Skills for green jobs

Country report Germany

by

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Munich, 12 February 2010

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ABSTRACT

The report 'Skills for Green Jobs' aims to illustrate how greening of the economy in the course of environmental protection influenced the establishment of green skills and green jobs in Germany. Environmental protection has been on the centre of public debates since decades and legislation and increments of awareness have influenced the restructuring of economic sectors and occupational competences. The following report gives an overview about the development of greening, its influence on the labour market and creation of green jobs in Germany. The German response on greening, with main focus on the skills response is illustrated and assessed. As major methodology desk research, interviews and eight case studies are used. The case studies give a practical insight in the greening process of existing occupations and the establishment of new occupations. The skills response on greening followed an integrative approach rather than specialising. For the future development a further integration for non-environmental occupations needs to be pursued and a higher occupational specialisation for the environmental sector.

EXECUTIVE SUMMARY

Environmental policies
The ecological commitment of German public authorities is fixed in the "Integrated Energy and Climate Programme' (IEKP) which was published by the Federal Government in 2007. The present conservative-liberal government confirmed the principles of this programme which formulates ambitious goals:

- 40 % reduction of greenhouse emissions by 2020 compared to 1990
- Annual growth of energy efficiency by 3 %
- Expansion of renewable energy to 18 % of the overall energy supply by 2020, and 50 % by 2050
- Increase of combined heat and power generation power to a share of 25 % by 2020

The recent economic stimulus package by the Federal Government includes a proportion of 13 % of total expenditures which is addressed to green investments.

Job creation
From the beginning of the public debate, environmental protection has not only been perceived as a step towards better living conditions. The market opportunities opened by environmental technologies and services have played an important role in policy decisions. Environmental policies have thus been used to create new jobs and support economic growth.

This expectation seems to have been fulfilled: 1.8 million people were working in the German environmental sector in 2006. This was 4.5 % of the labour force. Since 2004 the number of employees has increased by 290,000, a rise of around 20 % within two years. 64 % of the workers in the environmental sector are engaged in the operation and support of environmental protection facilities, 13 % in renewable energy, 10 % in the production of environmental investment goods, and a further 10 % in the production of materials.

In recent years jobs have particularly been created in renewable energy production and storage. Employment rose to between 15 % and 36 % between 2005 and 2007, mainly in geothermal energy production and solar energy. The highest growth rates were in companies with 10 to 50 employees.

Public environmental programmes are expected to create 500,000 additional jobs by 2020 and 800,000 by 2030. Renewable energy will be particularly important in this context. The environmental technology sector appears to be one of the major job machines in Germany.

With the decision to phase out nuclear energy plants and to reduce the share of coal power stations in favour of renewable energy, the energy sector will experience a major restructuring of jobs. Moreover, subsidies for coal mining will be terminated by 2018 which will cut most of the present 52,000 jobs in that sector. Renewable energy however is also entering a phase of restructuring which will be caused by the cut of subsidies. This can be expected to cause manufacturing jobs to relocate to other countries and favour research and development, operational engineering, marketing and value chain management in this business.

Skills response
The principal skills response to the rising demand for ecological competences followed an integrative approach rather than creating specialised ecological occupations. Many occupations and training curricula were adjusted and amended to the skill needs of the green and the greening industries. This approach can be attributed to the long tradition of dual training in Germany which provides the majority of the skilled workers at the intermediary level. Employers have a strong

influence on the structure and content of dual training and thus could easily integrate ecologically oriented training. Case Study 2 on Chemical Technicians e.g. exemplifies how the chemical industry integrated environmental protection into training. Case study 7 - Plant Mechanics for Sanitary, Heating and Air Conditioning - describes how an existing dual training course was adapted to the ecological needs and technologies.

This coincided with the expansion of continuing vocational training that amended competences and knowledge of the workforce with ecological aspects. Chambers and private suppliers are active in this field, and green companies initiated continuing training for their employees. In particular big companies like Siemens and BMW, and employers associations (e.g. the Federal Association of Wind Energy) established special courses to meet skill needs. Case study 1 on Motor Vehicle Mechatronics Technicians shows how BMW has adjusted the training of technicians to suit hybrid motor systems. Case study 5 offers an example of how Siemens Wind Power established a training centre for further training on wind turbines for their personnel and subcontractors. Case study 8 on Energy Consultants with a focus on energy passes captures the need for continuing vocational training in the course of new legislation.

Specialised ecological occupations have also been created. Four environmental technical trades are offered by the dual vocational training system:

- Recycling and Waste Management Technician (Fachkraft für Kreislauf- und Abfallwirtschaft; Case study 6)
- Water Supply Engineering Technician (Fachkraft für Wasserversorgungstechnik)
- Sewage Engineering Technician (Fachkraft für Abwassertechnik)
- Pipe, Sewer and Industrial Service Technician (Fachkraft für Rohr-, Kanal- und Industrieservice)

The number of apprentices in these trades increased to 2,500 by 2008.

At university level, 80 courses were offered in 2004 which mainly focus on the environment. Meanwhile the number has increased to around 100. The majority of these courses are in the area of engineering. 14,000 students were enrolled in 2009. Case study 3 on the bachelor study in engineering solar techniques – which has been initiated by Q-Cells and the Fraunhofer Institut – describes the emergence of a new course of study for a rapidly growing sector. Case study 4 describes the study course Green Business Management which focuses on a combination of environmentalism and management.

During the last upswing, skills shortages in engineering and technical occupations appeared. Green companies were in strong competition with other manufacturing sectors. At the moment the situation is much less tense but the awareness of skills shortages in green jobs is still high.

Conclusions and recommendations

The study suggests promoting the professionalisation of green competences in two ways:

- A higher level of occupational specialisation will be needed to improve competitiveness of producers of environmental goods and services. The supply of professionals will be pivotal to success.
- A higher degree of knowledge integration of green competences will be needed for the application of green technologies and the implementation of higher environmental standards in many non-environmental occupations. This is required to achieve the ambitious protective goals of the German environmental policy.

Moreover, a publicly financed life-long learning system is needed which provides the skills demanded by labour markets rather than workplaces. Germany has long since been reluctant to develop such a life-long learning system. The decreasing skills supply from the initial training – caused by demographic changes – points to a necessity to engage in this segment with greater emphasis.

Skills shortages can also be addressed to the lack of social partnerships in the green industries. Social partners play an important role in the formation of training courses, both in dual training and university training. Moreover, adequate representation of workers by trade unions could help to improve working conditions and social dialogue.

Skills shortages should also be prevented by the integration of youth with migration background and the reduction of school-drop-outs by adequate education and training measures. Pilot projects should contribute to the development of new approaches. The further integration of green competences should be promoted by the expansion of continuing vocational training.

Future research needs are identified in the area of employment and skills. Environmental research has focussed on natural science and technology for too long. The human capital aspect thus appears to be strongly underdeveloped. This applies to the quantification of green jobs as well as to the measurement of green skills and competences. Similarly, the job creation effects of environmental expenditures are not fully analysed. In particular, the net effects of green investments are not adequately measured.

1 INTRODUCTION

Objectives of the project

This country report presents an overview of the skills response in Germany to the greening of the economy. It first describes the policy context (Chapter 2.1) and goal settings regarding the mitigation of greenhouse emissions, and the most important measures to support the development of an environmentally sustainable economy (Chapter 2.2). Secondly, it presents the adaptations and changes of the education and training systems, which have in many ways responded to the increased demand for skilled workers from the environmental sector (Chapter 2.3). Moreover, the restructuring of economic sectors and the skill anticipation in the course of greening the economy are illustrated in Chapter 3. Conclusions (Chapter 4) and recommendations for further policy responses and for further research are provided in Chapter 5. The report is enriched with eight cases studies illustrating practical examples for new occupations, the greening of existing occupations and the retraining of declining occupations.

Main aspects of investigation

Climate change and environmental protection are at the centre of contemporary policy debates. The European Union has already determined ambitious goals for greenhouse emission reductions. In Germany the awareness for environmental protection has likewise influenced the political processes in a meaningful manner. Regulations and legal acts have been implemented that support the mitigation of emissions. Moreover, the integration of environmental protection in the education and training system has been pursued for more than two decades and thus plays a crucial role in occupational development.

From the beginning of the public debate, environmental protection has not only been perceived as a step towards better living conditions. The market opportunities opened by environmental technologies and services have played an important role in policy decisions. Environmental policies have thus been used to create new jobs and support economic growth. This expectation seems to have been fulfilled. The sector for environmental technologies and renewable energy emerged as an internationally competitive growth market stimulating exports and employment. This was not possible without well qualified staff. The greening of the economy has thus been associated with significant impacts on occupational profiles and formal vocational training in Germany. New occupations have been created and existing occupations have incorporated new environmental skills and know-how.

Skill needs in the environmental sector have mainly been covered by the creation of formal training courses within the German system of dual training and university training. This complies with a long tradition of German industries which organise training with the tripartite system of dual training rather than company-based continuing training. The report therefore focuses on this type of environmental training and takes the majority of cases from this area. This may be a deviation from the original study design, but has to be attributed to the particular character of vocational training in Germany.

An important finding of the study is that the majority of workers have been adapted to the process of a greening economy. New occupations have emerged however their relevance is still small compared to the great number of occupations which have been adjusted.

Method

The study used desk research, interviews and case studies as its major methodology. All results are based on published literature or expert opinions. Eight case studies were conducted in different areas of environmental training. The draft of the final report was discussed in detail with five

representatives of research institutes and public administration. All interviewees are named in list of key resource persons in the annex.

Key sources:

- Facts regarding policy making were primarily collected from the Ministry for Environmental Protection, Nature Conservation and Nuclear Safety (BMU) which is the main authority for policy making regarding climate protection in Germany. The report 'GreenTech made in Germany 2.0' offers a useful study on environmental technologies.
- A good overview of the integration of environmental aspects in the education and training system is provided in a study from the GTZ, 'Environmental education for a sustainable development in the initial and continuing vocational training system, environmental protection in the education and training system' from the year 2004.
- The Federal Institute for Vocational Education and Training (BIBB) offers training profiles for apprenticeship training programmes and is complemented with extensive information about occupation profiles from the Federal Labour Agency's national occupation catalogue BERUFENET.
- The number of workers in the environmental sector was estimated in a study by the German Institute for Economic Research (DIW), 'Employment effects due to environmental protection in Germany' conducted in the year 2009.

Feedback on the draft final report was collected from experts from different institutions in order to include opinions from various viewpoints. Institutions included were the BMU, the BIBB, the Association of German Chambers of Industry and Commerce (DIHK), the Foundation of Labour and Environment and the Institute for Environmental Protection in Education (IBU). Thus, opinions from policy makers as well as from union trades and experts regarding the educational system could be collected. The results of these feedback interviews were incorporated in the report.

The information for the case studies was collected via research and interviews with companies or associations from different sectors. For the selection of case studies a balance between occupations from dual vocational training, continuing vocational training and university courses was executed. Moreover, company initiated training responses could be included in the selection.

A supply-side approach

The aim of the study is to reveal the skills response to greening the economy. As indicated above, the main focus is on the supply-side represented by the education and training system as the demand-side represented by companies is strongly involved in the formation of vocational training. The main causes are:

- As companies approached environmental markets decades ago, the phase of selected company initiatives has passed. Current initiatives at a company level are rather small compared to changes in the education and training system, and are often provided for a flexible adaptation of employees' qualifications at a certain time.
- The education and training systems started to incorporate the rising demand for green skills at an early stage of greening. Currently a well developed list of occupations exists which represents good parts of green skills in Germany.
- German companies have been involved in the adaptation of the education and training system and are using the available supply of skills.
- The structure of research proposal relied on the idea of a mainly demand-side driven adaptation of training. This, however, hardly applies to the German VET system and required some alterations of the report structure.
- Companies' initiatives regarding training or skills anticipation are marginal. Training centres for in-company training or the integration of green modules are supplementary to formal training programmes. Thus, the selection of suitable case studies which were demand-side

driven was difficult. Nevertheless, three skills responses in the case studies were initiated by companies.

Re-skilling of jobs

The study is supposed to identify occupations that became obsolete in the course of greening. The disappearance of occupations or occupation profiles could, however, hardly be found. This mainly owes to the education system which trains apprentices and students for flexible employment in the labour market. The dual vocational system focuses on the transfer of basic knowledge rather than workplace specific competences. Specialisation is provided during the last part of training or as continuing training. Major parts of university studies also impart a basic education, for example in engineering, natural sciences or economics, and give the students the opportunity to focus on different areas. The majority of vocational training at intermediary and university level incorporates environmental aspects as far as is needed.

Thus, an occupation which became obsolete due to environmental protection does not exist. For the appropriate case studies in this area we therefore chose cases with retraining needs due to the restructuring of the corresponding sector: the automobile industry which focuses on modern propulsion techniques and the chemical industry which has adjusted all their working processes to an environmentally friendly and energy efficient approach.

2 POLICY CONTEXT

Policy making in the course of environmental protection has been significantly affected by the foundation of the Green Party in 1980. Coming from grassroot level it has represented the ideas of ecological sustainability, environmental protection, and the stop of nuclear energy production. The party became part of the red/green government from 1998 to 2005 and forced the implementation of various laws regarding ecology and climate protection, in particular, the eco tax, the exit strategy for nuclear energy and the Renewable Energy Law.

2.1 Key challenges and priorities for the green economy

Priorities
German priorities regarding climate protection were determined in the last 10 to 20 years. All in all climate protection already plays a major role in Germany. The main goal is the reduction of greenhouse emissions in order to restrict the climate change. The actual priorities regarding climate protection were repeated in the coalition agreement by the new Federal Government in October 2009. The government adheres to the decline of greenhouse emissions by 40 % by 2020 compared to 1990 in order to limit global warming to two degrees.

Moreover, the coalition agreement outlines the following priorities:

- The energy generation is supposed to be achieved from an energy mix with huge parts of renewable energy. Therefore, the Government favours increasing the promotion and the constant growth of this sector.
- Energy efficiency is supposed to go hand in hand with the restructuring of buildings in an energy efficient manner and with the ecological labelling of products.
- Energy generation from coal with low greenhouse emissions is supported by the construction of modern highly-efficient working power stations and the termination of coal mining subventions.
- On the subject of nuclear energy the coalition agreement does not directly point out the extension of nuclear power stations but by defining nuclear power as 'bridge technology', there is a possible prolonging of the nuclear phase-out.
- Research in energy, storage and mobility will be fostered by a new 'energy research programme'. In the circular economy the avoidance of waste is especially favoured by the government.

All in all, no new strategies or priorities have been pointed out which would lead to a total turnaround of the environmental policy from the last few years. The government is holding more onto the goal settings and acting strategies which were initiated in earlier time periods.

Challenges
Even though there are disagreements in the implementation of environmental protection, the goal setting is clear. A huge decline in greenhouse emissions must be achieved. This means that previous industrial structures have to be rebuilt and ecological change will influence technological innovations and the preliminary lifestyle of people. Growth, wealth, and social progress have to go hand in hand with environmental protection. The policy makers have to set incentives for technological innovations with ambitious standards and limit values. The internalisation of negative externalities and the more efficient use of natural resources are also essential. Therefore, climate protection alone and its successful implementation is the most ambitious challenge worldwide.
At the moment the further success of the development is, however, mainly challenged by the following essentials:

- A worldwide climate treaty is needed to avoid competitiveness disadvantages for local economic sectors. This refers especially to energy-intensive sectors which have already invested a lot of money in energy efficiency like the chemical industry, glass industry, paper industry and steel industry.
- The setting of sustainable incentives within the subsidisation of the renewable energy sector. Especially in terms of subsidised power from renewable energy sources some inefficient regulations have been revealed. According to the current discussion, the subsidy for solar power, for example, leads to an 'over-stimulation' whereas the use of wind power would be more efficient. Therefore, the Federal Government plans to cut the subsidies and to invent a mechanism which reacts flexibly to market developments. Nevertheless, a reduction of subsidisation might restrict growth in this sector. Thus, a trade-off between subsidisation on one hand and job losses on the other hand must be pursued.
- For further growth adequate skilled personnel is needed. Germany suffers from the demographic change which negatively affects the number of young people for vocational education and training. The policy has to step up efforts to integrate young people with migration background and to lower the number of school drop outs to increase the supply of workers not only for the environmental sector but also for the whole economy.

2.2 The response strategy

The following section summarises the general German policy, the goal settings and strategic responses to meet the requirements of increasing the protection of the environment and decreasing greenhouse emissions.

2.2.1 General environmental strategy

The importance of climate protection has increased in recent years and thus has developed as an important module in the German policy. Several measures and instruments have been implemented over the last few years. At the beginning of the 21 century many measures were formulated in the National Climate Protection Programme of 2000 and 2005. The latter focused on measures in transportation and private households. The German climate protection policy has also been influenced by the National Strategy for Sustainability of 2001. Even though there is a wide consensus in Germany about the goals and the need of climate protection and lower emissions, there is a discussion about the implementation.

General goal settings

As part of the Kyoto Protocol, the German Federal Government agreed to reduce greenhouse emissions by 21 % between 2008 and 2012 compared to 1990. In addition to this planned goal, the goal setting has been revised for an even greater emission reduction by 2020. A good overview is given by the 'Integrated Energy and Climate Programme' (IEKP) which was published by the Federal Government in 2007. Moreover, it comprises 14 laws and regulations and seven additional measures which were implemented for the achievement. In particular the ambitious goals are:

- A 40 % reduction of greenhouse emissions by 2020 compared to 1990.
- The productivity growth of energy by 3 % per annum. This means an efficiency which will be twice as high in 2020 compared to 1990
- The constant increase of renewable energy, specifically due to:
    - 18 % and 50 % of the overall energy being renewable energy in 2020 and 2050, respectively.
    - An increase of gross power consumption from 15 % to 30 % and of thermal energy requirement from 7 % to 14 % in 2020.
    - A higher proportion of biofuels to reduce greenhouse emissions by 7 %.
- A rise in CHP contribution (combined heat and power) to generate power to 25 % in 2020.

Policy responses and measures

In order to achieve these goals many measures and laws have been introduced. The most important policy fields in terms of climate protection and the related measures are summarised in the following paragraphs:

Renewable energy

The expansion of renewable energy is successfully developing in Germany. The contribution for the overall energy use has doubled since 2000 and amounted to 9.5 % in 2008.[1] The proportion of the electricity generation added up to 15 % (heat and fuel amounted to 7.5 % and 6 %, respectively). The extension is mostly supported by the Renewable Energy Law (EEG) and the Renewable Energy Heat Law (EEWärmeG). The EEG from 2000 determined a minimum reimbursement and the obligation to deliver energy from renewable sources. Thus, a guarantee for investments in renewable energy was established and this fostered the development of German companies in these markets. The law was revised in January 2009. The updated version emphasises, for example, re-powering older offshore wind stations and promoting improved access to the network grid for electricity which is generated by renewable energy. Correspondent to the Renewable Energy Heat Law, it is required that heat in new buildings has to be partly covered by renewable energy. The use of renewable energy is financially promoted by the Market Incentive Programme (MAP). It supports investments in buildings which contribute a higher use of renewable energy for their heat supply. In general, all installations in both new and existing buildings are fostered. The focus is on heat generating facilities such as solar panel installations or efficient heat pumps for hot water and heating in buildings. The specific measures are investment grants, low interest loans and repayment grants. In 2009, 400 million Euros were provided for this programme.

Biogas and biofuels

Biomass as part of renewable energy reached 6.6 % for overall energy use in 2008. It provides the highest contribution of renewable energy for fuels and heat and ranks second after wind power for electricity generation. The regulation of access to the natural gas network was recently changed to simplify the transport of biogas. Additionally, the extension of biofuels is persecuted by a renewal of the Biofuel Rate Law. Since 2009 the minimum rate of biofuel in petrol and diesel has to sum up to 6.25 %. In this context the Federal Government also approved the National Biomass Action Plan in April 2009. It aims to build up a conceptual approach to increase the contribution of bio energy for energy supply. The plan of action presents measures to raise the biomass production in a sustainable manner. One measure is the promotion of research and development. Therefore, in February 2008, the Federal Government established the German Centre for Biomass Research (DBFZ) which will be extended to a research institution for bio energy.

Energy efficiency

The Federal Government initiated several activities to anchor public awareness for energy efficiency: The German Energy Agency was established which communicates the initiated promotion programmes, technical possibilities and economical opportunities of energy efficiency. The agency, in cooperation with leading companies of the energy sector, founded the EnergyEfficiency Initiative. Promotion programmes include the energy efficient reconstruction programme of the Reconstruction Loan Cooperation (KfW), with a mobilised capital of 1.4 billion Euros per year between 2006 and 2008. Initiatives are given to reconstruct buildings to be more energy efficient. Moreover, due to the IEKP, the construction of combined heat and power (CHP) stations and heat grids is supported by around 750 million Euros per year (Law of Combined Heat and Power). Another promotion programme subsidises mini CHP stations in households depending on the electrical power used and the planned hours of use.

Emission trade

[1] BMU 2009: Renewable Energy in Figures, 2009.

In 2005 the emission trade for the reduction of greenhouse emissions started in order to raise incentives to increase energy efficiency and to decrease energy consumption. It can be seen as a market-based instrument of the climate protection policy, which aims to initialise the negative externalities of environmental pollution. Moreover, the emission trade supports the extension of energy efficient production and energy use as companies can sell their certificates if they emit a lower amount of greenhouse emissions. In the beginning the certificates were distributed for free, but since 2008 10 % of the certificates were sold at auction. In 2013 all certificates for electricity generation and parts of the certificates for the industrial area will be auctioned. Due to the sale in 2008 the Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) earned 400 million Euros which they used for climate initiatives, 280 million for a national initiative and 120 million for an international initiative. In this context the BMU promotes measures which help increase energy efficiency and the use of renewable energy and supports the protection of biodiversity in developing and emerging countries. To date, the national climate initiative includes six promotion programmes in total.

Sustainable mobility

About a quarter of all greenhouse emissions emerge in the transport sector. Thereof 90 % are induced by traffic.[2] At the beginning of the 90s the regulations for carbon emission limits were implemented and continuously tightened. The two last regulations - Euro 5 and 6 – are valid in 2009 and 2014, respectively. The car tax was revised as carbon dioxide oriented tax in July 2009. Moreover, car labelling has been introduced to identify environmentally sound cars with low carbon emissions. In this context, environmental zones have been established in many German cities and old cars with high emissions are not allowed to pass through these areas. This is supposed to lead to a higher demand for cars with low carbon emissions. Additionally, the Federal Government adopted the 'National Development Plan for Electric Mobility' in August 2009. It promotes the research and development as well as the market preparation for and the introduction of battery powered vehicles. By 2020, one million electric vehicles are supposed to be registered in Germany. The realisation of the plan is suffering at the moment because of a lack of qualified staff in battery technology research and trained technicians. Therefore, the plan includes a provision for 'a training initiative for newly recruited technical and scientific staff'. The Federal Government already promotes research in the area of energy storage, namely the research in lithium ion batteries, but there will be a higher need for qualified persons in the future. [3]

Nuclear energy

All in all 17 nuclear power stations operate in Germany. They contributed to electricity generation by around 28 % in 2009.[4] In 2000, the Federal Government decided to phase out nuclear power stations which are older than 32 years old. Additionally, in 2002 the law 'for the planned phase out of nuclear power for commercial electricity generation' was inured. This means that the generation of nuclear energy in Germany will end in 2022.

