reduced** when energy is saved.

On average, **each saved Petajoule (PJ) of end-use energy provides additional new jobs amountig to about 103 person-years**. Sectors such as handcraft or engineering will directly profit from energy savings. Furthermore, reduced energy costs for consumers and industry will stimulate the general consumption, thus having impacts on the job market, especially in the retail industry as well as in the hotel and catering industry.

Figure 3: Development of the net employment impact in sum of all 12 efficiency programms of the EnergySavingFund proposed by Wuppertal Institute and its partners [in person-years]



Source: Irrek/Thomas/et al. 2006