CEDEFOP
European Centre for the Development
of Vocational Training

Skills for green jobs

Country report

Germany

Preface

The world is coping with a host of environmental problems and an urgent need to reduce carbon emissions. A greener future also provides enormous potential for much needed employment growth. However, without suitable skills, this potential cannot be realised. Today, skills gaps are already recognised as a major bottleneck in a number of sectors, such as renewable energy, energy and resource efficiency, green building and retrofitting, environmental services, and green manufacturing. Training response measures are successful where they are coherent across policy domains, systemic and systematic, and targeted at disadvantaged groups. These training measures can only be effective if based on timely identification of skills needs.

The European Centre for the Development of Vocational Training (Cedefop) and the International Labour Organization (ILO) worked together in carrying out the project 'Skills for green jobs', identifying skills needed for greener economies with respect to structural shifts, and new, emerging and changing occupational profiles. The 'Skills for green jobs' study is embedded in the green jobs initiative, a joint initiative of the United Nations Environment Programme (UNEP), the ILO, the International Employers Organization (IOE) and the International Trade Union Confederation (ITUC), to assess, analyse and promote creation of decent jobs as a consequence of the needed environmental policies.

The Skills for green jobs - European synthesis report (Cedefop, 2010) covers six EU Member States: Denmark, Germany, Estonia, Spain, France and the UK, and Annexes 1-6 are summaries of the country reports. The ILO global synthesis report, Skills for green jobs: a global view (Strietska-Ilina et al., forthcoming), analyses the situation in all 21 countries involved in the study (Australia, Bangladesh, Brazil, China, Costa Rica, Denmark, Egypt, Estonia, France, Germany, India, Indonesia, the Republic of Korea, Mali, the Philippines, South Africa, Spain, Thailand, Uganda, the UK and the US). The reports are available at: http://www.cedefop.europa.eu (Cedefop's website; under 'Identifying skills needs', 'Skill needs in sectors') and: http://www.ilo.org/skills/what/projects/lang--en/WCMS_115959/index.htm (the ILO website).

Country reports benefited from major contributions from Kurt Vogler-Ludwig, Luisa Stock, Ida Bayer, Hanne Shapiro, Olav Aarna, Elvira Gonzales, Fernando del Rio, Cristina Castellanos, Cecile Mathou, Steph Charalambous, Michael Lawrie and Shane Beadle. The list of country experts is provided in each full country report.

NB:

The six full country reports are unedited and available only electronically. They were used as background information for Cedefop's *Skills for green jobs - European synthesis report*. Citations from the country reports are not permitted. They can only be taken from the synthesis report itself, available from Internet: http://www.cedefop.europa.eu/EN/publications/16439.aspx [cited 17.8.2010].

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Abstract

The report ‘Skills for Green Jobs’ aims to illustrate how greening of the economy, as a result of environmental protection measures, has driven the growth of green skills and green jobs in Germany. For decades, environmental protection has been at the centre of public policy development. The combination of legislation and incremental awareness has influenced the restructuring of German economic sectors and occupational competencies. The following report provides an overview of the evolution of this ‘greening’, its influence on the labour market, and creation of green jobs in Germany. Using desk research and interviews, the German response to greening, with the main emphasis on skills responses, are illustrated and assessed, particularly through the use of eight case studies. These case studies give practical insights into the greening process of both existing occupations as well as through the creation of new occupations. A key finding from Germany is that rather than creating new, specific ‘green’ occupations, many occupations and training curricula have been adjusted and refined to take account of the skills needs of increasingly green aspects of mainstream industry and business as well as eco-industries. In that respect, the skills response has followed an integrated approach. To enhance the green skills provision, further integration for non-environmental occupations needs to be pursued and there needs to be a higher occupational specialisation for the environmental sector.

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Executive summary

Environmental policies

The environmental commitment of German public authorities is established by the 'Integrated Energy and Climate Programme' (IEKP), published by the Federal Government in 2007. The present conservative-liberal government confirmed the principles of this programme which formulates ambitious goals, including:

(a) 40% reduction of greenhouse emissions by 2020 compared to a 1990 baseline;

(b) 3% annual growth in energy efficiency;

(c) expansion of renewable energy to 18% of overall energy supply by 2020, and 50% by 2050;

(d) increasing combined heat and power generation to 25% of power by 2020.