It might be possible that the new Federal Government – which was elected in September 2009 – will extend the duration of nuclear power in Germany. Even though this is a step backwards, the opportunity could be used to renew old coal power stations and integrate more combined heat power stations as the energy supply will be partly ensured by nuclear power.

Further responses to greening

Additionally to measures and laws which have already been implemented, the BMU published 'New Thinking – New Energy-Roadmap 2020' in January 2009. This roadmap shows how an integrated energy policy could be organised to ensure the targets of the Federal Government for 2020. Thereby, it focuses on 10 fields of action to guarantee a sustainable energy supply in the future. In this context

[2] BMU 2009: GreenTech made in Germany 2.0, S.174.

[3] http://www.bmbf.de/de/11828.php .

[4] BMU 2009: The World Nuclear Industry Status Report.

it analyses what has already been achieved in these fields and where and to what extent action is needed. One field for example identifies the chance of increased electricity generation by highly efficient power stations in order to decrease greenhouse emissions. Another field of action recognises an underachievement of emission decline in the transport area. Due to the roadmap scenario 20 % of greenhouse emissions from transport can be reduced with more efficient technologies, more electric vehicles and a greater use of environmentally sound public transport.

Markets for environmental technologies are important growth markets. Germany is one of the world leaders in developing and exporting environmental technologies. In a study by Roland Berger[5] it is expected that the German market for environmental technologies will grow from a 4% share of sales in all industrial sectors to 16 % in 2030. Moreover, sales of environmental technologies will exceed those of car manufacturing and mechanical engineering. Therefore, it is crucial that the ecological industrial policy develops business profiles to succeed these growth expectations and to ensure the competitiveness of the German industry. In this context, the BMU published the 'Ecological Industrial Policy: Sustainable Policy for Innovation, Growth and Employment' in October 2008. It presents strategic suggestions for a sustainable national economy.

2.2.2 Green response to the current crisis

The Federal Government introduced two economic stimulus packages: The first in November 2008[6] and the second in January 2009[7]. Altogether, the measures sum up to an amount of around 100 billion Euros.

According to a study by HSBC in 2009 the proportion of the German stimuli packages on green investments were around 13 %. Even though the focus has not been set on green issues, this proportion is higher compared to other EU member states. Additionally, there was no focus on renewable energy. Even so, as a world leader in solar and wind installations, Germany is already well established in these fields.

Both recovery packages set a focus on the promotion of energy efficiency. According to the first package 3 billion Euros are being used to foster energy efficient construction and reconstrucion of buildings between 2009 and 2011. The Reconstruction Loan Cooperation (KfW) offers another 2.5 billion Euros volume of credit within the programme for energy-efficient reconstruction of buildings.

Moreover, a further stimulus of 0.3 billion Euros is used by the KfW bank to supply credits with low interest rates for investments in innovations regarding energy efficient technologies. This promotion programme – special fund for energy efficiency – is addressed to small and medium sized companies. The second package furthermore promotes education, especially in terms of energy efficient research and reconstructing schools and universities with 6.5 billion Euros.

In addition, energy efficiency is promoted by a higher tax deduction for craft services for maintaining and modernising buildings and the tax premium was doubled. This is supposed to stabilise the craft business and to disburden private households.

Both economic stimuli packages focus also on the promotion of low carbon cars. A tax exemption for new cars was introduced for another year. If the cars meet the Euro 5 or Euro 6 standard the exemption can be extended for one year. Furthermore, the car tax was revised as a carbon dioxide oriented tax in July 2009, as already mentioned above. These two regulations increased the demand for new cars with lower carbon emissions.

[5] In this study, Roland Berger Strategy Consultants has interviewed 1,500 companies and 2,500 research institutes from the environmental technology sector. For more details, see BMU 2009, GreenTech 2.0.

[6] http://www.bmwi.de/BMWi/Navigation/Wirtschaft/Konjunktur/konjunkturpaket-1.html.

[7] http://www.bmwi.de/BMWi/Navigation/Wirtschaft/Konjunktur/konjunkturpaket-2.html.

In addition, 5 billion Euros were provided for the 'scrappage' bonus. The purchaser of a new car received 2,500 Euros if he or she deregistered a vehicle which was older than nine years old. The demand for the premium was high and since the beginning of September 2009 the budget is exhausted.

Regarding green investments, another 0.5 billion Euros were spent to foster application-oriented research in the field of mobility (e.g. hybrid motors).

2.3 The skills development strategy in response to greening

The number of people who work in the environmental sector has increased in recent years. To decide exactly how many people work in the area of environmental protection it has to be estimated using scientific studies. Many green goods and services are provided by traditional industrial areas such as machinery and vehicle construction and yet it is hard to define the exact number of workers in the field of environmental protection. Nevertheless, a study by the German Institute for Economic Research (DIW) estimated the amount of employees in the environmental protection sector to be around 1.8 million in 2006. This means a proportion of 4.5 % of the labour force (2004: 3.8 %).

Environmental technologies are expected to rise from 8 % to 14 % of GDP in 2020 due to a study by Roland Berger Strategy Consultants. This will lead to positive employment effects in the following years. Between 2005 and 2007 the personnel of interviewed companies in the environmental technology sector was already growing by 14 % on average.[8] As this sector produces an average of 90 % of its products in Germany, the employment effects are focused on the German labour market. The number of employees in the sector for renewable energy was around 235,000 in 2006 and is expected to grow to 500,000 in 2020 and 710,000 in 2030.[9]

The high growth rates in the sectors of environmentalism result in an increased demand for skilled workers. A response from the Federal Government in order to promote education and training is visible. Some promotion programmes have been initiated and the subject of environmental protection has been included in dual vocational trainings and university studies in recent years.

2.3.1. Policy initiated programmes

In 2006 the Federal Environment Ministry originated the educational initiative 'Environment creates perspectives' in association with companies in the fields of environmental technologies/renewable energy. In this context 6,000 additional apprenticeships were created in 2009. The initiative is supposed to identify the required apprenticeship trades, skills and competences needed in the environmental sector. The Federal Ministry of Education and Research (BMBF), the Federal Institute for Vocational Training (BIBB) and the German Chamber of Commerce (DIHK) are also participating in the initiative. One of the programmes set out by the initiative is the JOBSTARTER programme. It aims to acquire companies which start to train and thus, can offer apprenticeships to young people. Moreover, within regional promotion programmes additional apprenticeships can be provided.

Some areas of environmental techniques, for example waste disposal and management, have image problems. Therefore, in cooperation with the DIHK the BMU has published an information brochure about four trades in this area to improve the image and to motivate young people to start their apprenticeship in this sector.

[8] BMU 2009: GreenTech made in Germany 2.0, S. 20.

[9] Wissenschaftsladen Bonn 2007: Ausbildung und Arbeit für Erneuerbare Energien.

A pilot project which focuses on continuing vocational training was initiated by the BMU in cooperation with the German Federation of Trade Unions (DGB). It aims to teach employees a higher awareness of resource efficiency in operational and production processes. The concept which will be established during the study is supposed to be suitable for application in other areas afterwards.

In another pilot project the BIBB develops new ways to combine vocational training with forestry. The focus is on promoting young scientists and engineers in the field of bionics. Moreover, the Federal Government fosters research in energy storage for lithium ion batteries and research in bio energy in the German Centre for Biomass Research.

The Federal Ministry of Education and Research (BMBF) together with an international cooperation with the BRIC countries and South Africa promote the DAAD project 'studying and researching for sustainability: biogenic resources and value-added chain.' It aims to foster education and research to create solutions and competences for a sustainable production of biogenetic resources.[10]

A promotion programme by the BMU, the so-called 'Powerado' (2005-2008) and its successor 'Powerado plus', aims to find new ways to communicate renewable energy within education. On the level of vocational education suggestions for new curricula in craftsmen occupations have been developed to integrate the subject areas photovoltaic, solar thermal energy and biomass/wood firing systems.

Several promotion programmes target pupils in schools. One example is the activation programme 'climate protection in schools and educational institutes' by the BMU which promotes sensitising pupils to climate protection requirements and to motivate them to save energy. One programme point is the greenhouse emissions savings account. Pupils can look up online how much costs and environmental pollution is caused by the water, heat and electricity usage of their school. These programmes focus more on an increased awareness for environmental protection.

Table 1 Summary of policy initiated programmes

Programme	Initiator	Targets
Environment creates perspectives	BMU, BMBF, DIHK, BIBB	In 2009 6,000 additional apprenticeship training places were created in the fields of environmental technologies /renewable energy
Pilot project for CVT	BMU, DGB	Increase employees' and work councils' awarness for ressource efficiency in operational and production processes
Information brochure, IVT - environmental technicians	BMU, DIHK	Improvement of occupations' image, higher amount of apprentices
CVT in forestry	BIBB	Promotion of young scientists and engineers in the field of bionics
DAAD - studying and researching for sustainability	BMBF	Promotion of education and research to create solutions and competences for a sustainable production of biogenetic resources
Powerado and Powerado Plus	BMU	Promotion of new ways to communicate renewable energy within education
German Centre for Biomass Research	Fed. Government	Promotion of research in bio energy
Research in Lithium Ion Batteries	Fed. Government	Promotion of research in energy storage

Source: Economix

2.3.2. Integration of environmental protection in education

Another way to face the demand for skilled workers in the environmental sector is the adaptation of education. Environmental protection has been included in the education system in both dual vocational training and university education. The level of adaptation differs between integration and extension in existing education and the development of new education. New initial trainings and

[10] BMU 2008: Masterplan Umwelttechnologien.

university studies have been introduced and additional degrees with environmental specialisation have been added.[11]

Initial vocational training
Basic qualifications in environmental education are incorporated in every dual education due to the education system (*Ausbildungsordnung*). Even though environmental issues are often discussed to a limited extent didactic units about waste/recycling and working security/hazardous materials dominate thematically. Energy aspects were added so that cost degressions can be realised. Additionally, special elements are included such as environment days, excursions or projects.

Due to new environmental legislation and environmental technologies, a greater extent of environmental issues besides basic qualifications is required within initial training. Therefore, occupations have also been extended with special environmental issues and new occupations have been developed. Examples of a new occupation are four environmental technicians who have arisen from an existing occupation, the Provider and Disposer (*Ver- und Entsorger)*. It has to be taken into account that it is generally that new occupations arise more rarely than existing occupations are rebuilt or extended.

Here is a list of new trades:

- Recycling and Waste Management Technician (*Fachkraft für Kreislauf- und Abfallwirtschaft*)
- Water Supply Engineering Technician (*Fachkraft für Wasserversorgungstechnik*)
- Sewage Engineering Technician (*Fachkraft für Abwassertechnik)*
- Pipe, Sewer and Industrial Service Technician (*Fachkraft für Rohr-, Kanal- und Industrieservice*)
- Environmental Protection Technique Assistant (*Umweltschutz-technischer Assistent*)
- Biological Technique Assistant (*Biologisch-technischer Assistent)*

Existing initial trainings have also been extended with environmental subjects or tasks. An example of an extended trade is the Plant Mechanic for Sanitary, Heating and Air Conditioning Systems who implement modern heat, ventilation and air conditioners with a low energy input. Moreover, they work for companies who install solar powered techniques. Even chimney sweepers integrate environmental supervisory and consultant tasks in their work. Existing occupations are more often extended by continuing vocational training or additional degrees in specialist qualifications as the complete initial training is renewed.

Continuing vocational training
In Germany a huge proportion of required qualifications regarding the integration of environmental protection is communicated within continuing vocational training. Moreover, there is the possibility to receive additional degrees for specialising after a traditional education.

Environmental protection has been included in existing continuing training over the last 10 – 15 years, mostly due to the continuing vocational training regulation (*Fortbildungsordnung)* being renewed. Integrated updates comprise environmental legislation, knowledge on the consequences due to environmental protection measures for the company, and recycling possibilities as well as ways to control air and water pollution. In the area of environmental protection a craftsman can receive further education and become an energy consultant in his/her craft. For the following occupations new training regulations have been approved by the chambers:

- Craft Energy Consultant (*Energieberater im Handwerk*)
- Specialised Clerk for Waste Management (*Fackkraft für Abfallwirtschaft)*
- Recycling Mechanic (*Recycling Mechaniker*)

[11] An overview can be found in GTZ 2004, 'Umweltbildung für eine nachhaltige Entwicklung in der beruflichen Aus- und Weiterbildung'. The following facts are based on this report.

- Specialised Clerk for Water Pollution Control (*Fachkraft für Wasserschutz*)
- Specialised Clerk for Environmental Protection (*Fachkraft für Umweltschutz*)
- Specialised Clerk for Environmental and Building Biology (*Fachkraft für Umwelt- und Baubiologie*)
- Specialised Clerk for Building Maintenance (*Fachkraft für Gebäudeerhaltung*)
- Motor Vehicle Service Technician (*Kraftfahrzeugservicetechniker*)
- Environmental Technician (*Technischer Umweltfachwirt*)
- Environmental Protection Consultant in Craft (*Umweltschutzberater im Handwerk*)
- Building Energy Consultant (*Gebäudeenergieberater*)
- Assistant for Environmental Protection (*Umweltschutzassistent*)

After a dual vocational training there is also the possibility to participate in continuing training which leads to specialised certificates or higher degrees than foreman training and builds on a completed initial vocational training. Four main segments can be differentiated:

- Foreman training (e.g. Sewage Foreman)
- Technical training (e.g. Technician–waste engineering)
- Other continuing trainings, if applicable with certificate or chamber exam (e.g. Environmental Advisors, Specialised Clerk for Commercial-Technical Environmental Protection)
- 'Aufbau' (postgraduate) and contact study paths (as environmental legislation or European environment management)

In the subject area of energy continuing training has also been initiated by cooperation between different chambers and organisations. These are in particular:

- Service Technician for Wind Turbines (*Servicetechniker für Windenergieanlagen*)
- Anine month training course in 'renewable energy'
- Sanitary-, Heating- and Air Conditioning-Specialised Clerk of Solar Thermal Energy (*SHK Fachkraft Solarthermie*)
- Specialised Clerk for Environmentally Compatible Energy Techniques (*Fachkraft für umweltschonende Energietechnik*)
- Specialised Clerk for Solar Techniques – Solarteur
- Building Energy Consultant

It can be seen that the field for continuing training which focuses on ecological aspects is wide. An overall picture of all continuing trainings can hardly be presented at this point. Nevertheless, the main channels of greening have been explained above.

University studies

Environmentalism has led to the development of environmental products and technologies and the application of more effective product processes. Environmental management systems have been introduced in order to improve the operational organisation in an environmentally sound way. In these areas a high level of qualification and competences is required which are usually acquired from university studies. In this context a few studies have been supplemented by environmental issues and new studies have been developed in recent years. Graduates of these studies are in high demand, especially students from universities of applied sciences as these offer a practical-oriented education.

The amount of studies with regard to environment is hard to count. In 1999, 501 studies referring to the environment were offered.[12] Few of them were 'pure' environmental studies whereas a huge part only offered several classes which focussed on the environment. The majority of the studies (55 %) were in engineering. The studies were differentiated in the following fields:

[12] Umweltstudienführer 1999.

- Autonomous environment referring study courses (99)
- Environment referring focus within study courses (265)
- Environment referring 'Aufbau' study courses/postgraduate studies (53)
- Environment referring classes (76)
- Environment referring interdisciplinary study offers (8)

Since then the number of study courses has changed due to adaptations, renewals and extensions. In 2004/2005 the Institute for Environmental Research[13] found around 80 courses of study which mainly focussed on the environment. Currently on the web portal for university education and further training (www.fachhochschulen.de) around 100 environmental studies at universities for applied sciences are provided.

All in all, environmental aspects have been included in the studies at three different levels:

- Integration in existing studies
- Postgraduate courses
- Studies with a focus on the environment

In these levels the courses differ in the range of subjects. Some focus on environmental protection and environmental techniques, whereas others on environmental and resource management. All in all, greening is included in engineering, natural sciences and economic science related studies.

The integration of environmental aspects in existing studies comprise mainly environment protection and is included especially in courses which have a connection to the environment such as biology, chemistry or natural sciences.

Postgraduate studies are generally master degrees. It is also possible to attend study courses with an environmental focus at universities of applied sciences as postgraduate studies. Then the duration is abbreviated. Special master degrees are for example in:

- Environment technologies
- Environmental engineering
- Environmental protection
- Environmental planning and management

The studies with a focus on the environment are either bachelor degrees which last around three years or diploma studies which last around four years. The majority of these studies are in the area of engineering. Thereby the first two to four terms focus on basic education and the last terms focus on practical experiences[14] and specialisation. Specialisation can be obtained in environmental protection, process engineering and environmental techniques. The environmental techniques can also be divided into subsections such as:

- Disposal and recycling techniques
- Energy techniques
- Renewable energy
- Water and waste management

[13] http://www.infu.tu-dortmund.de.

[14] The practical experience is mainly imparted in studies at universities of applied sciences. The orientation in universities is more theoretical.

Study courses in natural sciences which focus on the environment can be environmental techniques in chemical engineering. In economic sciences the studies comprise environmental management and environmental planning.

2.3.3. Company initiated programmes

The education and training system in Germany is well structured. Thus, companies orientated on the different levels of the education system for their demand of employees. Some companies nevertheless realised own training initiatives in order to adapt skills of their employees. The initiatives are limited to the establishment of own training centres, extra modules in existing training or university studies in cooperation:

- The Siemens SE established an own training centre in Bremen in order to increase the supply and quality of their service staff for wind power turbines and wind power plants.
- The Juwi Group, one of the world's leading companies in the renewable energy sector with focus on solar, wind and bio energy, also opened their own training academy for training within the company. The training programme comprises basic specialised modules in wind, solar and bio energy, in which all new employees have to participate during their employment probation period. Moreover, employees, who work at the company for a longer time, may participate in the training.[15]
- The Federal Association of Wind Energy (BWE), the employment agency in Husum, the Chamber of Industry and Commence and local manufacturers and operators of wind energy facilities established a building centre for renewable energy. Workers in the fields of electro technique and machine building can participate in the training to become a Service Technician for Wind Turbines (*Servicetechniker für Windenergieanlagen*).
- The solar cell manufacturer Q-Cells SE in cooperation with the Fraunhofer Centre for Silicon and Photovoltaic (CSP) and University of Applied Sciences in Köthen (Saxony-Anhalt) established a study course in solar techniques.
- The Chamber of Crafts Hannover, the Heinz-Piest Institute for Craft Techniques of the University Hannover, the 3. Vocational School of the region and the Seecon SE Germany established the project 'CO_2 Workshop'. The cooperation partners together rearrange the training regulation of the Plant Mechanic for Sanitary, Heating and Air Conditioning in order to impart knowledge about the use of renewable energy more intensively. In the next years the evaluation of training contents of electronics and metal constructer will be included. The project is promoted by the German Federal Environmental Foundation (DBU) with 85,640 Euros. [16]

[15] http://www.juwi.de/fileadmin/user_upload/Presse/PM_juwi-akademie_2008_08_18.pdf.

[16] http://www.bne-portal.de/coremedia/generator/unesco/de/03__Aktuelles/02__Meldungen/Meldungen__national/Klimaschutz_20in_20der_20Berufsausbildung,sourcePageId=46274.html.

3 ANTICIPATION AND PROVISION OF SKILLS

3.1 Green structural change and (re)training needs

3.1.1 Green restructuring and its impact on the labour market

In the course of this report several activities have been highlighted which have emerged as future possibilities to improve environmental protection. These influence the behaviour of manufacturers and consumers: Energy manufacturers as well as manufacturers of consumer and industrial goods pursue reductions in greenhouse emissions by using optimised production processes and energy conservations. Moreover, there is a tendency to use renewables. Energy conservations are also influencing consumer preferences, the automobile sector and the building sector. The agricultural sector is following an environmental sound production while waste and water management have become more important. All of these areas identify growth potential in corresponding sectors and thus influence the employment there.

German companies are well situated in the green technology branches and develop and produce technologies which support the protection of the environment. The markets for green technologies are growing worldwide.

Reduction of greenhouse emissions

The reduction of greenhouse emissions has a comprehensive impact on different areas and sectors. Firstly, the energy production: Enormous saving potential can be realised due the use of modern and sustainable power plant technologies. Gas and steam power stations have an efficiency level of 60 % with lower greenhouse emissions per kilowatt hour than normal coal power stations. Flue gas cleaning plants reduce harmful emissions from power plants. New filters are being developed which will reduce the sulphur dioxide emissions by 90 %. Low carbon coal power plants with carbon capture and storage are being implemented as well as combined heat and power stations. Additionally, technologies to improve the possibilities of energy storage are required due to compressed air energy storage.

While power plants with fossil fuels are being improved and modernised, the use of renewables for energy production is also growing. The contribution of renewable energy for the overall energy use was 9.5 % in 2008.[17] In 2007 around 115 million tons of greenhouse emissions could have been avoided by using renewable energy. The growth expectations for this market are optimistic. The growth rates in solar thermal energy, photovoltaic, wind energy and biogas are estimated to increase worldwide by 20% per annum until 2020. German companies profit from these market potentials as they have positioned themselves well in these fields. They hold high market shares, more precisely 90 % in biogas, 25 % in wind power, 35 % in hydroelectric power, 21 % in photovoltaic and 23 % in solar thermal energy worldwide.

In recent years jobs have been created in all areas of environmentally friendly energy production and storage. Employment rose to between 15 % and 36 % during 2005 and 2007. The highest growth rates were in companies with 10 to 50 employees. For the period between 2008 and 2010 an average of 30 % more employees are expected. The highest increase has been estimated for the subsectors of renewable energy as can be seen in Chart 1. High employment growth rates are expected in 2010, especially in the geothermal sector.

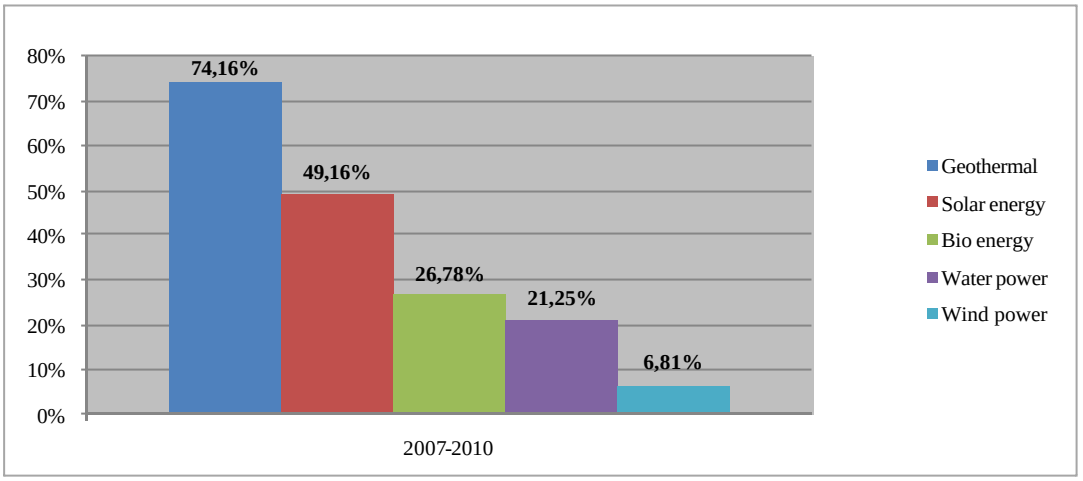
The high quantity of automobiles is also a driver of greenhouse emissions. A quarter of all greenhouse emissions in the EU 15 countries are traffic-related (excluding ship and air traffic). Automobile manufacturers counteract greenhouse emissions with more efficient propulsion

[17] BMU 2009: Renewable Energy in Figures.

technologies such as hybrid and battery driven cars. New electronics such as automatic speed regulators lower the fuel consumption as well. Tyre manufacturers developed a new tyre which lowers consumption by 5 %. Moreover, filter techniques can reduce humble emissions and intelligent traffic telematics and management may be able to optimise traffic flows. All in all growth will take place in the market for sustainable mobility.

Chart 1 Employment expectations for renewable energy markets

% change 2007 to 2010



Source: Wissenschaftsladen Bonn (2007)

German manufacturers are well situated in the market for filter/catalytic converters with a 44 % market share. 20 % of the worldwide market share in traffic telematics is achieved by German companies. The estimation for employment points upwards. Thus, the market for sustainable mobility could have the potential to develop as a job motor. However, it has to be taken to account that the automobile branch faces deficits in environmental techniques compared to other countries, for example Japan. The population's awareness of the environment has changed and will thus also influence the demand for cars. Environmental technologies are competitive factors especially in good markets. Early investments in environmentally friendly technologies will influence the employment sustainably.

Energy efficiency

Due to the need of reduced greenhouse emissions the efficient use of energy in production and consumption is becoming more and more important. Energy savings can be realised in several areas, for example by optimising energy usage in product processes. Due to technical adoptions of white goods in households high energy savings can also be achieved. Around one third of electricity use in households is needed for home appliances, thus there are substantial saving possibilities. There is also a third channel for saving energy due to increased energy efficiency in buildings. Heat insulation, modern heat systems and solar energy point out high potentials. The implementation of energy efficiency depends on the population's awareness of the environment. A higher awareness increases market potentials for the products.

German companies are well established in technical fields that support energy efficiency. In heat and air conditioning technologies they hold market shares of 15 % worldwide. In the production of white goods and heat insulation German manufacturers gain 10 % of market shares. The majority of small companies which work in the field of energy efficiency offer energy consulting and services to optimise buildings. As opposed to this, 80 % of bigger companies are manufacturers. Positive employment growth of around 15 % on average was achieved by the whole sector in the period 2005-2007 and a further increase on average of 21 % is expected between 2008 and 2010.

Waste management

Every human produces waste. The amount of waste varies between 200 and 800 kilograms per year depending on the development level of the country. Around 12 billion tons of waste is produced every year worldwide. The quantity will increase as the world population grows. Thus, there is a high demand for waste management technologies. It is important to avoid waste from the beginning – 80 % of the resources required are determined in the product planning phase. Ecological designs and resource-efficient production methods save the environment. Waste can also be avoided with reusable products.

The ecological use of waste as a raw material causes less residual waste. Sorting technologies and recycling technologies are becoming more and more important. In 2005 Germany recycled 87 % of building waste and 63 % of urban and product waste. Waste can also be used to produce energy. Waste is either burned to provide electricity and heat for production methods or it used in 'waste to energy' power stations to produce electricity.

Over the next few years the demand for recycling and sorting facilities will increase. German companies hold market shares of around 24 % in recycling and 64% in sorting facilities. In recent years employment rose by around 24 % on average in the sector for circular economy. Continuing growth is also expected in the upcoming years.

Sustainable Water management

Water as a natural resource is becoming scarce. Water consumption has increased enormously and is estimated to rise by 30 % to 5,000 cubic kilometres in 2025. At the same time 3.2 billion people in developing countries will suffer water shortages. Polluted water and a lack of effluent disposal are reasons for 80 % of diseases in these countries. Two measures can support the sustainable water supply: On one hand it is crucial that the water production, distribution and disposal are in an environmentally sound way. Public sewage systems have to be repaired, renewed and monitored. The monitoring is supported by innovative technologies. Moreover, special filter systems improve the water purification and conditioning. On the other hand the efficient use of water has to increase. Saving potentials are given in industrial production, in home appliances and in the agricultural sector.

In the next few years high investments in sustainable water management will be initiated. In the European Union alone 170-230 billion Euros will be invested in the sewage regulations. German companies have market shares of 20 % in distributed water management, 20 % in efficiency improvements and 12 % in wastewater treatment. New market potentials are also expected for technologies in dyke constructions to repel floods. High growth rates of employment have been realised in recent years and the positive trend is estimated to continue. Mostly medium sizes companies with 10 to 50 employees will have the highest growth rates of 17 % between 2008 and 2010.

Restricted sectors

Not all sectors which are influenced by environmental protection show growth potentials for sales and employment but they are still influenced by it. For example in the production of products with chemical ingredients, tight regulations have been introduced. In 2007 the REACH Regulation was imparted. REACH means registration, evaluation, authorisation and constraint of chemicals. The manufacturers and importers have to register the quantity of substances with the European Chemical Agency (ECHA). Moreover, they have to guarantee the responsible and sure utilisation of the substances in the whole supply chain. Alarming substances such as carcinogenic or mutagenic substances can be prohibited.

The main emissions of the chemical industry which stress the environment are chemicals which are contained in products – in other words the ingredients in washing powder, cosmetics, biocides, pesticides, medicines and paints. These chemicals are difficult to degrade and so they pollute the environment nowadays more than waste and sewage. As a result of the new regulation evaluation of

work processes will take place. The chemical industry is the fourth biggest industrial branch in Germany. All in all around 437,000 were employed in the chemical industry in 2006.[18]

The agricultural sector influences the environment in two different ways. On one hand its helps to preserve landscapes, plant species and animal species due to extensive farming. On the other hand wrong use of agriculture affects the natural resources negatively due to water pollution air pollution and ground pollution. The European Agrarian Policy (GAP) promotes measures to protect the environment. Financial incentives are offered to farmers who use environmentally friendly work methods. Thus, the work and tasks of farmers will change as well as the production of biogas instead of animal breeding and cereal production.

Future development
Germany decided on the nuclear phase out. Although there might be an extension of the duration, the phase out will be realised in the next few decades. Jobs in the nuclear power stations will be lost. This will mean that the employees will have to shift to different branches. Opportunities for sustainable energy production are given in the sector.

The energy generated by coal power stations is still the most common in Germany. 56 % of energy is produced from coal.[19] For the production hard and brown coal has to be removed, which affects huge parts of mining. Due to the improvement of generating energy with alternative generation schemes such as with renewable energy, there might be a lower use of coal power stations in the future. Employment will decrease for employees in the stations as well as in mining. In 2007, 52,000[20] people were working in the coal mining sector. The scenario will only take place if the energy supply is ensured by other alternatives. A decision by the Federal Government to stop the subsidies for coal mining by 2018 will also bring a strong job decline.

Impacts on the labour market

Employment in the environmental sector
A study by the German Institute for Economic Research (DIW) in the year 2009 estimated the amount of people working in the German environmental sector at around 1.8 million people. This means 4.5 % of the labour force. The environmental sector includes the number of workers in environmental protection meaning those who are operating facilities, supervising standards, researching and analysing ecological issues etc. Thus, environmental protection has become important for the whole labour market. The number of employees increased by 290,000 compared to 2004, which is a rise of almost 20 % within two years. The estimates of the number of environmental jobs have calculated the employment effects on the basis expenditures with the help of input-output models. The distribution of the employment for 2006 and 2004 is presented in Table 2.

Investments in environmental protection comprise waste management facility plants. The employment in this area was 175,000 people which is around 10 % of all employees engaged in environmental protection. Material costs are expenditures on raw materials and supplies which are needed for operating environmental protection facilities. In sewage treatment plants that would be the cost of the electricity or a new filter. All in all 175,000 workers can be added to this category. The foreign demand for environmental protection goods only induced 49,000 of the employees. 49 % of these were directly affected as they are employed in the environmental protection sector and the other 51 % indirectly as they work for supply firms. As there are many environmental protection facilities in Germany, trained staff is needed to operate them. The required personnel are incorporated in the personnel costs section and in services in environmental protection. All together

[18] www.vci.de.

[19] BMWI 2009, BMWI Energiedaten, Tabelle 3.

[20] BMWI 2008, 'Der Bergbau in der Bundesrepublik Deutschland 2007', S. 78.

around 1.1 million people work there. This means that 64 % of all employees are providing services in environmental protection facilities.

The employment in renewable energy has increased from around 160 to 235 thousand people (+47 %). In this context the biomass sector experienced the highest growth (+38,400) and also amounts to the most employees (95,400) in the renewable energy sector. But also the other sectors developed positively: solar thermal (40,200, + 60 %), wind power (82,100, + 29 %) and geothermal (4,200, + 130 %) established well in recent years. Only water power decreased by 1 % due to increased labour productivity.

Table 2 Employment in the environmental sector (Germany), 2006

	Employees		Difference	% change
Employment effects of environmental expenditures on	2006	2004	2006/2004	2006/2004
investments	175.000	153.000	22.000	14,4%
material costs	175.000	183.000	-8.000	-4,4%
services and staff	1.132.400	944.300	188.100	19,9%
renewable energy	235.600	160.500	75.000	46,7%
foreign demand for environmental protection goods	49.000	35.000	14.000	40,0%
Sum	**1.767.000**	**1.475.800**	**291.200**	**19,7%**

Source: DIW (2009)

Employment effects in net terms

The presented estimation of 1.8 million environmental jobs takes only into account the gross employment which has been created due to environmental protection but ignore the possible job losses due to crowding-out effects and cost, price and competition effects. The exact net number can only be estimated by model calculations or scenario analyses. Studies over net effects in particular sectors were conducted, but an estimation about net effects of all employment does not exist:

- A study by the German Aerospace Centre (DLR) calculated the net effect of the existing promotion of renewable energy to 120,000 additional jobs by 2030.[21]
- The Federal Environmental Agency (UBA) estimated a net gain of 30,000 jobs for shifting subsidies for coal into building retrofits.[22]
- Another study calculated a net plus of 260,000 jobs due to energy efficiency in 2020.[23]

Future employment expectations

In the next decades the amount of people working in environmental protection points upward. According to a study by the BMU in 2008 the policy measures included in the IEKP will lead to a decrease of 35 % of greenhouse emissions by 2020 compared to 1990. This can be achieved by investments of on average 30 billion Euros per year in renewable energy, insulation and more efficient home appliances and cars. The investments will support employment growth and lead to 500.000 additional jobs in environmental protection by 2020 and 800.000 by 2030.[24]

Regarding the IEKP the employment effects for 2020 were also estimated by a study of the UBA in 2008[25]. The authors used the PANTA RHEI[26] method for the analysis. Employment effects compared to a reference scenario were investigated for five points of the IEKP:

[21] BMU (2006), Erneuerbare Energien: Arbeitsplatzeffekte.

[22] BMU (2009) Umweltwirtschaftsbericht.

[23] Lehr et al. (2009), Klimaschutz, Energieeffizienz und Beschäftigung.

[24] BMU (2008) Investitionen für ein klimagerechtes Deutschland, Zwischenbericht.

[25] Lutz et al.(2008), Beschäftigungseffekte des Klimaschutzes in Deutschland.

[26] PHANTA RHEI is a model for simulation and forecast which is used for the analysis of environmental economical issues (Lutz 2008).

- Promotion programmes for climate protection and energy efficiency beyond buildings
- CO_2 Building reconstruction programme
- Switching the car tax to a carbon dioxide based tax
- Improved control of the lorry charge
- Inclusion of the air traffic into the emission trade

The estimation for employment effects for 2020 adds up to the results presented in the following table:

Table 3 Estimated employment effects of particular measures of the IEKP for 2020

Investigated measures of the IEKP	Employment
Energy conservation due to information instruments	22,070
Building reconstruction	33,490
Carbon dioxide car tax	14,000
Doubling of lorry charge	30,800
Including air traffic in emission trade	1,500
Sum of measures	**101,800**

Source: Economix

Other studies also estimated positive employment growth in renewable energy. A rise to 400,000-500,000 employees by 2020 and to 710,000 by 2030 is expected.[27]

According to estimates of Roland Berger Consulting an even more favourable job performance arises: in addition to the 1.2 million people who already worked in the environmental technology sector in 2008, an increase by 1.1 million is expected up until 2020 in this sector.[28]

3.1.2 Identification of (re)training needs

As the highest potentials of employment are given in the environmental technologies sector and the energy generation from renewable energy, it will focus on the required training needs of these sectors.

Companies in the environmental technology sector often originate from other branches and then switch to the manufacturing of environmental technology because high sales can be made. 21.6 % of the companies are machine builders, 16.7 % are from the building industry, 11 % are energy suppliers and 6.5 % come from the chemical industry. German companies are well established and are often technology leaders. The research and development of new products and the processes involved play an important role as companies can win cost and competitive advantages. A basic requirement is the supply of qualified workers. Companies which were interviewed by Roland Berger in 2007 evaluated the availability of qualified personnel beside the demand for their products as the most important location factor. The highest demand arises for occupations with a technical focus.

The renewable energy sector will grow enormously in the next few years. In 2030 around 700,000 employees are expected to be employed. Thus, there will be high demand for people with suitable qualifications. A typical competence profile will be identified. Professionals usually have a classical education as a basic qualification, e.g. as technicians, engineers or craftsmen. An initial vocational training which concentrates on renewable energy does not yet exist and the number of students on

[27] Wissenschaftsladen Bonn 2007.

The estimations for 2020 come from a study by the DIW (2007) and the Federal Association for Renewable Energy, whereas the estimation for 2030 from Roland Berger.

[28] The number was estimated with a market model, which is based on company interviews. All in all 1,400 companies from the environmental technology sector were interviewed.

corresponding university studies is still marginal. Therefore, companies have to incorporate their own training measures. Work experience in renewable energy also plays a crucial role as there is a high demand for experienced employees.

In 2007 the Wissenschaftsladen Bonn interviewed companies and experts in the renewable energy sector and accumulated information about the education and employment structure in the sector. The work force could be distinguished into groups with different education levels: 41 % were skilled labour (Facharbeiter), 19 % academics, 27 % commercial clerks (kaufmännisch Angestellte), 8 % foremen and 5 % semi-skilled labourers (Angelernte). The academics are mostly engineers and are represented in 80 % of the companies. [29]

Apprenticeships in 40 different trades are offered. The majority are mechanics, mechatronics, electronics and electrics. These are occupations beside engineers which are in high demand in this sector. The training rate, which is the ratio between the apprentices and the employees of a company, lies at around 5 %. This is quite low compared to an average of 6.5 % in Germany. This means that the companies in the renewable energy sector more often than not recruit qualified workers rather than offering dual training courses. The development might be explained by two facts: On one hand, the sector has experienced high growth rates and dual training programmes take time. On the other hand the education system did not integrate a suitable initial training for renewable energy so companies have to recruit qualified workers and train them further for their own needs. The ratio of female apprentices is around 29 % which is also very low compared to other branches. 17 % of the companies plan to increase their female apprentices over the next few years.

The companies also evaluated the existing initial training and university studies to the extent that they have imparted sectoral knowledge in order to ensure the fitting of the personnel to the required skills. 56 % of the companies are satisfied whereas 44 % could point out a significant need of improvement. 51 % would prefer a higher incorporation of specific subjects in the existing education and 41 % claim new initial training measures and university studies.

Skills shortages

Even though there was the engagement to adapt and increase the supply of studies and vocational trainings in environmental protection, there is still scope for improvements. The companies who work in environmental technologies or in renewable energy already face a lack of skilled workers.

In the environmental sectors the demand for skilled workers focuses on graduates of the so-called MINT subjects (mathematics, engineering, natural sciences and techniques). As these had low graduation rates in recent years there was already a shortage of highly qualified engineers and technicians of around 165,000[30] in the environmental sector in 2006. According to the companies, skills shortages were already limiting the growth of the sector at the time of the survey. Meanwhile the economic downturn has reduced labour shortages. It can be assumed that green industries can better fill recent jobs.

The largest problem is the availability of engineers. Graduation rates have been low in recent years and the prospects for the next years have not changed. Many experienced engineers will retire in the next years and thus the lack of engineers will worsen. The German 'engineer replacement rate', which defines the rate of newly graduated to retiring engineers, is low compared to other European countries and counts only 0.9 in 2008. That means that for ten retiring engineers only nine entrants are available from universities.

Moreover, recruiting in the environmental technology sector has to compete with the automobile sector which is the largest employer of engineers. Especially the fact that companies in the environmental technology sector are still small in terms of sales makes them less attractive regarding

[29] Wissenschaftsladen Bonn 2007.

[30] IWD 2007 Ingenieure deutsche Mangelware, iwd Nr.20, 17.05.2007.

working conditions and career prospects. Companies have difficulties to compete with companies like BMW or Siemens.

The initiative 'Environmental Creates Perspectives' by the BMU supported the creation of new apprenticeship training places for young people in the renewable energy and environmental technology areas. However, not all open vacancies could be filled. This can partly be attributed to the demographic change in the German society but also to image problems of different areas loke waste, sewage and sanitary installation.

3.1.3 Skills response

The retraining within economic sectors in the course of green restructuring mainly orientates on the education and training system. Companies' initiatives are marginal compared to the well structured and organised training system.

The skills response in terms of promoting education and training is visible. Promotion programmes have been established, technical qualification trainings are offered and new study courses and further training with environmentally relevant subjects have been developed. Beyond new types of training, many existing training courses are becoming greener due to the integration of environmental protection aspects. Especially the offer of continuing vocational training related to environmental protection is substantial. Moreover, there is the possibility to participate in education-integrated studies. Companies offer an initial vocational training and at the same time the apprentices participate in a university course.

In the course of the establishment of the environmental technology sector and its continuous growth, specialists have been increasingly required. German universities established new study courses with focus on environmental technologies. The number of students has been growing in recent years. All in all around 7,000 students were studying engineering with a focus on environmental techniques (inclusive recycling) in 2009.[31] Moreover, as mentioned in section 2.2.2., four environmental technicians were established as a dual apprenticeship in 2002. These are able to work in the waste management, sewage and recycling area and have adapted skills to operate the facilities in this area. All together around 2,500 apprentices were employed in these trades in 2008.

Another contribution for educating professionals is from research institutes. The number of research projects has risen in the last few years and thus, specialised knowledge has accumulated. The educated scientists who work at the institutes often change in the industrial sector to a future date.

More specialised skills response for retraining needs cannot be identified. The greening of skills is considerably more persecuted in all economic sectors and to a major part captured by the education and training system. Thus, it is difficult to differentiate between the skills response regarding retraining needs and regarding skill needs as the establishment of new training programmes with corresponding qualification training modules goes hand in hand. The three main channels – initial vocational training, university studies and continuing vocational training – are systematically organised and the companies orientate on these levels. Thus a further assessment of skills response is presented in section 3.2.3.

3.1.4 Case studies

For the case studies regarding retraining, occupations from two economic sectors were chosen, which were influenced by environmental protection to a greater extend and thus work tasks changed substantially. This is the Mechatronics Technicians in the automobile sector who have to adapt his/her knowledge in hybrid propulsion and the Chemical Technicians from the chemical industry.

[31] Statistisches Bundesamt 2009, Fachserie 11, R4.1, WS 2008/2009.

The automobile branch pursues further developments in environmentally friendly propulsion techniques such as in hybrid, electric and hydrogen cars. Moreover, fuel emissions can be reduced thanks to smart electrics which support driving in an environmentally friendly way such as start-stop techniques or automation of distance measurement. Thus, Mechatronics Technicians and Electronic Technicians have to acquire new knowledge in these areas.

The chemical industry for its part has adjusted all working processes to Responsible Care, meaning the integration of environmental protection in all stages of work.

Case study 1: Motor Vehicle Mechatronics Technicians - BMW

Introduction to the occupation
Motor Vehicle Mechatronics Technicians work in the planning, servicing, inspection, diagnosis, repairing, equipping and refitting of motor vehicles in the key areas of automobile, commercial vehicles, and motorcycle and communications technology.

The initial vocational training to become a Motor Vehicle Mechatronics Technician is an approved trade and lasts 3.5 years in Germany. The training venues are in companies and at part-time vocational schools. For the continued training of young skilled workers, instruction courses at inter-company training centres have been agreed by social partners.[32]

Around 74,800 people did an apprenticeship in this trade in 2006 (57,600 in 2005), which means an increase of 30 % compared to 2005. Only 2.2 % of these were women. The average age was 18.5 years old and the majority of the apprentices (44.7 %) had previously completed an intermediate school (*Realschulabschluss*), 34.5 % had a certificate from a secondary school *(Hauptschulabschluss*) and 5.4 % had a general qualification for university entrance (*Abitur/Fachhochschulreife*). The remaining part had either other qualifications or no school leaving certificates.[33]

In 2007 around 252,000 people were working as motor vehicle repairers which include motor vehicle mechanics. Compared to 2005 the number of workers only marginally decreased. Also, in previous years the number of workers slightly decreased by 3.4 % between 1999 and 2007. All in all, 1.4 % of the workers in 2007 were women. The majority (41.1 %) was between 35 and 50 years old, 26.7 % were between 25 and 35 years old and 19.5 % were older than 50 years old. The remaining 12.7 % were younger than 25 years old. A large proportion of 88.4 % held a degree in a dual vocational training, but thereof only 0.9 % had a general qualification for university entrance.[34]

Skill gaps and identification of skill needs
Hybrid propulsion is the new trend in the automobile industry. Cars are equipped with a combustion engine and additional electric motors and energy storages. Due to this combination the fuel consumption can be reduced and thus greenhouse emissions diminished. Another environmentally friendly solution offer hybrid propulsions which use fuel and natural gas. Motor Vehicle Mechatronics Technicians have to adapt skills in hybrid technologies in order to build up the new motor systems.

The German automobile manufacturer BMW recently included two hybrid cars in its product portfolio, the X6 and 7 BMW. The development of and working with hybrid cars can be dangerous. Hybrid cars release voltages of 400 volts which leads to death if someone acts incautiously while working on these cars. Therefore, people who work with hybrid cars need additional knowledge of health and safety at work and basic technical knowledge about hybrid technologies.

In 2009, BMW therefore implemented a new training module in the existing dual apprenticeship for Motor Vehicle Mechatronics Technicians. The training module comprises technical knowledge for

[32] www.bibb.de, www.berufenet.de.

[33] www.bibb.de.

[34] IAB, Berufe im Spiegel der Statistik.

hybrid technologies in the automobile area. On completion the apprentices receive a special certificate; an extra qualification as an 'Electro Technician for Specified Tasks on Hybrid Vehicles' (*Elektrofachkraft für festgelegte Tätigkeiten am Hybridfahrzeug*).[35]

Due to legislation the trade association only allows trained electricians or mechatronics technicians who have acquired the corresponding knowledge to carry out work on hybrid cars. Thus, BMW decided to integrate the missing knowledge directly in the dual apprenticeship as an extra module. This means all Motor Vehicle Mechatronics Technicians who complete their training at BMW will be qualified to work with hybrid cars.[36]

Existing provision of education for the occupation
Motor Vehicle Mechatronics Technicians who completed their training before the new module was integrated obtain further training in hybrid technologies if needed. This means that the training and the selection of required training modules are decided individually and depend on work experience and work tasks in the production process.