The recent economic stimulus package by the Federal Government includes a proportion of 13% of total expenditures directed towards green investments.

Job creation

From the outset, German policies on environmental protection have not only been perceived as a step towards better living conditions, but also as a mechanism to develop market opportunities for domestic suppliers of environmental technologies and services. The roll out of environmental policies has therefore been used to create new jobs and support economic growth. The environmental technology and services sector is now one of Germany's major economic sectors, employing 1.8 million people in 2006 (4.5% of the labour force). Between 2004 and 2006 the number of employees increased by 290,000, a rise of around 20% within two years. The majority of workers (64%) are engaged in the operation and support of environmental protection facilities, 13% in renewable energy, 10% in the production of goods and a further 10% in the production of materials.

Job creation has rapidly developed in the renewable energy production and storage sectors with employment rising 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. With the decision to phase out nuclear energy plants and reduce the share of

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coal fired power stations ([1]) in favour of renewable energy, the energy sector will experience a major restructuring of jobs. However, whilst there are likely to be significant opportunities for the operation and maintenance of renewable energy assets in the future, Germany is also now considering subsidy cuts which have greatly helped to pump-prime the renewable sectors, particularly for solar photovoltaics. If approved, this can be expected to lead to restructuring and cause manufacturing jobs to relocate to other countries (for example, German solar manufacturing giant Q-Cells has already established a manufacturing plant in Malaysia) and favour research and development, operational engineering, marketing and value chain management continuing to reside in Germany.

Skills response

In general, the principal skills response to the rising demand for environmental competencies across the German economy has followed an 'integrated' approach, as opposed to the creation of specialised environmental occupations. Many occupational competency frameworks and vocational training curricula have been adjusted and refined to take account of skills needs arising from the increasing environmental requirements on mainstream industry as well as the eco-industries themselves. This approach is a result of a long tradition of 'dual' training in Germany which provides the majority of skilled workers at the intermediary level. Employers have a strong influence on the structure and content of dual training and therefore can easily integrate environmentally-oriented training. For example, Case Study 2 on Chemical Technicians exemplifies how the chemical industry integrated environmental protection into training, while Case study 7 on Plant Mechanics for Sanitary, Heating and Air Conditioning Systems describes how an existing dual training course was adapted to incorporate environmental needs and technologies.

To help roll out environmental training across the economy, Chambers and private training providers are active in the field, whilst firms (both mainstream and eco-industries) have also initiated continuous environmental training programmes 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 its training of technicians to suit hybrid electric 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 as a result of new legislation.

Given the skills and competency requirements of the eco-industries, specialised environmental occupations have also been created. Four technical environmental trades are

([1]) Coal mining subsidies will be terminated by 2018 which will cut most of the present 52,000 jobs in that sector.

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offered by the dual vocational training system, with the number of apprentices in these trades increasing to 2,500 by 2008. These cover:

(a) recycling and waste management technician (Fachkraft für Kreislauf- und Abfallwirtschaft; Case study 6);

(b) water supply engineering technician (Fachkraft für Wasserversorgungstechnik);

(c) sewage engineering technician (Fachkraft für Abwassertechnik);

(d) pipe, sewer and industrial service technician (Fachkraft für Rohr-, Kanal- und Industrieservice).

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

Prior to the current economic downturn, skills shortages appeared in both engineering and technical occupations. Eco-industries were in strong competition with other manufacturing sectors. At the moment however the situation has eased but there is still a good appreciation of potential skills shortages across green jobs.

Conclusions and recommendations

This study suggests promoting professionalisation of green competencies in two ways:

(a) a higher level of occupational specialisation will be needed to improve the competitiveness of environmental goods and service suppliers. The supply of professionals will be pivotal to success;

(b) a higher level of knowledge integration of green competencies will be needed for both the application of environmental technologies and the implementation of higher environmental standards in many non-environmental occupations. This is required to achieve the ambitious environmental protection goals of German environmental policy.

Moreover, a publicly-financed lifelong learning system is needed to provide the skills demanded by labour markets rather than workplaces. Germany has long since been reluctant to develop such a life-long learning system and a declining skills supply, caused by demographic changes, requires much a greater emphasis on this area in the future.