Especially engineers involved in the development of hybrid cars need extra training as well as the technicians who are responsible for error analysis after the cars have been assembled. During the assembling process the cars are not energized and thus voltage training is not required for all workers in the production process.

The skills response
In 2008 the new module for Motor Vehicle Mechatronics Technicians was examined by a pilot project in the production plant in Munich. The training lasted one week. All in all 32 apprentices participated.

Since 2009 the module has been integrated in the dual apprenticeship programme for apprentices at the production plants in Regensburg and Dingolfing and from 2010 all production plants in Germany will include the new training module. Altogether around 100 apprentices per year will receive the training which now lasts two weeks.

The training module comprises the following contents:

- Hybrid and high voltage techniques: facts, potentials and functional principles by comparison
- Mode of action and theoretical structure of high voltage components
- Electromagnetic compatibility: explosion control
- Standards, technical rules and regulations for hybrid cars
- Internal practice – Handling of hybrid cars and high voltage components at BMW
- Safety concepts and secure component evaluation
- Measuring hybrid cars and/or high voltage components
- Practical work with hybrid cars and/or high voltage components
- Exemplary creation/handling of diverse specified tasks
- Diagnostics and function test, maintenance, special situations

The training ends with a theoretical final exam and the participants receive a certificate after passing the exam. The certificates are approved by the trade association. The training is conducted by internal trainers who also set the exam.

Assessment of effectiveness and organisation of this response
BMW established the training module for specific tasks on hybrid cars as a permanent feature in their dual apprenticeship for Motor Vehicle Mechatronics Technicians. For this innovation, BMW received the Innovation Prize 2009 from the Federal Institute for Vocational Education and Training (BIBB) for the exemplary function of the module, the close connection to the dual apprenticeship programme and its labour market relevance.[37] Compared to other automobile manufacturers only

[35] Manfred Theunert, head of initial and continuing vocational training at BMW in Munich.

[36] Helmut Kroneder, manager of initial and continuing training for Motor Vehicle Mechatronics Technicians at BMW.

[37] http://www.foraus.de/web.select/news/showarticle/3787?skin=1.

BMW has integrated the hybrid module in the dual apprenticeship. All the others only offer their employees continued training in hybrid techniques.

After completing the training module Mechatronics Technicians are able to work with hybrid cars. The pass rate of the final exam lies at 100 %. In the future BMW plans to include a practical test at the end of the module. This will be made possible because hybrid cars have become part of BMW's product portfolio. Moreover, the section at BMW which is responsible for the training module also works closely with other departments in order to adapt and include new technological changes in the training module as necessary. The company sees the extra training as an investment in young people which increases their chances in the labour market and their qualifications for future work tasks.

BMW tries to employ all Motor Vehicle Mechatronics Technicians after their training but due to the economic crisis not all apprentices can be employed. Nevertheless, the company at least tries to integrate the apprentices in the BMW group network, meaning that employment is not limited to German plants but that the apprentices can also be employed by international plants in UK, China or USA.

Outlook

BMW expects the success of hybrid cars in the future. The demand for environmentally friendly cars is increasing due to the newly introduced carbon dioxide oriented tax. With the right use of hybrid cars a reduction of fuel consumption by 15 % is possible.[38] At the moment BMW only offers two of their models as hybrid cars but they plan to increase the supply over the next few years after experiences with the existing models have been made and the technology has been optimised for mass production.

Moreover, experts forecast the increase of electrical vehicles in the future. Research in the fields of electric mobility is promoted by the Federal Ministry of Education and Research (BMBF) and the recovery programme of the Federal Government. Before the electrical vehicle is standardised for mass production the infrastructure for charging stations, uniform plug and power points have to be improved in order to ensure cars can be recharged. BMW has already developed this technology in Mini cars. The company is testing electric motors in 500 Minis in a pilot project in the US. Thus, Motor Vehicle Mechatronics Technicians will also have to acquire knowledge in electric propulsion and electronics as well as in the maintenance of batteries for future tasks.

[38] Helmut Kroneder, BMW.

Case study 2: Chemical Technicians as an example for the Chemical industry

Introduction to the occupation

Chemical Technicians control and monitor machines and facilities for the production, bottling and packaging of chemical products. They mainly work for companies in the chemical industry which manufacture fertilisers, adhesives, paint, varnish and pesticides, as well as for cosmetics manufacturers and companies involved in processing mineral oil. They are also employed in the pharmaceutical industry.[39]

The initial vocational training to become a Chemistry Technician is an approved trade and lasts 3.5 years in Germany. The training venues are in companies and at part-time vocational schools. Many selection possibilities during the training process mean the apprenticeship structure is flexible.

Around 5,600 people did an apprenticeship in this trade in 2008[40] (5,700 in 2007), which means a decrease of 1.5 % compared to 2007. 14 % of these were women. The number of apprentices declined also in previous years by 12 % compared to 2003 while the number of all apprentices in Germany slightly increased by 0.6 % in the same period. The average age of apprentices was 18.8 years old and the majority of the apprentices who started their training in 2008 (67.6 %) had completed an intermediate school (*Realschulabschluss*), 8.7 % had a certificate from a secondary school *(Hauptschulabschluss*) and 16.5 % had a general qualification for university entrance (*Abitur/Fachhochschulreife*). The remaining part had either other qualifications or no school leaving certificates.

In 2007 around 160,000 people were working as Chemical Industrial Workers (*Chemiebetriebswerker*), which includes Chemical Technicians. Compared to 2005, the number of workers marginally increased although it decreased by 6.6 % between 1999 and 2007. All in all, only 15.8 % of the workers in 2007 were women. The majority (49.9 %) was between 35 and 50 years old, 18.4 % were between 25 and 35 years old and 25.5 % were older than 50 years old. The remaining 6.2 % were younger than 25 years old. A large proportion (70 %) held a degree in a dual vocational training, but thereof only 1.7 % had a general qualification for university entrance.[41]

Skill gaps and identification of skill needs

The training regulations for Chemical Technicians and four other trades in the chemical industry were revised in 2002 as the idea of Responsible Care was included. This means that the apprentices continuously receive training in work safety, health and environmental protection over the whole training period in order to increase their awareness for these subjects. Responsible Care refers to a sustainable development in the chemical industry which comprises social, economical and ecological dimensions. The other trades mentioned are part of the production areas; Chemical Production Specialists and the Pharmaceutical Technicians, and part of the laboratory area; Chemical Laboratory Technicians, Biological Laboratory Technicians and Lacquer Laboratory Technicians.[42]

The idea of Responsible Care is an international initiative of the chemical industry. It expresses the willingness of the sector to continuously improve work security, environmental protection and health protection independent of legislation. It was voluntarily integrated by companies of the chemical industry. The integration of the idea in the dual apprenticeship training in this sector guarantees its implementation and its internalisation at all stages of work.

The chemical industry has been influenced by environmental protection via many channels which will also substantially influence the work in this sector in the future: In research the sustainability of chemical products is persecuted not only in the production but also over the life cycle of the products. This includes fast and complete degradability of the products after being released in the environment. The development of degradable chemical substances' can be improved if it is known

[39] www.bibb.de, www.berufenet.de.

[40] The number for 2008 is preliminary.

[41] IAB, Berufe im Spiegel der Statistik.

[42] www.bibb.de.

which molecular structures are particularly favourable and degrade easily. The European Parliament and the EU Commission supports this approach by the 6th Environmental Action Programme. It states that chemicals may only be produced and used if they have no negative effects on the environment. Therefore, the establishment of substitutes and environmentally sound products is expected in both the medium and long-term.[43]

Previously, the chemical laws were upgraded by the REACH Regulation in 2007. REACH stands for registration, evaluation, authorisation, and constraint of chemicals. The quantity of used substances has to be registered at the European Chemical Agency (ECHA) by companies in the chemical industry.[44]

Additionally, the 'Globally Harmonised System of Classification and Labelling of Chemicals' (GHS) came into effect at the beginning of 2009. As defined by its name the GHS controls the categorisation and labelling of chemicals with the same criteria worldwide. This comprises the harmonisation of categorisation, the labelling criteria and the security data sheet. Beside the REACH regulation, the new regulation GHS is an additional burden for companies in the chemical industry.[45]

Existing provision of education for the occupation

The chemical industry was the first sector that promoted the integration of environmental protection aspects in the dual apprenticeship training in the 80s. Chemical catastrophes such as in Basel, Chernobyl and India discredited the image of the chemical industry and thus a rethink was needed.

In 1987 the regulation for apprentices programme in the chemical industry was revised. The duration was extended from 3 years to 3.5 years. The integration of environmental protection was the main argument for the prolongation.

The industry is still investing a lot of money in environmental protection and has already developed many learning materials. The chemical industry can partly be seen as holding the leading role for integrating environmental aspects in the training system and sets an example for many other sectors.

The skills response

At the beginning of the decade the training regulations for apprentices in the laboratory and production areas in the chemical industry were revised. The training modules were adapted to new work organisational and scientific-technical changes in the chemical industry and extended by the idea of Responsible Care. Thus, the elements of Responsible Care were integrated in all training modules.

In the course of revision, training modules were restructured with a selection of optional and obligatory subjects, enabling a training which fits perfectly. Six training modules are obligatory and comprise the following contents:

- Laboratory technical basic operations
- Mechanical chemical engineering: mechanical processing of reagents and products
- Installation techniques, maintenance and installation engineering
- Instrumentation, control and automation
- Thermal chemical engineering: thermal processing of reagents and products
- Operation of manufacturing plants for the production and/or processing of products

Alongside the obligatory modules the training offers a total of 19 optional subjects, of which one has to be chosen. These are for example electronic techniques, automation techniques or pneumatic and hydraulic techniques. One interesting optional subject comprises environmental protection techniques. With this qualification the apprentices can be employed in the industrial areas of sewage treatment plants and waste utilisation plants. In the module the apprentices learn work tasks which enable them to

[43] Kümmerer 2009, Nachhaltige Chemikalien, Stabil und abbaubar.

[44] Lahl 2009, Chemikalienpolitik, REACH-Neue Standards in Europa.

[45] http://www.vci.de/default~cmd~shd~docnr~125813~lastDokNr~102474.htm.

implement processes of sewage and extracted air treatment and purification. Moreover, they adapt knowledge in waste utilisation and disposal. Training in the optional subject lasts 10 weeks and extends the apprentices' qualification in the area of environmental protection techniques.[46]

Assessment of effectiveness and organisation of this response

The idea of environmental protection is integrated in the chemical industry to a large extent. Due to the use of energy efficiency greenhouse emissions could be reduced by 36 percent compared to 1990 while energy production increased by 57 percent in the same period. Moreover, chemical products conserve altogether twice as much emission than what is needed for their production.[47]

Responsible Care implemented environmental protection in all areas of the chemical industry. The results are summarised in the yearly published report of Responsible Care by the Association of the Chemical Industry (VCI) which shows the high awareness for environmental and climate protection in this sector.[48]

The chemical industry integrated environmental aspects in the training system in 1987. Moreover, in cooperation with the BIBB the social partners involved Responsible Care in the initial training in the chemical industry. There is also the possibility of specialising in environmental techniques as part of the training. The idea of Responsible Care was also integrated in the continuing vocational training programme to become a Specialised Foreman in Chemistry (*Industriemeister Chemie*) which is the specialised training for apprentices in the chemical industry.

A decreasing number of Chemical Technicians in the apprenticeship programme can mainly be explained by a rising number of Mechatronics Technicians in the chemical industry. Due to increased automation in the processes and the resulting need of maintenance, repair and operations of machines and facilities, a major proportion of Mechatronics Technicians are trained.

The REACH and GHS lead to a lot of administrative effort and high labour costs, especially in small and medium sized companies as all used substances need to be registered. Thus, jobs in the chemical industry are threatened by these regulations. [49]

Outlook

Over the last 50 years an increasing amount of highly qualified workers could be identified while the amount of low qualified workers is decreasing. This development has mostly been affected by the rise of technological improvements and the integration of environmental protection, which leads to more complex work tasks. The trend is expected to continue in the following years.

The chemical industry acts as a global player. Due to high investments in environmental protection the sector faces competitive disadvantages compared to companies in countries that have low ecological standards. The problem is the missing global climate agreement. Thus, there is danger of losing both market shares and jobs to these countries which would negatively influence the climate and employment in Germany.

[46] www.berufenet.de.

[47] ICCA 2009, Innovations for Greenhouse Gas Emission Reduction.

[48] VCI 2009, Responsible Care 2009.

[49] Hans-Günther Glass, BVCI.

3.2 New and Changing skill needs

This section gives an overview of new occupations and about the greening of existing occupations in the context of greening the economy.

In Germany technical qualifications to perform an occupation are imparted by three main channels: completion of an initial vocational training, a continuing vocational training or completion of university studies. Due to continuing vocational training a specialised degree or a foreman degree (*Meister*) can be obtained. Skills can also be extended via informal learning during work. For the further assessment of new and greening occupations these channels will mainly be investigated.

A more precise insight about skill gaps and skills needs is presented in the case studies. In terms of new occupations two new university courses are outlined: Green Business Management and Solar Techniques. The latter was initiated by companies from the solar sector and thus gives little advice about the companies' strategy of initiation. Furthermore, one case study outlines the new Siemens training wind power training centre for its own personnel and its customers.

In terms of greening existing occupations, two case studies about initial vocational training are presented: The Plant Mechanic for Sanitary, Heating and Air Conditioning and the Waste Management and Recycling Technician. The latter is about Environmental Technicians who were established in order to meet the requirements of an increasing technical need within the sewage and waste sector. The third case study in this section is about Energy Consultants with the main focus on energy passes. This is part of new legislation and thus defined the need for skills adaption.

For further analysis one needs to distinguish between new green occupations and the greening of existing occupations. In some cases the exact differentiation might be difficult. In the given methodology of classifications new occupations arise if the increment or change of a qualification is drastic or if the occupation is defined as new according to the national catalogue of occupations. The greening of existing occupations comprises incremental changes of qualifications. For example a Plant Mechanic still installs heat systems but has to take into account energy conservation or must be able to install a solar cell facility. Hereby the occupation profile has become greener. On the contrary, a Solar Technician is a new occupation as the specialisation in this field did not previously exist. It was recently established and the focus of the occupation lies on the production of solar cells.

It has to be taken into account that in all occupations which have integrated environmental protection to a certain extent in recent years, environmental protection always represents an additional qualification which is integrated in the existing training. The main character of the training keeps basic knowledge in technical, economical or scientific subjects as a standard qualification. The greening of the economy and the educational system in general leads to a higher demand of skilled workers as the qualification level rises due to increasing technical requirements.

3.2.1 New green collar occupations

In the national catalogue of occupations BERUFENET[50] of the Federal Labour Agency 36 job descriptions can be found in the occupational area 'Occupations in environmental and nature protection'. These differentiate in types of training – initial vocational training, continuing vocational training, university studies, specialisation and civil servants – as presented in Table 4. The training form for the occupations that are classified as specialised can either be university studies or continuing vocational training or a mixture of both. Thus the classification 'specialisation' takes up these occupations as they cannot be allocated to fit the other training systems exactly. The table of environmental occupations only gives little advice about the classification of new jobs or greening

[50] www.berufenet.arbeitsagentur.de.

jobs. Even though one can get an idea that many occupations regarding environmental protection already exist.

In another occupation area 'techniques in the field of renewable energy', six occupation profiles can be found. These occupations can be classified as new since the renewable energy sector was, to a great extent, established in recent years. The six occupations are summarised in Table 5 including a short job description, an explanation for the need of the occupation and the classification of training.

Table 4 Occupations in environmental and nature protection

Initial vocational training in a vocational school	• Business Assistant - environmental protection • Technical Assistant - regenerative energy techniques and management • Technical Assistant - renewable resources • Environmental Technical Assistant
Continuing vocational training	• Specialised Clerk in environmental protection • Technician - waste engineering • Technician - chemical engineering (environmental protection) • Technician - mechanical engineering (environmental protection techniques) • Technician - environment/nature • Technician - environmental protection techniques specialising in either renewable energy, laboratory techniques, landscape ecology, process engineering or sewage disposal.
University studies	• Business Management - environmental economy • Geo ecologist • Hydrologist • Computer scientist - environmental informatics • Mechanical Engineer - regenerative energy techniques • Engineer - environmental protection/environmental techniques • Environmental scientist
Specialisation	• Waste Management Officer • Water Pollution Control Officer • Immission Control Officer • Recycling Specialist • Environment Auditor • Environmental Chemist • Expert on environmental matters • Environmental Management Officer • Laboratory Technician in environmental protection
Civil servant	• Civil servant in environmental administration

Source: Berufenet/Economix

Table 5 New green occupations in the renewable energy sector

Occupations	Training	Short job description	Need for occupation
Technical Assistant - renewable resources	Initial vocational training	Technical Assistants for renewable resources supervise, regulate and maintain facilities for the generation and provision of renewable energy or the production of materials which are all or part of renewable resources. They mainly work in companies which generate renewable energy or produce biogas or biofuel. Moroever, they are employed by manufacturers who produce products from renewable resources.	The need for this occupation can be explained by the increasing use of renewable energy and regenerative resources for production. A main advantage of the Technicial Assistants is a training duration of only two years.
Technical Assistant - regenerative energy techniques/management	Initial vocational training	Technical Assistants for regenerative energy techniques/and management are involved in research and development as well as in the production preperation of renewable energy techniques. They mainly work at energy suppliers, e.g. in wind, water or solar plants. Additionally, they are employed by electronic motors pumps manufacturers.	The training combines knowlege of technical and organisational services in the renewable energy sector.
Solar Technician	Continuing vocational training	Solar Technicians calculate, plan and build solar plants for warm water preparation or generation of electricity. They mainly work in companies which install sanitary and electro technical facilities as well as in planning offices and utility companies.	Solar Technicians acquire technical knowlege in the installation of solar plants for private use. Solar plants are often installed by companies of the sanitary area or by roofers and therefore further qualifications are required.
Technician - environmental protection techniques (renewable energy, energy consulting)	Continuing vocational training	Technicians for environmental protection techniques with a focus on renewable energy, energy consulting and ecological energy use take on leading and technical work tasks as well as consulting work tasks in the development, proving and apply of techniques for the use of regenerative energy sources. They mainly work in the technical investigation and consulting. Moreover, they are employed by manufacturers of machines and facilities from environmental techniques, especially renewable energy. Additionally, they work at energy suppliers and environmental protection agencies.	Energy management is becoming more and more important reagrding cost degressions due to energy conservations and energy efficiency. Technicians for environmental protection techniques can support environmental departments in companies or work as energy consultants.
Mechanical Engineer - regenerative energy techniques	University studies	Engineers for regenerative energy techniques develop, plan, operate and supervise facilities for the use of renewable energy sources as wind, water, solar, geothermal and biomass. Thus, they contribute to sustainable resource input and climate protection. They are employed by operators and manufacturers of renewable energy plants. Moreover, they work in reseach institutes, at universities or in consulting companies.	As the amount of renewable energy for energy supplies strongly increased in recent years, high skilled workers were needed for the work in production plants and for the research of new technologies. Due to the further increment of renewable energy a wide range of work tasks will arise for these engineers in the future.
Service Technician for Wind Turbines	Specialisation	Service Technicians for Wind Turbines are responsible for assembling, disassembing, repairing and the maintenance of wind turbines and its components. These are in general workers who have completed an apprenticeship as an electronical technician or hold a university degree as mechanical engineer. They work in the construction of wind turbines or in engineering offices for the technical planning. Moreover, they are employed by wind turbine manufactuers.	The number of wind turbines used to generate energy is rising. For both construction and service, technical knowledge is needed.

Source: BERUFENET/Economix

Other occupations can be classified as new even if they are not yet listed in the national catalogues. Many of these arise at university level. A wide spectrum of university studies are provided by universities and universities of applied sciences. On the Wissenschaftsladen Bonn[51] website around 257 courses of study at different universities can be found, all relating to renewable energy. This

[51] www.wila-bonn.de.

comprises bachelor or diploma study courses which either completely or partly focus on renewable energy and master courses with the same classification. Sub-categories are photovoltaics, bio energy, wind energy, water energy or geothermal energy. All of these train people to work in the renewable energy sector.

University studies which focus on environmental protection were also established in other sectors. A selection of relevant new courses of study differentiated in the economic sector is presented in Table 6.

Table 6 New occupations – university studies in different economic sectors

Economic Sector	Study course	Contents/Skills
Agriculture	Agrarian ecology	The students acquire knowledge for an environmentally friendly and sustainable production of food, renewable resources and renewable energy. The graudates will have the skills to find the balance between production and ecological needs.
Architecture	Building techniques	The study course prepares the students to construct together with architectures buildings, which are to a major part energy efficient or to find energy efficient solutions for existing buildings. The students acquire skills in construction techniques which fulfil climate aspects, in air conditioning and ventilation, in heat and refrigerating engineering and in electronical techniques.
Building industry	Efficient Building and Planning	Students of this study course learn all basics for optimising buildings in a energy efficient way. Besides, they acquire knowledge in architecture, constructural engineering and physics.
Energy sector	Renewable Energy	New sustainable working tasks are imparted especially in study courses with focus on renewable energy. Either wind or solar energy or a general study course on energy generation from renewable energy is possible. The students obtain basic knowlegde in energy techniques or engineering and focus on the construction of facilities for the production of renewable energy.

Source: KURSNET[52]/Economix

New occupations which arise due to continuing vocational training are hard to identify as continued training is more often used to green existing occupations. Nevertheless, three different continuing training programmes are presented in the renewable energy sector in the table above. Other continuing training programmes which lead to new skills and qualifications regarding the support of greenhouse emissions' mitigation focus on environmental engineering.

Skills in the renewable energy sector

A special investigation of skills in the renewable energy sector was conducted by the ISW Institute in 2005[53]. The qualification development and skills need in renewable energy were examined. In the study solar energy, geothermal energy, wind energy, biofuels and additionally the skills needs in combined heat and power (CHP) were part of the investigation. The skills needs for personnel in different processes were determined and are summarised below. The study defined occupations appointed to work processes and the competences required.

- Solar energy: R&D, manufacturing, consulting and sales, installation
- Geothermal energy: Hydrothermal systems, geothermal systems
- Wind energy: Production of wind turbines, technical service
- Biofuel: Biogas plants, production of bio diesel
- CHP: Installation of CHP plants

Solar energy:

In the solar energy sector especially foremen in chemical engineering, electro techniques or precision engineering are needed to support academics´ work in research. The practical knowledge of a foreman helps to find solutions which are practically applicable. Therefore it is important that the

[52] www.kursnet.arbeitsagentur.de.

[53] ISW (2005) Qualifikationsentwicklung im Bereich Erneuerbare Energien, Halle, 2005.

foreman can cooperate with the academics and tries to adapt missing knowledge in chemical engineering, electro techniques or precision engineering dependent on the basic qualifications. Thus, in-company training for communication techniques, missing technical knowledge, process techniques and team training would be necessary.

In the manufacturing of solar cells a low supply of qualified workers existed in the years before the study was conducted. The recruited worker had to persecute 'learning by doing' to integrate the missing knowledge. These were Chemical Technicians, Electro Technicians, Fitter or Automation Engineering Technicians. All of them had parts of needed skills for solar cell production but an occupation which included all required skills did not exist. The needed occupation would combine cross-sectional qualifications of the four named occupations. Moreover, is important that the workers integrate the following competences:

- IT-knowledge as all facilities are computer-based
- Knowledge in sensor technology and pneumatics
- Basics in mechanics, acids and gases and in electronics

For the further qualification of employees it would be necessary to impart the missing knowledge with further training. A preparation of modules with technical and basic knowledge of the named occupations would be possible. In order to meet the requirements of solar cell production a course on solar techniques was recently established at the University of Applied Sciences in Köthen (Saxony-Anhalt) in cooperation with solar cell manufacturers.[54]

In the area of consulting and sales of solar facilities, only sales from manufacturers to distributers (crafts businesses) are defined, meaning that the sales to private customers are not taken into account. In this context the employees especially need technical knowledge on solar cells, the facilities and their functionality. On the contrary the installation of solar facilities is mainly executed by handcrafts or plant mechanics. The required qualification is mainly imparted by further training courses. Moreover, continued training to become a 'Solateur' is provided, which comprises basic knowledge in power engineering, heat engineering, electrical engineering and technical knowledge in solar thermal energy, photovoltaic and either heat pumps or biomass.

Geothermal:
The work tasks involved in geothermal energy mainly comprise energy distribution which means generating, transforming and using energy. Due to high automation in the plants a control is only needed in the rhythm of 71 to 78 hours. The employees can therefore also maintain other plants in the business association. Thus, employees do not only need technical knowledge in electricity and heat generation in geothermal plants but also in conventional plants such as fossil fuel plants. The relevant occupations are Energy Plant Technicians, Fitter and Electro Technicians who have to acquire knowledge - mostly during further in-company training - in turbine techniques, electrical process control techniques and training contents of Fitters and Sanitary Plant Mechanics.

Surface geothermal facilities can be installed to supply heat to buildings. In this context, the areas of craft business and consulting, maintenance and sales are influenced. Energy consultants have the necessary qualifications to evaluate the building's heat insulation and energy needs and have acquired the relevant knowledge about concepts of different geothermal facilities. For installing such facilities, the same skills requirements are needed as for installing solar facilities.

Wind energy:
Wind power has been used to generate electricity for the past 15 years. For the production of wind turbines one could draw on knowledge from the areas of steel production, mechanical engineering and the metalworking industry. The traditional occupations in these fields are Fitters, Cutters, Polishers and Electrical Technicians. These have mostly been recruited and trained further for wind turbine production. Special knowledge is needed in rotor blade production, especially in the field of polymer processing. An apprenticeship in this field would be necessary as this knowledge is only

[54] Further information available in the case studies.

imparted in the training programme for the Mechanic in Plastics and Rubber Processing. Moreover, this technical knowledge is not adequate. For the production of the generators the Electrical Technicians' qualification fits the requirements. For facility maintenance the occupation Service Technicians for Wind Turbines was established, who have extended their knowledge in safety aspects while working on wind turbines and the functionality of the turbines.

Biofuels:
In bigger plants higher gains can be realised due to an improved input of materials and restoring of additional materials. In this area mainly Chemical Engineers and Process Engineers are employed. They are often supported by Fitters and Laboratory Technicians who investigate the quality of the used raps oil. No new developments in the qualification profile could be defined.

The production of bio ethanol is identical to the production of alcohol. In general wheat, corn and rye or sugar canes are used for the production. Thus, no new qualification profiles are needed.

CHP:
CHP plants can either be used for a decentralised heat and power generation or small CHPs can be used for the production of heat and power for one building or a complex of buildings. The installation, maintenance and consulting is executed by handcrafts. Only the use of fuel cells is a new required skill. If necessary, continued training is mostly provided by the manufacturer of CHPs. Additionally, further training in the basics can be pursued. This training comprises electronic components, the function of motors and generators, basic knowledge in power and exhaust behaviour of renewable energy and connections of technical systems.

3.2.2 Greening existing occupations

Initial vocational training
On the level of dual apprenticeship training, environmental protection has been integrated in all initial vocational training regulations and therefore a greening of the whole dual vocational training can be observed. The chemical industry in particular played a leading role in the integration of environmental aspects in their sector and apprenticeship training. The first revision of training regulations within the chemical industry with environmental protection was in 1987 and was updated in 2002 and 2009.

For occupations which are not affected directly by the environmental sector the integration focuses on basic knowledge in waste recycling and energy conservation. The extent of integration regarding company training strongly depends on the company offering the apprenticeship as only a minimum requirement is determined by the regulation.

Over the last few years greening can, to a larger extent, be identified by the apprenticeship training programmes shown in Table 7. The Waste Management and Recycling Technician, one of the Environmental Technicians, and the Plant Mechanic for Sanitary, Heating and Air Conditioning are investigated more closely in the case studies.

Table 7 Greening revision of existing initial training regulations

Occupation	Year of regulation revision	Greening contents
Environemtal Technicians	2002	The environmental technicians emerged as four training programmes from the "Provider and Disposer" (Ver- und Entsorger) training. They present a modernised apprenticeship with greening character. These apprentices still hold technical qualifications as standard qualification and have additionally integrated wide knowledge regarding environmental protection. The environmental technicians mainly work in waste and sewage disposal and recycling.
Plant Mechanic for Sanitary, Heating and Air Conditioning	2003	For this trade especially the increased use of sustainable energy input was part of the revision. The apprentices adapt knowledge to use regenerative energy and to conserve energy by efficient energy use. They will intensively install solar facilities, heat pumps and wood pellets for heating. Moreover, they will acquire knowledge for control systems and building system automations which take the weather forecast into account and thus help to increase the energy conservation.
Electronic Technician for Energy and Building Services Engineering	2003	For this trade the same extended work tasks apply as for the Plant Mechanic for Sanitary, Heating and Air Conditioning
Builder of Stoves and Air Heating Systems	2006	For the Builder of Stoves and Air Heating Systems also the integration of an increased use of sustainable energy dominate the greening part of the training revision.

Source: Economix

Continuing vocational training

Greening an existing occupation within continued training comprises additional skills which can be adapted by the training. These include basic trainings which impart environmental protection aspects such as waste and recycling, energy conversation or environmental legislation as well as specialised training for further work as an environmental specialist, energy consultant or environmental engineer. A list of occupations is presented in section 2.3.2.

The need for further training is mostly affected by either new legislation or new technologies and the corresponding need for skills adaptation. To illustrate skills adaptation as a consequence of new legislation the energy consultant was included in the case studies. According to legislation landlords and other people who sell buildings and dwellings require an energy pass which defines the energy need of the building. Only a designated group of occupations may opt out these energy passes. A special group are craftsmen who have completed a continuing training to become an energy consultant.

A greening of an existing occupation in the course of technological change is for example the already mentioned Solar Technicians. Due to the establishment of solar plants, skills to install these plants especially in private are needed. The target group are craftsmen, Plant Mechanics for Sanitary, Heating and Air Conditioning and Electronics, who adapt the required competences with help of continued training.[55]

University studies

An overview of university courses which curricula were adapted to green contents or which support the greening of occupations are presented in Table 8, differentiated in economic sectors.

[55] The occupation Solar Technician was categorised as new occupation in section 3.2.1. Nevertheless, for craftsmen who participate in the continuing vocational training the work tasks became greener due to the further training.

Table 8 Greening of existing occupations – university studies in different economic sectors

Economic Sector	Study course	Contents/Skills
Agriculture	Agrarian Sciences	A mandatory study module in this study course comprises environmental and resource economics. The students learn to economcially interpret environmental problems, specialities of environemental goods, national and European environmental policies and environmental targets and instruments.
Architecture	Energy efficient design	Architects have in general to acquire knowledge in energy efficient planning and construction. A possibility would be a master degree for example in energy efficient design. The study course imparts knowledge how to remediate existing buildings and how to plan and construct energy efficient buildings.
Automobile	Automobile techniques	During the bachelor in automobil techniques students learn how to develop and construct an automobile. Thus, a lot of knowledge about engineering is imparted. One course comprises environmental aspects regarding construction which fulfils recycling and production-integrated environmental protection.
Building industry	Constructural engineering	In the master degree students have the possibility to focus on environmental techniques. The module imparts theoretical basic knowledge and knowlege for the practical realisation of infrastructural measures in industrial effluent disposal, sewage sludge disposal and waste management. A combination of constructural engineering and environmental engineering is also possible.
Chemical industry	Environmental chemistry	The study comprises basic courses in chemistry and a focus on environmental chemistry. The students obtain knowledge about chemical processes in environmental chemistry, synthesis concepts to minimise waste and environmental pollution, hazardous materials and their disposal as well as knowlege on the complexity of environmental processes. The study focuses on training of computer-based measure techniques and skills in practial work in the laboratory.

Source: KURSNET/Economix

The greening of existing occupations has to be seen as a cross-sectional subject which has been included in the major part of occupations in Germany. Only the extent of integration differs. In general three main strategies can be summarised which are more or less pursued in different economic sectors regarding the mitigation of greenhouse emissions:

- Energy efficiency
- Recycling/avoidance of environmental pollution due to waste, sewage, hazardous materials
- Energy conservation

These influence the overall greening of occupations. In the craft sector skills are adapted to insulate buildings in order to conserve energy. Moreover, energy efficient facilities are integrated to conserve energy. These are also partly used with energy from renewable sources. In this context, energy management plays a crucial role in many companies in order to evaluate the current energy consumption and to assess the saving potential of buildings, work and production processes and to optimise energy use. In the future energy management will become more and more important in order to avoid cost and competitive disadvantages.

Skills shortages

For future developments the integration of environmental protection will continue to play an important role. Nevertheless, the establishment of special green occupations will not be pursued at least not on the level of initial vocational training. According to the BIBB[56] it is more efficient to integrate greening and to keep basic qualifications in the training. This is because the demand for

[56] Marion Krampe, BIBB.

specialised environmental apprenticeships is low and apprentices are at risk of being trained unilaterally, which may be a disadvantage in the future. Thus, environmental protection will also mainly be included in the future as a cross-sectional aspect while specialising depends on other qualifications.

Further greening of occupations might be in the following fields:[57]

- Agricultural occupations that commit to organic farming
- Traffic occupations that support an environmentally friendly mobility act
- Energy occupations that focus on renewable energy and energy conservations
- Manufacturing occupations that produce products from recycled materials
- Chemical occupations that use biodegradable substances
- Motor vehicle occupations that invent alternative propulsion technologies

3.2.3 Identification of skill needs

Initial vocational training
New or modernised occupations at the level of dual apprenticeship programmes arise due to a revision of the training regulations of an existing occupation or the integration of a new training regulation. Between 1996 and 2009 a total of 82 occupations were newly involved and 219 occupations were modernised.[58]

The creation of a new or the modernisation of an existing initial training regulation and its adjustment of the curricula (*Rahmenlehrplan)* of the Federal Länder is conducted in a multilevel process. The employer, trade unions, the Federal Government and the Länder are mainly integrated in the process. According to legislation (§§4 and 5 of the Vocational Training Act) a skill need has to be identified by the economy for a modernisation or the establishment of a new training regulation. In a proposal conversation in the appropriate ministry - in the case of environmental aspects the Federal Ministry of Environmental Protection, Nature Conservation and Nuclear Safety - the particular training modules are determined by a consensus between the associations of employers and employees and the Federal Ministry for Education and Research. This will be the basis for the further development of the training regulation by the Federal Institute for Vocational Education and Training and the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder.[59]

The revision of the training programme of the Provider and Disposer in the four environmental technical occupations was mainly influenced by the Association for Recycling when the need for a trade with a focus on recycling arose due to stricter laws regarding waste disposal in the 90s.[60]

Continuing vocational training
Greening of existing qualifications often happens within the system of continuing vocational training. According to a study by the Research Institute for Vocational Education and Training between 28,000 and 35,000 suppliers of continuing vocational training were found in 2002.[61] There is no law which regulates this market and an evaluation of quality is seldom provided.

The establishment of new continuing training courses or the modernisation of existing trainings is mainly determined and organised by company needs. For private suppliers the training programmes

[57] GTZ 2003.

[58] BIBB 2009: Neue und modernisierte Berufe, Stand 23.07.2009.

[59] www.bibb.de/de/4963.htm, 15.01.2010.

[60] Marion Krampe, BIBB.

[61] Severing and Fitz 2002.

are products which must be sold and thus the supply is influenced by the demand for the product. Technological changes and new legislation mainly cause the need for continuing training. Moreover, continuing training is often provided by equipment manufacturers. Siemens, for example, built a training centre for wind turbines to train its own staff but also to offer safety and product training its customers' employees, who are operators of singular facilities or of whole wind parks.

University studies

At a university level, the demand for new courses of study can be initiated by either the economy or cooperation between the university and companies which have a demand for specially trained students. Moreover, universities can decide to establish courses of study because they are aware of a potential demand for the establishment. A particular analysis does not exist. The contents and the establishment of university courses are, however, decided by the universities. Quality is often evaluated by ranking the courses and the universities.

A small insight is presented with the university courses Green Business Management and Solar Techniques which are assessed in the case studies.

3.2.4 Skills response

In 2008 around 2,500 apprentices were employed as Environmental Technicians. The apprentices have technical know-how and their work qualification is concentrated on the recycling, waste and sewage sector. The number of required workers is kept relatively constant and thus only the number of workers needed is trained. This is a huge difference compared to other trades, for example Mechatronics Technicians, who are trained in surplus. Even though the number of required apprentices is small it is difficult to occupy all the open training vacancies as the sector suffers image problems.

There is also a problem in recruiting suitable workers for apprenticeships in craft businesses. Especially in the area of waste, sewage and SHK (sanitary, heat and air conditioning) the number of apprentices is low as the image of these working sectors is poor. Moreover, the demographic change also lowers the supply of adequate workers now and, to a larger extent, also in the future.

In the official university statistics by the Federal Office of Statistics only the university courses presented in Table 9 can be directly connected to environmental protection. It has to be taken into account that these courses of study do not include all students who focus on ecology, as these issues have been integrated in various existing courses. Nevertheless, more precise information cannot be presented at this point.

Table 9 Number of students in environmental-related university courses between 2003 and 2009

University studies	Number of students						% Difference
	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2003 to 2009
Nature conservation in agrarian sciences	482	484	449	442	393	455	-5,60%
Waste management	224	272	261	239	274	132	-41,07%
Energy technique	1,753	1,681	1,902	2,172	2,139	3,049	73,93%
Environmental techniques: including recycling	5,150	5,441	5,862	6,603	6,739	7,039	36,68%
Environmental protection in urban planning	3,564	3,510	3,549	3,347	3,435	3,432	-3,70%

Source: Statistisches Bundesamt 2004-2009, Fachserie 11, R 4.1

An obvious trend can be defined from the statistics. The number of students in energy techniques and in environmental techniques has risen constantly in recent years. In the university course 'energy techniques' the difference between 2003 and 2009 amounts to 74 % and in 'environmental techniques' it amounts to 37 %. Compared to the total number of students in Germany, which was

around 2.2 million in 2009[62], the number presented in the university courses is only marginal. The number of students in waste management has declined which, on one hand, can be explained by the unattractive image of the sector and on the other hand by the fact that the sector for wage disposal will not expand over the next few years, but will rather keep a constant level of workers.

The promotion of education and training which supports the greening of the economy is visible. Beyond new types of training, many existing training courses are becoming greener due to the integration of environmental protection aspects. There is, however, still scope for improvement. If the future forecasts for the growth rates in environmental technologies are to prove true, the supply of skilled workers must to be secured. There is a tendency that the shortage of skilled workers in recent years continues for the years following. The educational policy has missed the opportunity to increase the capacities sufficiently as they underestimated the high demand growth. As in previous cases of rapid transition, the education and training system was slow to avoid skills shortages.

Moreover, companies of the renewable energy sector have not yet shown much effort in establishing a dual vocational training. A dual apprenticeship training in renewable energy, however, would be useful. Specialising in an existing training, such as the Mechatronics Technician for Renewable Energy, could be a possibility. A more specialised form would not be adequate in order to keep both the quality of training and quantity of apprentices at a high level.

3.2.5 Case studies on new green collar occupations

Case study 3: Bachelor of Engineering-solar technique

Introduction to the new occupation
Since the end of 2008, the University of Applied Sciences in Köthen (Saxony-Anhalt) in cooperation with the Q-Cells SE and the Fraunhofer Centre for Silicon and Photovoltaic (CSP) offers a study course in solar techniques. The study course combines knowledge in natural sciences, engineering and theoretical knowledge in solar techniques.[63]

The study course is a dual bachelor degree course and results in a Bachelor of Engineering in solar technique. A precondition to participate in this study course is a work contract at a company within the solar branch.

A special feature of this study is the combination of the technical theoretical basics which are taught at university and the practical experiences which are acquired at the companies. The students are employed at the companies and matriculated at the university at the same time. When there are no lectures, they work in the companies and gain experience in different departments. At university they follow the study plan. All in all, the dual study lasts six terms (3 years).

In October 2008 the first students started their study at the University of Applied Sciences in Köthen, 16 students at Q-Cells and two at the Fraunhofer Centre. During their work experiences within the companies the students already supported different research projects with their technical knowledge.[64]

Initiators
Founded in 1999, Q-Cells SE is nowadays one of the largest manufacturers of solar cells worldwide with 2,700 employees. In 2008 the company produced monocrystalline and polycrystalline solar

[62] Statistisches Bundesamt 2009, *Fachserie 11, R 4.1.*

[63] www.q-cells.de, www.csp.fraunhofer.de, http://www.emw.hs-anhalt.de/www2/studieren/direktstudium/solartechnik/zum-studiengang.html.

[64] Information was collected due to an interview with Mrs. Leich, Coordinator Training at Q-Cells SE.

cells with a total capacity of 574 megawatts peak for producers of solar modules all over the world. A new production facility in Malaysia was founded in April 2008 and started production this year.

More than 250 scientists and engineers at Q-Cells are working on technology development to achieve Q-Cells' twin aims: driving down the costs of photovoltaics quickly and permanently, and making the technology affordable and competitive. Alongside its activities in its crystalline core business, Q-Cells SE produces photovoltaic modules under its new brand Q-Cells Modules on the basis of CIGS and CdTe thin-film technologies.

Furthermore, Q-Cells International specialises in the planning, construction and maintenance of large solar parks and rooftop arrays will extend the business of Q-Cells, while Q-Cells Clean Sourcing has established a new business segment by providing industrial customers with green energy.

Q-Cells SE has branches in Italy, France, Hong Kong, China, Japan and the USA. The company is quoted on the Frankfurt Stock Exchange (QCE; ISIN DE0005558662) and also listed in the TecDAX, the German technology index.[65]

The Fraunhofer Centre for Silicon and Photovoltaic CSP in Halle is a centre for crystallisation and material evaluation and conducts research and development for silicon material. The research centre was initiated by the Fraunhofer Institute for Material Mechanic (IWM) and for Solar Energy Systems (ISE). The ISE is the largest research institute for solar power in Europe.[66]

Skill gaps and identification of skill needs

The solar branch was one of the growing markets in Germany in recent years. As part of renewable energy the solar branch realised worldwide market shares of 21 % in photovoltaic and 23 % in solar thermal energy in 2007. Thus, suitable trained staff was needed to a large extent.

Photovoltaic is a special area and workers in this field need technical knowledge in natural sciences, but also in electro techniques and process engineering. This combination imparted by a study course did not exist at German universities. There was only the possibility to focus on one of these subjects. Moreover, before the introduction of the 'solar technique' bachelor degree, theoretical knowledge about photovoltaic was not taught either in any of the existing university studies.

The amount of people who are experienced in the theoretical background and the practical work of photovoltaic is still limited, as it is a relatively new technology. Thus, there has been a continual higher demand in the supply of trained staff in recent years, especially in photovoltaic.[67]

Q-Cells has therefore faced a lack of suitable job applications for open vacancies in recent years. Additionally, dual training courses did not exist either for renewable energy or for solar techniques. The growth was restricted due to missing qualified personnel. Thus, the company decided to initiate a new course of study which focuses on solar techniques. Today it can be seen as the main driver behind its realisation.

The idea of the study course was to train people with a combination of technical knowledge in natural sciences, electro techniques and process engineering and to additionally integrate technical knowledge in photovoltaics and special knowledge for solar cell production in the course of studies.

Another driver behind the initiation is the fact that there was no industry-wide engagement of companies in the solar branch to establish a national-wide training programme. Thus, Q-Cells was forced to their own initiative in order to guarantee a suitable amount of skilled workers to reach the

[65] www.q-cells.de.

[66] www.csp.fraunhofer.de.

[67] Leich, Q-Cells.

required production level and further growth, respectively. Moreover, for adequate research in this field high skilled workers are needed to optimise technologies and to develop them further in order to stay competitive.

Existing provision of education for the occupation
Graduates of solar technique will later work in work fields of research and development, process optimising and facility maintenance. As the amount of students is expected to be low and the first students will graduate in 2011, the existing work force at Q-Cells has to be adapted to the required qualification level.

The work force which is employed in the corresponding areas consists mainly of postgraduates from different fields of natural sciences and engineering. All of them face skill gaps in photovoltaic to a certain extent. Thus, they receive continuing vocational training to close their skill gaps. The type and need of training is decided between the employee and the superior in appraisals. Some employees perceive the possibility to do for example a master degree in physics or chemistry. Others obtain training with varying contents depending on the skill gaps. The training is selected individually for every employee. Some examples for continuing training are:

- Basics, dimensioning and use of photovoltaic energy
- Process and plant trainings for wet chemistry, metallisation, diffusion and SiN deposition
- Technology for silicon production
- Types of solar cells and solar cells with high level of efficiency
- Technology for Si solar cells
- Measurement techniques and cell tester

If possible, the training is conducted by internal trainers who are experienced employees in the required fields. If needed, external trainers can be hired or trainings at external locations are attended. Due to external trainings the employees gain experiences from other companies in the branch. The training courses help to adapt the employees' qualification to follow the development of photovoltaic technologies as they precisely meet the requirements. Nevertheless, a study course with the required contents is favoured as further training is not as sophisticated as a student course.

The company arranges different possibilities for their employees. Either they are trained further or they start their training at the company with dual vocational trainings or the university course. The company follows this strategy in order to position itself with employees who have different types of training.

The skills response
The Q-Cells SE as the main initiator cooperated with the University of Applied Sciences Köthen to develop the bachelor degree in solar techniques. It was the first study course in this field in Germany. The study contents have been compiled by the technologists of Q-Cells and the university. Some modules were completely developed by the company.

The study plan has a modular structure and consists of both optional and obligatory modules. During the study a specialisation in either facility techniques or technology is possible. The contents of the study are the basics and applications of natural sciences, introduction to photovoltaic, processes of silicon production, solar cell production and solar module production. Moreover, knowledge of foreign languages, presentation techniques and business knowledge are taught. An overview of the study contents is presented in Table 10.

The first four terms at university are structured rather similar with 12 weeks of lectures, three weeks of project work, five weeks of work experiences, four weeks of exams and two weeks of holidays. In the fifth and sixth terms the students have a longer work experience of 18 weeks in the companies, and in the latter they also have to write their bachelor thesis.

At university the lectures are all held by professors. The basic natural sciences courses are taught by professors who were working at the university before. For special modules professors with technical knowledge were acquired. One of the professors works at the Fraunhofer Centre.

On completing the university course the students receive a Bachelor of Engineering degree in solar techniques. Afterwards they can work as engineers in companies of the solar branch or continue with further studies to attain a master degree.

Table 10 Overview of study contents in the bachelor degree - solar techniques

Terms					
1	**2**	**3**	**4**	**5**	**6**
Mathematics	Mathematics	Measury and regulation techniques	Basics in automation	Work experience	Work experience
Chemistry	Material techniques	Production engineering	Solar cell production (thin-film)	Quality and environmental management	Online course business management
Physics	Electro techniques	Informatics	Solar module production	Use of photovoltaic	Bachelor thesis
Technical mechanics	Fluid mechanics	Silicon production	Elective subject 1	Maintenance	
Introduction photovoltaic	Physical basics in photovoltaic	Solar cell production (Wafer)	Robot techniques/Chemical VT 2	Elective subject 2	
Soft skills (presentation, foreign language)	Soft skills	Construction CAD/Chemical VT 1	Electronic, power electronics/SVP, Process optimising	Facility techniques/ Solar cells production 3	

Source: Q-Cells SE

The students receive 500 Euros per month from the company as a kind of training salary. The company has no extra fees for the students as there are no tuition fees in Saxony and the universities in the federal state are paid for by the state government. Therefore, the company also favours the study course as it costs less than an initial continuing training.

However, the capacity of the company to take up students is limited as all the students will finish the study course at the same time and they are also all in the company during their practical work at the same time. Thus, further training is also needed to adapt the qualifications of existing employees and of newly recruited employees of other study courses in order to fulfil the requirements of the solar branch.

Assessment of the effectiveness and organisation of this response

The bachelor degree in solar techniques is a good way of obtaining skilled workers with adequate qualifications. It promotes the availability of qualified workers. Moreover, it is not necessary to train them further. This is a disadvantage for employees who lack competences in working with photovoltaic technologies. Furthermore, the students are already familiar with the company which increases their motivation.

Q-Cells SE defines investment in the students as an investment in the future because they are the ones who will support the company's progress. Moreover, the company expects the graduates to support the achievement of environmental targets. Due to more research the company will be able to lower production costs and energy consumption. Thus, the company will produce in a more environmentally sound and resource-conserving manner.

Q-Cells supported 16 students in the first year of implementation in 2008. In 2009 there were no new students employed due to the economic circumstances. Next year, in 2010, the company plans to give 10 students the chance to participate. There is a high demand for these places as the company expects to receive around 300 applications.

As the course of study started only recently, the study contents might be slightly changed in the future. Some contents of existing modules might be adapted depending on the development of the market, e.g. if new technologies are introduced.

Outlook
The Q-Cells SE and the Fraunhofer Centre also work closely with the Martin-Luther-University in Halle-Wittenberg. There, a focus on photovoltaic was initiated within the master study of physics. It comprises relevant lectures and seminars which are partly given by training staff of the Q-Cells SE. Additionally, the company offers the students internships, jobs as working students and postgraduate research jobs.

The study course in solar technique only had 5 new students in October 2009. This low number is mainly caused by organisational problems between the University Köthen and Q-Cells. The company decided to employ no new students and thus, the university had problems finding new companies to collaborate with. Nevertheless, the demand for the study course is high especially amongst students.

Therefore the university is implementing a platform for students so that they can apply directly to the university and the university will afterwards try to place them into corresponding companies. New companies of the solar branch have been acquired and the university will also try to integrate other companies before the next study course starts in October 2010. The university plans to have at least 18 – 25 students but would also have capacities to incorporate more students up to 50 or even more. The number is dependent on the cooperating companies which have to offer work contracts to the students.[68]

Moreover, the university already has a completed concept to introduce the study course as an independent study in which the students need no contract with a company of the solar branch. However, the plan which has been created will not yet come into effect. The university decided to not start this study course in the next year because they prefer the existing systems with a dual study course. The university sees it more as an opportunity for the following years.

[68] Information was collected due to an interview with Prof Dr. Andrea Jurisch, chairlady of the study commission for the study course solar technique at the University Köthen.

Case study 4: Bachelor of Science – Green Business Management: BiTS Iserlohn

Introduction to the new occupation
Since the end of 2008, the private University of Applied Sciences BiTS (Business and Information Technology School) in Iserlohn (North Rhine-Westphalia) offers studies in Green Business Management. The course combines lectures in management, economics and environmentalism. [69]

The course lasts six terms (3 years) and results in a Bachelor of Science degree. In October 2008 the first students started their studies at the BiTS, 11 students altogether, 4 of which were women. In the second year 9 students, 3 women and 6 men, started to study Green Business Management at the end of 2009.[70]

Green Business Management was mainly initiated by the president of the university, Dr. Walther, who expects Green Business to be a future subject and a growing demand for graduates who specialise in environmental protection. Moreover, as a private university it is always necessary to find market niches. Therefore he cooperated with an experienced professor in ecological and management aspects, Professor Dr. Meuser, who helped establish the course of study.

Since 2009 the patron of the course is the former Environmental Minister, Sigmar Gabriel, which illustrates the actuality and seriousness of the study course.

Founded in 2000, the BiTS University of Applied Sciences is an officially recognised university which offers studies focusing on management and entrepreneurial aspects. Since February 2009 the BiTS is part of the Laureate International University network which comprises 45 different universities in 20 countries with around 550,000 students.

Skill gaps and identification of skill needs
The significance of energy management is becoming more and more important: Energy use, possibilities of energy conversation and assessment of energy efficiency in production processes are fundamental priorities which have to be included in all business strategies. Companies which do not integrate environmental protection will suffer competition and cost disadvantages in the future.

The initiation of Green Business Management resulted from positive expectations of an increasing demand for qualified graduates in environmental protection and business management. Even though a specific need to establish such a study course was not expressed by companies, they showed a high amount of interest after discovering that such a course exists which combines management and environmentalism. At the moment companies which will offer internships and bachelor thesis themes to the students can be acquired.

The demand for qualified ecological managers is more often already defined at bigger companies like BMW or Daimler, but will – according toProfessor Dr. Meuser –also increase in small and medium-sized companies in the future.

In recent years there has been an increasing trend to develop study courses which combine technical studies and the environment as the environmental technology sector has shown high potential for employment growth. Nowadays not only technologies which support environmental protection are needed, but also skilled workers who are able to give advice on energy conversation within companies in all economic sectors. Therefore, the establishment Green Business Management is essential for a further integration of green aspects in the educational system.

The students of the study course will be able to work in the interface of both environmentalism and management and can thus realise cost degressions and will support the companies in obtaining their mandatory and voluntary climate targets.

Existing provision of education for the occupation
Nowadays companies which are interested in employees who have acquired good knowledge in both management and environmental protection need to recruit graduates of management sciences who

[69] www.bits-iserlohn.de.

[70] Professor Dr. Meuser, dean of the study course.

have partly focused on the environment or they have to train them further. A combination of both as a main subject did not exist before the study course at the BiTS was established.

The skills response

The study course Green Business Management lasts 3 years which means six terms in Germany. In the first three terms the study contents are determined by the university. In the last two terms students can choose different areas that they would like to focus on and they have to write their bachelor dissertation. In the fourth term the students have to do a 16 week internship at a company. An overview of the study contents is presented in Table 11.

The curricula of the study course were all developed by Professor Dr. Meuser who is a specialist in ecological studies. Together with 8-9 other professors he gives green lectures to the students. All of the professors had to be newly recruited.

Table 11 Green Business Management: Study contents

1. Term	2. Term	3. Term	4. Term	5. Term	6. Term
Management Basics	Corporate Accounting and Quantitative Methods	Finance and Business Management	Urban Study	Bachelor thesis	
Environmental Management I	Environmental Management II	Environmental Management III	Internship	~~Elective subjects:~~ (examples)	
Sustainable Business I	Sustainable Business II	Sustainable Business III		Eco-Marketing,	Eco Techniques,
Economics I and Law I	Economics II	Economics III and Law II		Sustainable Entrepreneurship	Sutainable Finance
Soft Skills – Basics	Soft Skills – Advanced	Soft Skills – Special		Logistiscs	Marketing

Source: BiTS, Economix

A special feature of the study is a four week 'Urban Study' at a fellow university in an eco-city such as Mexico City, Sao Paulo or New Delhi. The event takes place at the beginning of the fourth term before the students start their internship. In this year the students – who are the first students of the study course – visit Quito,Ecuador, at the end of January 2010. The initiation of the Urban Study has two main drivers. On one hand it increases the attractiveness of the study course. But on the other hand it is supposed to improve the students' awareness of environmental pollution and environmental protection possibilities in a country where environmentalism is not as common as in Germany. For this reason Quito is a favourable example to become acquainted with, the rainforest on one side and the waste problems in the city on the other side.

The study course all in all costs 24,015 Euros per student not including costs for living and dwelling. The students can apply for a studentship. Altogether only 2 out of 20 students are supported by two companies which pay for half of the fees. All other students are supported by their parents.

Assessment of the effectiveness and organisation of this response

Only 20 students began the study course in the first two years. In 2010 an upward trend in terms of students in expected by the university. There are possible reasons why not many students have chosen the study course. On one hand, young people who have recently finished school are, according to Prof. Dr. Meuser, often not that interested in environmental protection and thus start to study other subjects such as Sport & Event Management or Business Psychology. On the other hand, environmentalism still has an alternative image and is therefore not that popular yet.

This particular bachelor study course has only been around for 1.5 years, thus an evaluation of the graduates' chances on the labour market does not exist yet. Nevertheless, there are positive expectations that all students will find a job. Moreover, the university is trying to build up networks with regional and interregional companies in order to promote their study course and to enhance the job search for their students.

The bachelor degree in Green Business Management is a good way of obtaining skilled graduates with combined knowledge in management and environmental protection who will be able to work in the interface of both subjects and additionally bring them closer together. The students will be able to support the company in realising climate targets.

Within the internal network of Laureate Universities, two universities have already shown interest in the study concept of Green Business Management. They will probably integrate the curricula in their own concept and use it as a procedure document.

Outlook
As mentioned above young peoples' interest in environmental aspects is often low. . Therefore the university wants to introduce a master degree in Green Business Management as the awareness and interest in environmental aspects increases with age. The university plans an occupational master degree for employees who are aware of the importance of environmental protection and who are willing to participate in further training.

There is no concrete starting date as the university is waiting for the evaluation of the bachelor course and its development. Nevertheless, as a private university the BiTS would be able to rapidly develop the new master programme if necessary.

Case study 5: Service Technicians - SiemensWind Power Training Centre, Bremen[71]

Introduction to new occupation

In 2009 Siemens established a new wind power training centre in the city of Bremen. Thus, the company now offers a broad-based qualification programme for customer personnel and service technicians. The training centre is an important part of the Siemens European Service Headquarters for Wind Power in Bremen alongside three other training facilities in Europe and the U.S. Moreover, it helps Siemens to meet training needs for wind power services.[72]

Siemens in general concentrates on three sectors, namely Industry, Energy and Healthcare. The wind power business segment is part of the renewable energy division, a division belonging to Energy. Its headquarters are located in Denmark.

The trainings are especially directed at electronic technicians or mechatronics technicians. Between August and December 2009 around 180 technicians participated in the training. All participants were personnel of Siemens and its subcontractors. As soon as all training modules have been realised (the training centre opened in August 2009 and thus not all training modules have been finalised yet) around 800-1000 training participants are expected per year.

The wind power training centre was implemented by the European Service Headquarters for Wind Power. The Service Headquarters have 550 employees (260 in Germany), of which 390 (160 in Germany) are service technicians who work with services at Siemens wind turbines and the remaining 160 (100 in Germany) work in the office (in Bremen). The training centre was built in Bremen because the city has good structural conditions and forms a structural competence network for onshore and offshore wind power in the region. Bremen also supported the realisation of the training centre.

Nine different types of Siemens wind turbines exist which realise between 1 MW to 3.6 MW. Further turbines types lower than 1 MW are in operation. In Germany, 1400 Siemens wind turbines corresponding to 1500 MW are installed which means a contribution to greenhouse emissions´ reduction of about 3 million tones CO_2

Skill gaps and identification of skill needs

First of all Siemens established the wind power training centre in Bremen in order to guarantee a high quality service for Siemens wind power facilities. The training centre is part of an international programme at Siemens which comprises health, safety and environment. Every Service Technician learns to organise the daily work in wind parks in a safe and efficient way.

Moreover, technicians who are employed by Siemens Wind Power are usually electronic technicians or mechanic graduates. Due to high safety and technical standards of Siemens' wind turbines further training regarding safety and technical modernisations is constantly needed. The special condition of wind energy plants – the working place is often located 80 metre above the ground or the sea – requires repeated and comprehensive safety training.

Furthermore, newly employed technicians may not start work on the wind turbines before they have completed seven days of safety training. In addition, they have to obtain continual technical training afterwards in safety and technical know-how.

The training centre was established due to the high need of trainings for both experienced workers and newly recruited workers. The training modules could be created in the company´s own initiative and no dependency on external suppliers for the training exists.

Existing provision of education for the occupation

Before the training centre was established Siemens' employees only received product trainings on small simulators in the Danish headquarters. The training included features and the functionality of

[71] The information was collected by an interview with Nils Gneiße, who is the manager of the training centre.

[72] http://w1.siemens.com/press/pool/de/pressemitteilungen/2009/renewable_energy/ERE200908078e.pdf.

the turbines. As technologies of wind turbines and its modules became more and more specific and complex in recent years, a special training for adapting qualifications was required.

The skills response

The training programme comprises technical and safety trainings such as the construction, service and maintenance of Siemens turbines or specific offshore safety training modules. Training courses impart a wide theoretical and practical knowledge. Experienced trainers conduct the courses. The training measures are for service personnel of Siemens and its customers, operators of singular facilities or whole wind parks and technical works managers.

Siemens' employees are still provided with product trainings and moreover, eight additional trainings are offered by the training centre. An overview of the training modules and their contents are presented in Table 12. Alongside the eight training modules a special IT training for turbine IT-technologies also exists. [73]

Table 12 Service Technicians for wind turbines - training modules and contents

Training module	Short description	Training contents
Basic Safety Training	There are different access zones in a wind turbine. Training at the tower model grants participants access to zone 1 (tower and nacelle). Course participants will learn how to use the climbing protection system up to 14 meters above the ground. Moreover, they will intensify their skills in rescuing colleagues and themselves at heights while considering a wind turbine's special conditions and surroundings.	• Usage of personal protective equipment, safety equipment and lifting points • Safe rescue and evacuation of wind turbine considering location, position etc. • Safe and correct rescue of casualty from access zone 1 • Self evacuation at height • Correct user inspections of rescue and evacuation equipment
Advanced safety training	The heart of the training centre is an original nacelle from 2.3 MW Siemens wind turbine. Course participants take part in safety trainings on this nacelle for working at extreme heights and rescuing injured persons. Training contents are designed to be as close to reality as possible	• Rescue of causalities in access zones 1 to 3 in wind turbine • Safe and correct use of Siemens Rescue Kit in rescue situations • Assistance for rescue teams • Harnessing and rappelling of an unconscious person on a spine board or a basket stretcher • Evacuation of wind turbines
Specific Offshore Safety Training	Work on the open sea calls for special requirements for operational safety. Offshore wind turbines are most frequently anchored using monopole structures – a pole forms the turbine tower's socket and basement, access zone levels 4 and 5. Adequate safety procedures are trained in this course as well as rescuing persons from the basement.	• Rescue of causalities in access zones 4 and 5 • Safe and correct use of Siemens Rescue Kit in rescue situations • Assistance for rescue teams • Harnessing and transport of an unconscious person on a spine board or a basket stretcher • Evacuation of wind turbines • Assistance in helicopter rescue situations
Personal protective	The greatest challenge for service technicians working on wind turbines is	• Maintenance and testing of personal protective equipment

[73] Siemens delivered information brochures about the training centre and training contents.

equipment	that installing and maintaining the turbines takes place at great heights. Siemens wind turbines are equipped with a comprehensive safety system. Every person mounting the turbine must be wearing personal protective equipment, which is connected to an anchoring system via steel wiring. Equipment inspections and maintenance are just as much part of the training as safe and correct handling and usage	• Safe and correct usage of protective equipment and safety systems • Safe and correct usage of protective equipment on the ladder • Standards and regulations applying to working at heights
Basic electronics and hydraulic	Wind turbines are equipped with diverse electric and hydraulic system components. The interplay of electronics, sensors and hydraulic systems is complex and calls for diligent coordination. The course participants refresh their knowledge in electrical and hydraulic engineering. The theory is put into practice in the various trainings modules.	• Electrical system concepts such as Ohms law, AC & DC voltage, transformer, diodes, contactors, etc. • Hydraulic system aspects such as filter technology, hydraulic oil, brake station, etc. • Correct and safe operation on the basic electric and hydraulic system • Proper use of tools and measuring devices, such as manometer and millimetre • Read, analyse and understand electric and hydraulic systems
SWT – 2.3 Build-up and functionality	Siemens has developed a special simulator with several components to simulate construction, functionality and behaviour of a Siemens 2.3 MW wind turbine. Participants can experience smooth operations, fault identification and troubleshooting in realistic surroundings. Siemens research and development results are conveyed to the participants. The resulting comprehensive knowledge on functionality and control of the turbine enables sustainably safe and efficient operation.	• Electric, mechanical and hydraulic systems of a 2.3 MW turbine • Basics of construction of a wind turbine, shielding of cables and generator systems • Converter, gear, oil and cooling system • Use of E-plan and hydraulic diagrams • Gearbox principles • Stopping and electrical/mechanical locking of the turbine • Use of personal protection and electrical safety equipment • Troubleshooting in electrical and hydraulic systems
Crane and chain hoist – operation and services	Modern Siemens wind turbines are equipped with a service crane and chain hoist to lift weights and perform maintenance services. Participants may gather experience in operating the hoist mechanism in Siemens wind turbines. A second course for service and maintenance of crane and chain hoist is offered.	• Construction and components • Crane and chain hoist operation • Directions and prohibitions for chain hoist • Documentation and special equipment • Hydraulic and electric load diagrams • Safety inspection and risk analysis • Inspection and tuning of hydraulic system • Maintenance of crane and chain hoist • Fault diagnosis for relevant systems

Bolted joints	Precise and reliable bolted joints are essential for technical operation of wind turbines. In the tower, rotor, nacelle and generator there are a number of them and they must all withstand heavy loads. Participants learn about different systems for bolted joints and different techniques for insertion and testing. The course is for participants using manual and hydraulic tools to perform torque and tensioning of bolts	• Different bolt types and their making • Use of hydraulic tensioning tools according to the Siemens documentation • Avoidance and correction of bolts that are too loose or tight • Visual inspection of the pump tubes for damage and leakage • Determine if a tower assembly needs shimming • Filing out check list for bolted joints

Source: Siemens/Economix

The training contents were determined by the Wind Power headquarters in Denmark, whereas the focus was on safety and quality of services at Siemens wind turbines. The contents were implemented with a focus on objective precision, promotion of activity and success.

All new employees have to participate in the training modules, but not all training modules are required. The focus is especially set on safety training. Employees who were already employed at Siemens partly obtain the new training modules dependent on their work experience and the qualifications of every single worker.

Siemens bears the costs of the training for its own employees and subcontractors or external companies pay for their employees. The average time of a training module is five days.

Assessment of effectiveness and organisation of this response

Siemens has good business prospects in the 'services' area and thus, the training centre meets the strategic orientation of Siemens Wind Power. Together with the city of Bremerhaven, Bremen has good structural conditions and both cities form a competence network for wind power.

The training comprises practical and theoretical modules. The effectiveness is examined by education objective accounts. All in all the organisation of continual training has improved and due to the new training courses the employees' qualification has been enhanced. This is also visible in the product trainings, which the employees still receive. Appreciation for training has improved and has thus led to increased effectiveness and efficiency of both product training and services.

Compared to other wind turbine manufacturers the amount of training at Siemens is high. This has also increased the image of the products and the demand for Siemens wind turbines. Moreover, the additional training ensures the efficiency, quality and availability of facilities because well qualified service technicians can more easily reveal the faults as they have detailed technical knowledge about the wind facilities.

Outlook

Even though the training modules improve Siemens' services, a continuous improvement is being pursued. The training structure is always extended and trainers are trained further. Moreover, if new technologies or features are introduced the training modules have to be adapted. At the moment the majority of changes are implemented by the headquarters in Denmark, but the cooperation between the different locations of wind power service centres and the headquarters is due to be strengthened in the future.

3.2.6 Case studies on greening existing occupations

Case study 6: Recycling and Waste Management Technician

Introduction to occupation

Recycling and Waste Management Technicians make sure that waste is correctly disposed of and exploited. They organise the collection and distribution of waste and recycled products and dispose of them. They mainly work in disposal firms, utilisation and treatment facilities, for example, glass and paper recycling facilities, landfills, composting facilities, and chemical and physical treatment plants. In public cleansing they organise the service of rubbish collection cars and optimise their rounds. In disposal firms they ensure that waste and sewage does not pollute and harm the environment. Moreover, they accept, identify and assign waste to disposal systems or repair waste utilisation, treatment and disposal plants. Recycling and Waste Management Technicians work in a pro-environmental manner. [74]

The dual training course to become a Recycling and Waste Management Technician is an approved trade. The apprenticeship lasts 3 years in Germany. The training takes place in special areas of logistics, collection and marketing or waste utilisation and treatment or waste disposal and treatment.

The trade was newly implemented in 2002. Before that an existing initial vocational training, the Provider and Disposer (*Ver-und Entsorger*), covered that field. However, as work tasks became more and more complex and a specialised qualification was required, the initial training was revised into four environmental technical trainings, namely the Recycling and Waste Management Technician, the Water Supply Engineering Technician, the Sewage Engineering Technician and the Pipe, Sewer and Industrial Service Technician. [75]

In 2002, 102 apprentices were already performing the new trade and the number continuously increased to 553 in 2008. The proportion of women is low and amounts to between 9 % and 10 %. The percentage of foreigners is only 1.2%. In 2006 the average age of the apprentices was 19.4 years old. 24.4 % of apprentices had the equivalent of the secondary general school (*Hauptschulabschluss)*, 50.2 % completed a intermediate school (*Realschulabschluss*) and 11.7 % had a general qualification for university entrance (*Abitur/Fachhochschulreife)*. The remaining part had either other qualifications or no school leaving certificates.

As the former training for Provider and Disposer was divided into four different trades, the number of trained 'providers and disposers' had to be compared to the number of people in the trainings for the four environmental technicians. In 2002, 1,258 people were trained as 'Providers and Disposers'. In comparison, the four environmental technicians added up to 2,500 apprentices in 2008.

Companies mainly train for demand, which means that the chances of being employed after completing the apprenticeship are high. The amount of unemployed Recycling and Waste Management Technicians is thus low.

In 2007 around 54,800 people were working as Waste Disposer and Street Cleaner. Compared to 2005, the number of workers marginally decreased (54,900 in 2005). In previous years, the number of workers decreased altogether by 9.4 % between 1999 and 2007. All in all, 3.0 % of the workers in 2007 were women. The majority (53.6 %) was between 35 and 50 years old, 14.1 % were between 25 and 35 years old and 28.5 % were older than 50 years old. The remaining 3.9 % were younger than 25 years old. A large proportion of 55.9 % held a degree in a dual vocational training, but

[74] www.bibb.de, Verordnung der Berufsausbildung in den umwelttechnischen Berufen 2002 BGBI. I S.2335.

[75] www.berufenet.de.

thereof only 0.7 % had the general qualification for university entrance. 33.6 % had not completed any dual vocational training and of the remaining 10.1% the educational training was unknown.[76]

Skill gaps and identification of skill needs
Growing pollution and increased environmental awareness led to constant improvements in technical environmental protection. Trained staff in waste management and recycling facilities was required to handle waste disposal and growing amounts of waste. Moreover, the avoidance of facility breakdowns and restricted air pollution raised the need of qualified workers with a technical qualification and skills in environmental technique, natural sciences and protection techniques against emissions. As disposal firms specialised more and more and, at the same time, waste management became more complex and technically sophisticated, a trade in special areas was needed.

The need for a revision of the existing trade Provider and Disposer came up mainly due to the discussion of whether a special trade for recycling was needed, especially influenced by the Association for Recycling. Moreover, in the 90s new laws regarding waste disposal were implemented and thus influenced the waste sector sustainably. Waste was previously stored at rubbish dumps and the separation and recycling of waste was not common. This was changed with stricter regulations for waste disposal. There was a strong need for qualified persons who also had acquired knowledge about the new legislation.

The former trade in this area, the 'Provider and Disposer, had obtained a more general training. Due to the risen complexity and the technological changes, trades with a stronger specialisation were required which could adapt knowledge in modern technologies and the wide field of legal regulations. Moreover, they needed to reflect the higher awareness for environmental aspects in Germany.[77]

In cooperation with the Ministry for Environment, the Federal Ministry for Education and Research (BMBF) initiated an investigation to define the need for a revision. Authorised experts from organisations conducted the study and interviewed companies in different branches. Mainly companies in the areas of paper, electronic and scrap disposal were questioned. These experts suggested different contents for the revision of the training.

The training for the Recycling and Waste Management Technician was provided with three specialisations in order to give firms of different fields the chance to select apprentices with the focus on their requirements. Thus, a Recycling and Waste Management Technician is supposed to meet requirements for different types of disposal firms.

For the new trade Recycling and Waste Management Technician it was important that the apprentices after completion would be able to use their technical knowledge for the use of the facilities in this sector on the on hand and to be aware of environmental protection while executing work tasks on the other hand. Thus, Recycling and Waste Management Technicians have adapted technical know-how to use environmental facilities in the disposal sector and can therefore actively support the protection of the environment.

Existing provision of education for the occupation
The training regulation for the Provider and Disposer was implemented in 1984. The duration of training lasted three years. In the first year the training comprised a wide fundamental training in natural sciences and in the second year technical knowledge was imparted. In the third year the apprentices could decide to specialise in water supply, sewage or waste. Accordingly to the election the apprentices worked after completion in the areas of:

[76] IAB, Berufe im Spiegel der Statistik.

[77] http://www.bibb.de/de/1573.htm.

- water production, water conditioning and distribution
- waste water draw-off
- waste treatment including recycling

Skills response

Initial vocational training
In the first 15 months of factory training and during the first 18 months in the vocational school the four environmental technicians are taught the same basic contents before they start specialising. Basic contents comprise environmental techniques, ecological cycles, and hygiene as a basis which include reasons and interactions with air, water and ground pollution and the possibilities of avoiding and minimising environmental pollution with facilities and techniques. The former Provider and Disposer training communicated the same contents for two years before the apprentices began specialising. One of the main changes is that the four environmental technicians are strongly trained in customer-orientation and service-orientation.

In the second part of their training the apprentices acquire technical knowledge and become specialised. The Recycling and Waste Management Technician learns amongst other things, measures for occupational safety during the collection, transportation and treatment of waste, hazardous materials and special waste. Moreover, they learn how appliances and facilities are operated, monitored and serviced.

The training targets vary regarding the specialisation fields:

- Apprentices who focus on logistics, collection and marketing concentrate on road and freight traffic laws for the collection and transportation of waste, the calculation of cost and benefits, and the conduction of stationary and mobile collection.
- Apprentices who focus on waste utilisation and treatment concentrate on sampling, preparation and its record and the cognition and correction of appliances and machines.
- Those who concentrate on waste disposal and treatment focus on how waste has to be separated, temporarily stored and provided for disposal and how these processes are navigated, regulated and monitored.

An overview of training contents is presented in Table 13.

Table 13 Recycling and Waste Management Technician - Contents of training

Part of training	Practical training	Vocational school
First part of training	Economical processes, work organisation	Planning an environmental concept
Basic qualifications 1. year	Information and documentation and quality management	Use of environmental chemicals
	Environmental protection technique, ecological circulation and hygiene	Examination of water and waste ingredients
	Basics of of machine and process techniques, measuring techniques and regulation techniques.	Operation and maintenance of machines and facilities
	Materials, auxiliary and hazardous materials. Dangerous working materials and material processing	Collection, transportation of waste. Chemical and biological treatment of waste
Second part of training	Costumer-orientated and business-orientated acting	Waste disposal
2.-3. year	Recycling processes	Waste investigation
	Safety and opertaion instructions	Waste treatment
	Logistics and disposal	
	Information technology	

Source: Berufenet

Continuing vocational training

A successful start in the job is just the beginning: the occupational career depends on the maintenance of technical knowledge and the continuous supplementation and deepening of specialised knowledge and the adaption of new developments. The subject area for continuing training for technical adaption is wide and ranges from waste disposal to recycling. The Recycling and Waste Management Technicians can also continue with foreman training to either become a Certified Senior Specialist for Recycling, Waste Management and Public Cleansing or a Senior Technician for Waste Techniques or Environmental Techniques. There is also the possibility to study engineering with a focus on waste management, environmental protection/techniques or processes at university. In the waste sector it is quite common that apprentices proceed with further training, especially with the foreman degree.

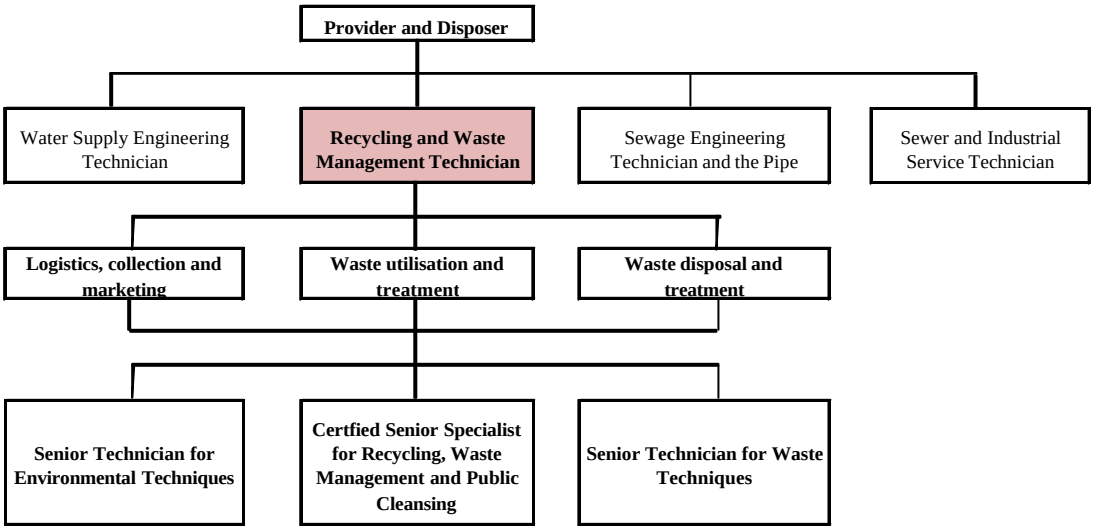
Outstandingly capable apprentices can be promoted by a studentship for continuing vocational training, foreman trainings or university studies. The studentship is offered by the BMBF.

Assessment of effectiveness of response

As the revision of the Provider and Disposer was implemented in cooperation with authorised experts of employers and employees, many new requirements were incorporated. Especially firms favour the possibility of three different specialisations. Thus, the companies can only train the needed knowledge for their work tasks.

There is still the discussion of whether a separate training for the recycling sector is needed. As the initial training for the Recycling and Waste Management Technician meets the minimum requirements, companies of the recycling sector are supposed to train with a focus on recycling.
To a certain extent companies complain about the low number of apprentices as the demand for apprentices is sometimes higher than the supply. In cooperation with the DIHK the BMU published an information brochure in order to improve the image of the four trades and to increase the number of apprentices.

Chart 2 Recycling and Waste Management Technician - Histology of trade



Source: Economix

Outlook

The Recycling and Waste Management Technician is a trade with a sound future. Experts forecast a growing demand for waste as fuel for generating energy. As resources are becoming scarce raw materials are not longer obtained by mining but rather from recycled waste. In this context the term 'urban mining' has emerged. This means that recycling waste and the added value of the waste management sector is becoming more important. The focus is expected to be set on the use of waste rather than on waste disposal.

Case study 7: Plant Mechanic for Sanitary, Heating and Air Conditioning Systems

Introduction to existing occupation
In general Plant Mechanics for Sanitary, Heating and Air Conditioning Systems plan, install and maintain complex plants and systems in supply engineering. Moreover, they do the technical service. They mainly work in installation firms or at heating and air condition constructors. Nowadays an increasing number of them install energy-saving systems which work with renewable energy sources, e.g. solar power, and they also, renew old heating systems.[78]

In 2003, this trade was created from the former trades of gas and water installer, plumber, constructor and central-heating and ventilation constructor. Parts of the systems mechanical trade central-heating specialists in utilities technology (gas, water and power) are included in the training programme.

The dual training course to become a Plant Mechanic for Sanitary, Heating and Air Conditioning Systems is an approved trade. The apprenticeship lasts 3.5 years in Germany. The venues for training are within the company and at a part-time vocational school. The training focuses on special areas of water technique, air technique, heating technique or environmental technique/renewable energies.

Around 33,000 people did an apprenticeship in this trade in 2006 (2005: 25,500), which means an increase of 30 % compared to 2005. Only 0.8 % of these were women. The average age was 18.5 years old and the majority of apprentices (51.3 %) had a certificate of education from a secondary general school (*Hauptschulabschluss*), 31.9 % completed an intermediate school (*Realschulabschluss*) and only 2.1 % had a general qualification for university entrance (*Abitur/Fachhochschulreife*). The remaining part had either other qualifications or no school leaving certificates.

In 2007 around 177,000 people were employed as pipe installer, who includes installer of gas, water, heating and conditioning technologies.[79] Compared to 2005, the number of workers slightly increased by 1.5 % (2005: 174,500). In the years before, however, the number of worker decreased by 27 % between 1999 and 2006 (1999: 240,000). All in all only 0.5 % of the workers in 2007 were women. The majority (46.7 %) was between 35 and 50 years old, 23.7 % were between 25 and 35 years old and 19.7 % were older than 50 years old. The remaining 9.9 % were younger than 25 years old. A large proportion of 84.4 % held a degree in a dual vocational training, but thereof only 0.6 % had the general qualification for university entrance (*Abitur*).

Skill gaps and identification of skill needs
At the beginning of the 19th century occupations such as well builders, pump builders and coppersmiths existed. Later the occupation of a plumber developed, which can be referred to as the precursor of the gas and water installation craft. At the beginning of the 20th century steam heating was built to a lesser extent. The grids were established by plumbers or coppersmiths. In 1938 the occupation of a central-heating and ventilation constructer evolved because of the increased demand for heating systems. The occupation was technically sophisticated as the automation of firing systems and control systems progressed and the requirements of environmental protection had to be fulfilled.

In 1989 the trainings in metal fields were revised and the dual vocational training for central-heating and ventilation constructor and gas and water installer, plumber and constructor (Gas- und Wasserinstallateur) were reworked and adapted to meet new occupational requirements. These two

[78] www.bibb.de, www.berufenet.de, Verordnung der Berufsausbildung zum Anlagenmechaniker für Sanitär-, Heizungs- und Klimatechnik 2003 BGBI. I S. 1012, 1439, 1543.

[79] IAB, Berufe im Spiegel der Statistik.

trainings were combined in 2003 and converted into the Plant Mechanic for Sanitary, Heating and Air Conditioning Systems. At the same time the initial training regulation for this trade was renewed.

Due to the revision of the training regulation in 2003 the contents of training became first of all more service-oriented as costumer relations became more important in recent years. Moreover, knowledge about the use of sustainable energy input was part of the revision. The apprentices have to adapt knowledge to use renewable energy and to conserve energy by efficient use of facilities. Furthermore, as Plant Mechanics will intensively install solar facilities, heat pumps and wood pellets for heating, an inclusion of training modules about renewable energy facilities and energy efficiency in the existing training was required. Technical knowledge about renewable energy sources and technical know-how about the installation and maintenance of facilities using renewable energy was at that time a new work task.

Moreover, in recent years regulations regarding energy use of sanitary systems in buildings were introduced. Energy efficient facilities which are combined with energy sources from renewable energies became mandatory in new buildings. According to the Energy Saving Regulation (EnEV) especially old heating systems had to be renewed as they exceeded limit values for greenhouse emissions. Thus, reconstruction of existing buildings were needed and partly individual solutions had to be found, for example office buildings required extensive measures for building service engineering and utility engineering. Plant Mechanics for Sanitary Heating and Air Conditioning Systems were appointed for the work. They have to plan reconstruction possibilities and to install the required facilities. A skills adaption was also needed for these tasks.

New requirements in the future

Since January 2009 according to the revised Energy Saving Regulation, sellers and landlords need an energy pass for their buildings and dwellings if they were built after 1966. The obligation applies to non-residential buildings since July 2009. In 2012 a revision of the regulation is planned, which means energy requirements will be tightened for new buildings and building reconstruction.

Energy saving is possible with heat insulation, solar powered facilities and new heating systems. Therefore, energy consulting will become more and more important. This is a new occupational perspective for the Plant Mechanic for Sanitary, Heating and Air Conditioning Systems. They will also support the planning and development of new energy-saving facilities. The demand for these will increase after the energy pass is implemented. They are also able to install equipment for solar thermal energy and to plan heat control systems.

Skills response

Initial vocational training

The training to become a Plant Mechanic for Sanitary, Heating and Air Conditioning Systems is structured in two sections: basic training and technical training (Fachausbildung). The contents for the basic training are imparted during the first year of the apprenticeship. During the following years the focus is set on technical competencies. This comprises for example the use of plant and system technologies and the operation of equipment. An overview of contents is presented in Table 14. The knowledge of customer relations to plan, regulate and control working tasks and knowledge of quality management are part of the training in all sections and are included in combination with other training contents. These competences are essential later on for the job.

Depending on the different companies in which the apprentice is employed the focus can be set on water, air or heating technologies or on environmental techniques/renewable energy. The sphere of activity is decided by the company that traines the apprentices.

Table 14 Plant mechanic for SHK - Contents of initial vocational training (summary)

Part of training	Practical training	Vocational school
First part of training 1. and 2. year	Operational, technical and customer-related communication	Production of structural elements
	Planing and regulation of working task, control and evaluation of resuts	Treatment of plant sections
	Quality management	Customer orders
	Installation of electrical modules in facilities and systems	Production of simple modules
	Consideration of sustainable energy and water systems	Maintenance of technical systems
	Conduct of measures for insulation and security	Installation of facilities for drinkable water
	Assembling measurement and control facilities and systems	Installation of drainages and heat distribution facilities
Second part of training 3. and 4. year	Use and operation of plants and systems	Installation of heat-generating plants
	Customer-oriented order processing	Installation of plants for heating of drinkable water
	Consideration of construction physical, construction ecological and economical conditions	Integration of resource-conserving plants in systems of buildings and energy techniques
	Function control and maintenance of plants and systems	Maintenance of plants and systems

Source: Berufenet

Continuing vocational training

The occupational career depends on the maintenance of technical knowledge, the continuous update and deepening of specialised knowledge, and the adaption of new developments. The subjects for continuing training for technical adaption are wide and range from advancement in measurement and control technology to the use of new materials. The Plant Mechanic for Sanitary, Heating and Air Conditioning Systems can also continue with foreman training to either become a certified senior specialist for installations and heating engineering or a senior technician for sanitary techniques. There is also the possibility to study engineering with a focus on supply engineering or facility management.

An example of further special training in the field of renewable energy is training in solar thermal energy plants. Moreover, an appropriate further training programme to become a Solar Technician exists. It lasts 4 months (8-12 months in part-time) and focuses on photovoltaic, solar thermal energy, and overvoltage. An overview of training modules is shown in Table 15. The training ends with a final exam and the participants obtain a certificate. The requirements for participation are either a completed foreman training in a craftsman′s trade or a completed dual vocational training and several years of work experience in sanitary, heating and air conditioning systems or in electronics and construction.

Solar technicians are able to work out concepts for solar plants, warm water generation and the generation of electricity. They inform customers about the profitability of solar powered facilities and promotion programmes. Moreover, they install solar equipment and integrate it in the existing sanitary technical supply devices. They also service the plants if anything should break down or not work properly.

Outstandingly capable apprentices can be promoted with a studentship for continuing vocational training, foreman trainings or university studies. The studentship is offered by the BMBF.

Table 15 Plant mechanic for SHK - Contents of initial vocational training (summary)

Module	Hours
Photovoltaic basics course	42
Photovoltaic advanced course	40
Solar thermal basic course	42
Solar thermal advanced course	40
Overvoltage/lightening protection	16
Sales promotion and market analysis	32
All	**172**

Source: Berufenet

Assessment of effectiveness of response
The demand for regenerative heating systems and energy consulting has increased. This opens wide working tasks for plant mechanics for sanitary, heating and air conditioning systems. They already have the basic competences for the required orders.

The segment offers new fields for installation crafts. A quarter of all sales in this branch is obtained by heat pumps, solar thermal or wood fired heating. Employees with this type of training are able to install, operate and maintain them. The continuing training for solar thermal energy or solar power techniques gives adequate possibilities for adapting knowledge and qualifications for the handling of regenerative plants.

The companies in all fields of renewable energy train apprentices in 40 different trades. One of the technical trades is the Plant Mechanic for Sanitary, Heating and Air Conditioning Systems. The main trades which are trained, however, are mechatronics technicians, mechanics, electrics, electronics, office clerks and industry clerks (Büro-und Industriekaufleute).[80]

High job growth rates was expected in 2007 for the next few years in the fields of service, maintenance and overhaul (+27,2 %), especially in the solar branch (+28,6 %). In particular skilled employees with work experience are in demand. In this context plant mechanics can be employed. During the dual vocational training during the practical work in the companies the apprentices can be trained according to the companies needs in the specialised fields within renewable energy.

Outlook
All in all the need for regenerative heating systems has already risen in recent years. Due to a study by the Research Institute EuPD in the end of 2007, around a quarter of sales in installation crafts is obtained by heat pumps, solar thermal heating or wood-fired heating. 15% of the 306 interviewed companies stated that they could create new jobs due to the high demand. Moreover, 80% of the companies assume that the interest in regenerative heating systems, especially solar thermal systems and heat pumps, will increase in the future. Thus, the Plant Mechanic for Sanitary, Heating and Air Conditioning Systems has a sound future and can exploit new working tasks as well as expand existing working tasks.

[80] Wissenschaftsladen 2007.

Case study 8: Energy Consultant with focus on energy passes

Introduction to existing occupation
Energy Consultants check the requirements of companies and private households for a systematic energy use and inform them about conserving energy and being environmentally friendly, especially in the context of reorganisation measures, reconstruction and investments in new and commercial buildings.[81]

They monitor the technical conditions of heating, sanitary, ventilation and air conditioning systems and work out energy concepts. Therefore, they are also well informed about home appliances and household items such as stoves, microwaves, dishwashers and heating systems so that they can consult the private households on energy use. In councils they compile regional energy concepts in order to enable the use of district heating with regenerative energy sources. Moreover, at exhibitions Energy Consultants inform, for example, about the use of solar cells on rooftops.

Energy Consultants mainly work in energy consultant companies, engineering offices, architectural offices and public administration offices (e.g. administrative district offices). Additionally, they may be employed by consumer organisations or energy suppliers. They work at manufacturer of solar cells, heating systems, and at water conditioning plants.

The training to become an Energy Consultant is a continuing vocational training according to the Craft Regulation (*Handwerksordnung*) and the Vocational Training Act (*Berufsbildungsgesetz*). The training lasts one month in full-time and 3-6 months in part-time. It is offered by the Chambers of Craft, the Ministry of Transport (MOT) and the Centre for Green-Minded Building (*Zentrum für umweltbewusstes Bauen, ZUB*) at the University of Kassel. There is also the possibility of telecourses and e-learning courses. As there are no official statistics and so many providers that offer the training, it is difficult to estimate how many people have participated in recent years. However, at the ZUB around 1,500 people were trained as Energy Consultants in 2008.

In 2007 around 4,700 people were working as consumer advisors, which also include Energy Consultants.[82] 3 % of these were women. The number of workers decreased between 2005 and 2007 by 3 % (2005: 4,850). The majority (53.2 %) were between 35 and 50 years old, 13.2 % were between 25 and 35 years old and 31.1 % older than 50 years old. The remaining 2.5 % were younger than 25 years old. 26.6% of the consumer advisors in 2007 had a degree from either a university or from an applied university of sciences. The majority (58.9 %) held a degree in a dual vocational training, thereof 6.6% had the general qualification for university entrance (*Abitur*). The rest of the employees had other forms of education.

Skill gaps and identification of skill needs
In the past regulations regarding the energy use of building were introduced: In 2007 according to the renewed Energy Saving Act (2007) the energy pass was implemented for new buildings and its sanitary, conditioning and heating systems. Furthermore, it was introduced for new non-residential buildings and its sanitary, conditioning and heating systems and for reconstructions. An energy pass identifies the energy need of buildings and provides basic information about insulation and reconstruction improvements.

Today the revised Energy Saving Act of 2009 is valid. Since January 2009 according to the new act, sellers and landlords need an energy pass for their buildings and dwellings, which were built after 1966. The obligation applies to non-residential buildings since July 2009. In 2012 a revision of the act is planned. Thus, energy requirements will be tightened for new buildings and building reconstructions.

[81] www.bibb.de, www.berufenet.de.

[82] IAB, Berufe im Spiegel der Statistik.

Therefore, trained workers are needed who have acquired technical knowledge to evaluate the energy use and greenhouse emissions of buildings and beyond that have the right to opt out energy passes. Paragraph 21 of the Energy Saving Act 2009[83] regulates who may opt out an energy pass for existing buildings. The following are the only groups:

- Persons with an university degree qualifying for a profession in the fields of :
- Architecture, structural engineering (Hochbau), civil engineering (Bauingenieurwesen), building services, physics, building physics, machine building and electrical engineering.
- Other technical or scientific fields with a focus of training in the fields named above.
- Interior Architects with a university degree
- Foremen in crafts with a focus on building, heating construction, installation, and chimney sweeping and crafts without a foreman degree who are qualified for the mentioned fields.
- Officially recognised and approved technicians with training focus on the evaluation of building envelopes, heating and warm water systems and ventilation and conditioning systems.

All of these four groups need to additionally fulfil at least one of the following requirements in order to be authorised:

- Focus on energy saving buildings during their studies or at least two years of essential work experience in the fields of construction and technical facilities after their studies.
- A successful continuing training in the area of energy-saving building, which focuses on the evaluation of building envelopes, heating and warm water systems, ventilation and air conditioning systems, inventory, certificate delivery and recommendations of modernisation possibilities.
- Experts on public commission for energy-saving buildings or in the fields of construction and technical facilities.

For non-residential buildings only graduates who fall into group 1 are entitled to opt out of the energy pas ses.

One specified occupation which fits into the requirements is the certified Energy Consultant if he/she has participated in the corresponding continuing vocational training to become a Building Energy Consultant. Moreover, there is a specialised training for energy passes.

Beside the use for skilled workers to opt out energy passes, the evaluation of energy use and the assessment of energy efficiency regarding production processes or work in offices become more and more important. Energy Consultants will not only be used for the evaluation of buildings but also for energy management in companies. Nevertheless, the following investigation of Energy Consultants refers to Energy Consultants who are needed for opting out energy passes as according to legislation the energy pass has become mandatory and skilled workers are thus needed.

Skills response

The continuing vocational training to become an Energy Consultant takes place at the Chambers of Craft or at private educational providers. The participants acquire knowledge in energy consulting, construction and building physics and installation engineering. The whole training comprises around 240 hours of lessons. An exemplary overview is presented in Table 16. Preconditioned occupations to participate in the training are foremen in crafts, engineers or technicians with corresponding qualifications.

[83] BAFA 2009, Verordnung zur Änderung der Energieeinsparverordnung.

Continuing training energy pass
Specialised seminars/trainings for energy passes are also provided. The following example refers to the training which is offered by the Centre of Green-Minded Building at the University Kassel.[84]

Table 16: Energy Consultants - exemplary overview of training contents

Contents	Hours
Basics of energy consulting	**48**
Environment and energy economy	
Basics in legislation, technolgies and physics	
Sotware for on-site consulting	
Promotion options	
Structure of an energy consulting	
Calculation of profitability	
Constructional engineering, building physics	**76**
Basics in constructional engineering	
Alignment and design of buildings	
Knowledge of building material	
Basics in heat protection and protection against moisture	
Energy Saving Act and energy pass	
Special energy relevant regulations	
Practical application areas	
Installation engineering, technical building services	**80**
Heating and ventilation engineering	
Electrical engineering	
Project work, group work, final exam	**36**
Preparation of an energy pass	
Preparation of an exemplary energy consulting	
Elaboration of an exemplary report	
Preparation and implementation of a presentation	
Final exam	
Sum	**240**

Source: Berufenet

The training is a four day module which enables the participants to opt out of energy passes for residential buildings. Project work and a final exam are mandatory. The target group comprises foremen, technicians and Energy Consultants. The price is 699 Euros. The training contents include:

- Preparation of demand-oriented energy passes for residential buildings
- Preparation of customer-oriented energy passes
- Investigation and evaluation of geometric sizes and energised characteristic values of the building envelope
- Investigation and evaluation of service plants
- Simplifications for the record of geometric sizes and the investigation of energised characteristic values
- Empirical values for building and plant components
- Recommendations for modernisations

[84] http://www.zub-kassel.de/weiterbildung.

On the first day of training an excursion to an exemplary building and to building systems takes place. With the aid of the building an energy pass is compiled with the software EPASS-HELENA

Assessment of effectiveness of response
Due to new regulations energy passes have become mandatory for sellers or landlords of buildings. Only specific persons are authorised to approve the certificates. This ensures that only persons with the appropriate knowledge of energy-saving buildings are permitted and there is no misuse. Suitable trainings have been implemented in order to ensure the adaption of knowledge.

The demand for further training in the area of energy passes and energy-saving buildings is the result of an environmental protection act by the Government. With the energy pass, energy-efficiency is supposed to be promoted in order to increase reductions of greenhouse emissions. The new training has not been implemented on the demands of companies or by companies' initiatives. On the contrary, the energy pass is a mandatory certificate which sellers and landlords of buildings need and which is postulated by the state. Therefore, this example differs to other cases in which the greening or adaption of an occupation or skill was realised because of a companies' need.

The energy pass was evaluated with a field experiment for residential building. The study was commissioned by the German Energy Agency (dena) and conducted by the Fraunhofer Inistitute ISI, the Eco-Institute and the Fraunhofer Institute for Building Physics IBP in 2005.[85] Due to the study modernisation recommendations by energy consultants leaded to a 30-40 % conservation of primary energy use and the majority of asked participants pointed out that they could better evaluate the energy use with help of the energy pass. Moreover, also the people who opted out the energy pass were evaluated regarding their technical knowledge to objectively assess the energy use of the building and to give advice for improvements to reduce energy use. All of them were consistently assessed as well skilled regarding their technical know-how and their service.

Outlook
New regulation concepts of building automations have been developed, which take the weather data into account and introduces these in the regularisation of heating, ventilation and conditioning systems and sun protection mechanisms. Due to this connection the heating and cooling systems save up to 40 percent of energy. When Energy Consultants inform consumers of the possibilities and technologies for saving energy, they have to consider the new regulation concepts for building automations. In order to ensure the required knowledge is communicated, they have to extend their own knowledge with continued training.

[85] ISI et al. (2005), Energiepass für Gebäude, Evaluation des Feldversuchs.

4 CONCLUSIONS

4.1 Main 'greening' shifts in economies and labour markets

Greening of the economy

As the previous analysis revealed, restructuring toward a green economy follows an integrative approach. This applies to many aspects of this process: manufacturing of green technologies, application of environmentally friendly techniques, implementation of ecological standards, image creation and marketing, consumption and mobility behaviour etc. It appears to be the rethinking of existing processes rather than the invention of new solutions.

The greening of the economy is therefore going to change economic activities at multiple points and thus suggested the integration of green aspects to be a superior approach. This applies to both products and work.

A purely sectoral approach to the analysis of green jobs would be misleading as it measures the emergence of specialised industries but not the importance of green production. Similarly, an occupational approach indicates the specialisation of workers on ecological issues rather than the scope of green activities. Due to the fact that environmental aspects have to be considered in many activities, a cross-sectoral or cross-occupational perspective is much more important. Some economic sectors are more affected than others but almost none are excluded from the integration of environmental aspects and the accumulation of environmental know-how.

The main causes of the wide spread integration of environmental know-how are:

- Energy from fossil fuels is becoming more and more expensive. CO2 emissions are gradually priced and thus contribute to rising energy prices. The use of energy efficiency at all working stages support cost saving and competitiveness. Moreover, the use of renewable energy is partly subsidised. It secures a partial independence from price fluctuations of fossil fuels.
- The population's awareness has changed and the greening of products and businesses has become a matter of public concern. Companies are reacting to these changes on consumer markets in order to avoid damaging their image and competitive disadvantages.
- Legislative measures and constraints regarding environmental standards are affecting product development, production, investments and consumption behaviour.

While the direct restructuring impact is mainly on energy production, indirect effects can be discerned in many economic sectors: construction, the automotive industry, mechanical engineering, transportation and logistics, the chemical industry, metal production, agriculture etc.

Green industries

The greening of the economy has nevertheless led to the creation of an environmental sector which is directly engaged in the production of environmental goods and services. In Germany this is fostered by the rise of an internationally competitive green technology sector. However other, domestically oriented, sectors have emerged such as renewable energy, recycling and waste management, and energy consulting. Specialised industries are growing in the course of technological and economic development, as can be seen with information technology. Green industries appear to be in an early phase of this process.

The environmental technology sector comprises six leading areas in which German companies are well positioned: environmental friendly energy generation and storage, energy efficiency, resource and material efficiency, recycling, sustainable water management, and sustainable mobility. In many

of these areas high market shares have been achieved both nationally and internationally. Growth rates have hit a high and employment has expanded.

The renewable energy sector has established itself well and a further expansion of the market for renewable energy is being pursued with policy decisions. Nevertheless, policy makers are planning to reduce financial subsidies for solar energy, especially for the supply of electricity fed into the grid. An increasing growth of photovoltaic generation led to an excess supply and a big drop in prices in recent years. The price decline results in dead-weight losses and enormous additional costs within the Renewable Energy Law (EEG). The cut of subsidies will probably lead to outsourcing production to China and result in job cuts, especially in Eastern Germany, where the solar sector has been established as a major industry. The policy has missed the opportunity to attach conditions to the subsidies and now a correction of former development seems to be unavoidable. The solar sector will thus experience a restructuring process with less production and more knowledge-intensive work.

Labour market impacts
Greening the economy and the emergence of a green industry has positively influenced employment in Germany. In the environmental sector the number of jobs was estimated at 1.8 million in 2006. The renewable energy sector especially (235.000 jobs in 2006) has established itself as a job motor. Environmental protection promotes the direct creation of jobs, especially with the production of environmental techniques, but also indirectly because of the rising need for installation, operation and maintenance of environmental facilities.

The use of renewable energy is promoted and a further growth in this sector is therefore expected. The number of jobs is estimated to increase to around 400.000- 500.000 by 2020 and 710.000 by 2030. The alteration of promoting solar energy is expected to lower employment prospects.

4.2 Skills implications and development

4.2.1 Anticipation and identification of skill needs

Parallel to the economic structure, environmental protection has affected the skills composition of the workforce in Germany in two ways. On one hand new environmental occupations have been established by the education and training system in particular. On the other hand many occupations and workplace activities have been adapted to the rising needs for environmental protection. The adjustment has been achieved by continuous reforms of the dual training system, university courses and continuing training.

In principle this type of adjustment can be expected to continue. A multi-channel policy of competence enhancement, which uses all instruments, appears to be the best way to proceed: mass media, school teaching, pilot training programmes, institutionalised training courses and life-long learning all fit into this box.

A higher level of occupational specialisation will be needed to improve competitiveness of producers of environmental goods and services. However, international competition will rise as new suppliers are emerging in many countries – particularly in Asia. A higher degree of knowledge integration will be needed if the implementation of higher environmental standards is the target. This is required in many areas of economic and private activities if Germany wants to achieve its ambitions protective goals.

For the further development and growth of environmental sectors, particular skill needs can be identified:

- The extension of the renewable energy sector requires an adequate supply of skilled workers: These will be needed in the areas of manufacturing and servicing of plants but also in the areas of consulting, marketing and sales.
- For the installation, repair and maintenance of environmental plants the demand for intermediate workers will rise, especially in craft businesses.

- In the course of the restructuring process in the solar sector the need for skills in manufacturing solar cells will decrease and the focus will be set on R&D, value chain management and marketing. For these work tasks engineers, scientists and marketing experts will be needed while the demand for manufacturing workers can be expected to decrease.
- For the German environmental technology sector to have more of a competitive advantage on the world market, a highly qualified R&D segment and efficient production is required. The access to worldwide markets needs to be secured by international marketing and production structures. This opens work tasks for environmental researchers, engineers and international marketing experts. In principle an increased demand in highly qualified skilled workers will also emerge in environmental industries.

Many occupations in sectors beyond the environmental industries will have to accumulate skills further in energy saving, environmental legislation and the reduction of environmental pollution. Similarly, private households will also have to acquire such skills.

4.2.2 Response policies and programmes

The response strategy to adapt the skills needs in terms of environmental protection has been pursued for over two decades. In the beginning different laws regarding waste and pollution influenced the development. The first sector that consciously adapted environmental protection in work processes was the chemical industry. After suffering image problems in the course of chemical catastrophes the chemical industry included environmental protection in all their working processes. The regulations for apprenticeships within the chemical industry were the first that integrated environmental protection as an obligatory module. Step by step other sectors followed as the awareness for environmental protection rose.

Nowadays environmental protection has become a standard element that is always considered during the establishment or revision of training regulations or university curricula. The skills response follows mainly an integrative approach of greening aspects rather than focusing on specialisation. Basic skills remain and are enriched by the integration of environmental protection skills. The supply of continuing vocational training mainly contributes to the greening of skills. It offers efficient and targeted learning and flexibility with regard to current training needs.

Compared to the supply of the education and training systems company initiatives in the area of environmental training are marginal. Company-based continuing training is nevertheless an important supplement to formal training and contributed significantly to the acquisition of green skills.

This however cannot be a substitute for a publicly financed life-long learning system which provides the skills demanded by labour markets rather than workplaces. Germany has long since been reluctant to develop such a life-long learning system. The decreasing skills supply from the initial training – which is because of demographic changes – points to a necessity to engage in this segment with greater emphasis.

4.2.3 Effective delivery mechanisms

The greening of skills is mainly promoted by the education and training system. Beyond new types of training, many existing training courses are becoming greener by integration of environmental protection aspects.

The skills response on greening is comprehensive and offers a wide supply of possible adaptation opportunities. The focus of an integrative approach rather than on a specialised occupation guarantees flexible use of skilled workers and better job opportunities.

Initial vocational training offers trades in environmental techniques and the continuing vocational training system is an adequate instrument for specialisation or skills adaptation. University courses

support the supply of highly skilled environmental specialists. The support of both initial vocational training and university courses on one hand and continuing vocational training on the other hand is required for sufficient skills adaptations for future work tasks.

Parts of environmental industries lack efficient social partnership. The inadequate supply of training in the renewable energy sector can be addressed to this deficit as social partners have an important role in the formation of training courses, both in dual training and university training. Moreover, adequate representation of workers by trade unions could help to improve working conditions and social dialogue.

5 RECOMMENDATIONS

5.1 Policy recommendations

The principal recommendation of economists is to internalise the costs of climate change, pollution, and resource limitations. This would lead to immediate adaptations of products, production processes, and consumer behaviour. Companies and private households which do not adapt to environmental protection will thus suffer cost and competitive disadvantages. This, however, is difficult to achieve as the estimate of future costs – for example of climate change – is very uncertain. Adequate taxation and pricing environmental costs remain important tasks however they are not the solution.

Awareness for environmental protection therefore needs to be fostered by legislation which implies restrictions to economic activities. The price for such measures is lower growth in the short-run but more sustainable development in the future. Governments therefore play a crucial role in ecological development, and international agreements appear to be urgently needed.

Finally, the environmental behaviour of both companies and households is essential. Such considerations go beyond economic calculations, and therefore need to be promoted by a continuous public debate. This can be supported by improving the information base on environmental issues, the dissemination of this information in the public, and the evaluation of policy measures.

5.2 Recommendations for education and training

The education and training system has in many ways reacted to the demand for green skills and has strategically integrated the required qualifications in the training regulations. The approach is integrative and specialisation occurs in only a few cases.

The education and training system has to secure the supply of skilled workers and avoid skills shortages by adapting skills. Due to the rapid growth of environmental industries skills shortages have emerged in recent years, especially in the high skilled segment of engineers. Moreover, fewer young school graduates went for apprenticeships. While such shortages can hardly be avoided in boom periods, education and training policies have to follow a medium or long term path. It will therefore be important to find the right balance between short-term adjustments and long-term accumulation of human capital in this sector. The future of environmental industries therefore has to be analysed in the form of skills scenarios which are able to create the link between economic development and human resources.

In the German context, public authorities have to counteract skills shortages by integrating young people with a migration background. This has been on the agenda of labour supply policies for many years. The case of environmental industries underlines the need for improvements in this area.

In addition, the number of school drop-outs has to be cut in order to increase the overall number of adequate workers. So-called ‘production schools’ have been established e.g. in Hamburg, which set out to solve this problem. The participants adapt – following the Danish example - practical knowledge in production and service and thus heighten their chances on the labour market. Such initiatives need to be expanded. Modular vocational training is another tool to address the problems of a disadvantaged youth. The ideas are there. Now it is time for the training institutions to make a move.

In general, updating initial training regulations must become more flexible. This could help to adjust initial training more rapidly to the needs of a greening economy.

The collaboration between BMU, BMBF and BIBB could be improved. The BMBF and BIBB are mainly responsible for the education and training system. The BMU can only offer learning and

teaching materials which include a lot of expert knowledge. The use of these materials should be guaranteed with better cooperation.

The non-existence of social partnership within the renewable energy sector has decelerated the adaptation of training systems in this sector. A formation of employers' association would improve the dialogue between this sector and the education and training system and a further adaptation could be accelerated.

Continuing vocational training
The adaptation of skills to greening was achieved to a substantial part by the continuing vocational training system. Against this background it is important to develop this system further and to offer a structured and sustainable model for life-long learning in Germany. Nowadays the continuing vocational training is influenced by companies' needs, but these orientate on their own demands. The continuing training systems needs to be publicly determined and a balance between initial training (*Erstausbildung*) and continuing vocational training needs to be promoted.

It is recommended to offer considerably more opportunities for further specialisation due to selection possibilities in the last year of training or due to continuing vocational training which build on the initial vocational training, such as further certificates (foremen, technicians). Moreover, company initiatives have to be promoted to develop extra modules which can be integrated in existing training programmes. It would have the advantage that the modules are tested practically and if the need for an adaptation of skills increases, the module can be included in the training regulation.

Moreover, pilot projects need to be fostered (also in initial vocational training) to explore efficient methods to adapt to rapidly changing technologies. The projects should be divided up and focus on specialisations in regions, sectors and technologies. Additionally, continuing vocational training could be extended by the supply of internships. Employees could thus make experiences in other companies, work tasks or knowledge areas.

University studies
Within universities studies also an integrative approach of environmental aspects is favoured. Wide knowledge offers graduates better opportunities on the labour market. Chances are given within the bachelor and master degree system.

Basic technical knowledge should be included in the bachelor courses and specialisation should be part of the master courses. Moreover, environmental protection should not be seen as additional knowledge which is imparted in additional courses. Integration in all relevant curricula is needed, meaning that university studies have to integrate appropriate ecological aspects. This would imply a revision of university curricula. Moreover, a concentration of university studies which focus on environmental protection with expert knowledge would increase the quality of the courses.

5.3 Recommendations for further research and data collection

Green employment
Regarding the employment in the environmental sector only one study is provided which estimates the total number of workers. The number of jobs is predicted using an input-output model taking environmental expenditures into account. Alternative analysis methods should be tested for comparison.

Further research to estimate the overall net employment effect is required. In net terms only parts of the green policy measures are evaluated. Moreover, a more comprehensive supply of statistics would foster the research in this context.

Assessment and anticipation of skill needs
No skill identification or forecasting system exists which defines the need for green skills or green jobs. Further research is needed to ascertain the demand for additional jobs or other training forms.

For example it may be useful in the future to introduce two-year apprenticeship training programmes or apprenticeships in renewable energy. An evaluation of the adequacy, however, has not been conducted yet.

The current skills response regarding the education and training system has to be evaluated in two ways:

- Existing environmental protection aspects at all levels of education (from school to university) need to be examined and renewed, if needed. Moreover, sustainability has to be integrated but also tested in exams as an obligatory module. The assessment has to be at constant time intervals.
- The adequacy of existing skills responses within the education and training systems need to be evaluated.

Research outlook

- On behalf of the BMU a study was conducted which offers practical examples on energy and resource efficiency within apprenticeship training. The aim of the study is to offer the BMU a work document for the preparation of materials which provide instructions for an optimised integration of energy and resource efficiency and should be used by companies in all economic sectors.[86]
- The DIHK in cooperation with the BIBB will investigate the sustainability of apprenticeship training in the future.

In general, the human resource aspects of ecological research appear to be underdeveloped.

[86] BMU (2010), Energie und Ressourceneffizienz in Berufsbildung und Arbeit, forthcoming February 2010.

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Bündnins90/ Die Grünen: www.gruene.de

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Wissenschaftsladen Bonn: www.wilabonn.de

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ZUB: www.zub-kassel.de/weiterbildung

LIST OF KEY RESOURCE PERSONS

Expert interviews:

- Michael Assenmacher, DIHK, Head of the department 'technical occupations, focus on information technology and communication medium'
- Peter Franz, BMU, Head of the department 'Environment, Economy, Innovation and Employment, Environmental Audit'
- Marion Krampe, BIBB, Project leader dual apprenticeship training with focus on environmental protection within the initial training.
- Dr. Klaus-Dieter Mertineit, IBU, Business executive, Project leader
- Christian Sprute, Foundation Employment and Environment, Business executive

Case studies:

- Susanne Adam, Siemens Wind Power Centre, Business Administration Wind Power Services
- Nils Gneiße, Siemens Wind Power Centre, Head of Training Centre
- Hans-Günther Glass, BAVC, Business Executive in the department 'Education, Economy and Labour market'
- Prof. Dr. Andrea Jurisch, University Köthen, chairlady of the study commission for the study course solar technique at the.
- Helmut Kroneder, BMW, Manager of initial and continuing training for Motor Vehicle Mechatronics Technicians
- Claudia Leich, Q-Cells, Human Resources/ Q-Cells Training Centre
- Prof. Dr. Thomas Meuser, BiTs-Iserlohn, Dean of the study course Green Business Management
- Manfred Theunert, BMW, Head of initial and continuing vocational training in Munich

Other experts:

- Thorsten Henzelmann, Roland Berger Strategy Consultants, Green Tech Made in Germany

ABBREVIATIONS

BIBB	Federal Institute for Vocational Education and Training (*Bundesinstitut für Berufsbildung*)
BMBF	Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*)
BMELV	Federal Ministry of Food, Agriculture and Consumer Protection (*Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz*)
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*)
BMWI	Federal Ministry for Economy and Technology (*Bundesministerium für Wirtschaft und Technolgie*)
CHP	Combined heat and power (*Kraft-Wärme-Kopplung*)
DBFZ	German Research Centre for Biomass (*Deutsches Zentrum für Biomasse Forschung*)
DIHK	Association of German Chambers of Industry and Commerce (*Deutsche Industrie- und Handelskammer*)
DIW	German Institute for Economic Research (*Deutsches Institut für Wirtschaftsforschung*)
DGB	German Federation of Trade Unions (*Deutscher Gewerkschaftsbund*)
ECHA	European Chemistry Agency
EEG	Renewable Energy Law (*Erneuerbare Energien Gesetz*)
EEWärmeG	Renewable Energy Heat Law (*Erneuerbare Energien Wärmegesetz*)
EnEV	Energy Saving Act (*Energieeinsparverordnung*)
GAP	Common Agricultural Policy (*Gemeinsame Agrarpolitik*)
IBU	Institute for Environmental Protection in Eductaion (*Institut für Umweltschutz in der Berufsbildung*)
IEKP	Integrated Energy and Climate Programme (*Integriertes Energie- und Klimaprogramm*)
KfW	Reconstruction Loan Cooperation
MAP	Market Incentive Programme (*Marktanreizprogramm*)
SHK	Sanitary, heating and air conditioning systems (*Sanitär-, Heizungs- und Klimaanlagen*)
ZUB	Centre for Green-Minded Building (*Zentrum für umweltbewusstes Bauen*)