Skills shortages can also be addressed through improved social partnerships with eco-industries. Social partners play an important role in formation of training courses, both in dual training and university training. They are active in shaping the content of new training programmes.

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Skills shortages might also be prevented by exploring how environmental education and training measures and approaches (including pilot projects) can be used to reduce both the level of students dropping out of school early and improve the career prospects of youth from immigrant backgrounds.

Future research needs are identified in the area of employment and skills. For too long, environmental research has focussed on natural sciences and technology development, to the detriment of human capital which appears to be strongly underdeveloped. It will be important to measure green skills and competencies better as well as being able to quantify green jobs more systematically to help shape training provision, particularly for higher skilled jobs. Similarly, the job creation effects of environmental expenditures could be further refined. In particular, the net effects of green investments are not adequately measured.

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1. Introduction

1.1. 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 (Section 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 (Section 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 (Section 2.3). The restructuring of economic sectors and the anticipated skills needs in the course of greening the economy are illustrated in Section 3. Conclusions, (Section 4) and recommendations for further policy responses and for further research are provided in Section 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.

1.2. Main aspects of investigation

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

From the outset, German policies on environmental protection have not only been perceived as a step towards better living conditions, but also as a mechanism to develop market opportunities for domestic suppliers of environmental technologies and services. The roll out of environmental policies has therefore been used to create new jobs and support economic growth. Growth in the environmental technologies market (covering pollution control, cleaner production, resource efficiency and renewable energy) has stimulated German employment and exports and generated an internationally competitive supply side. Clearly 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

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follows a long tradition of German industries organising dual training rather than company-based continuing training. This report therefore focuses on this type of environmental training, taking the majority of case studies 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' occupations have been modified to take account of environmental considerations, in line with the overall German objective of greening the economy. Whilst new occupations have emerged, their relevance is small compared to the great number of existing occupations which have been modified.

1.3. Method

The study used desk research, interviews (see Annex for full consultation list) and case studies as its major sources of information. Key information sources included:

(a) 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 environmental and climate protection in Germany. The report 'GreenTech made in Germany 2.0' provided a useful study on environmental technologies;

(b) a good overview of the integration of environmental issues into the education and training system was provided in a 2004 study by GTZ, 'Environmental education for a sustainable development in the initial and continuing vocational training system, environmental protection in the education and training system';

(c) the Federal Institute for Vocational Education and Training (BIBB) offered training profiles for apprenticeship training programmes, complemented with extensive information about occupation profiles from the Federal Labour Agency's national occupation catalogue BERUFENET;

(d) the number of workers in the environmental sector was estimated in a 2009 study by the German Institute for Economic Research (DIW), 'Employment effects due to environmental protection in Germany'.

Eight case studies were selected across different environmental training areas, striking a balance between occupations drawn from dual vocational training, continuing vocational training and university courses. Company initiated training responses could be included in the selection. Case study information was obtained via research and interviews with companies or associations.

Feedback on the report was obtained from experts (comprising policy makers, trade unionists and educational system experts) to validate the research findings and incorporated in the report. Institutions included the BMU, BIBB, Association of German Chambers of Industry

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and Commerce (DIHK), Foundation of Labour and Environment, and the Institute for Environmental Protection in Education (IBU).

1.4. A supply-side approach

The aim of this study is to reveal the skills responses from greening of the economy. As indicated above, the main focus is on the education and training supply-side, since the demand-side (i.e. companies) is strongly involved in the formation of vocational training. The main reasons for this are:

(a) the maturing of environmental markets over the past two decades has lead to a reduction in company-specific training initiatives as the general needs of employers are now met through changes in mainstream education and training system. Current initiatives at the firm level are more focused on refinements to employees' qualifications and continuing professional development;

(b) the education and training systems incorporated the rising demand for green skills at the same time as greening the economy started to take off. Germany now boasts a well developed list of occupations which cover substantial green skill areas;

(c) German companies have been involved in helping to refine and adapt the education and training system and now benefit from the resulting skills supply;

(d) there are few company initiatives which anticipate skills needs or provide training. Training centres for in-company training or the integration of green modules are supplementary to formal training programmes. It was therefore difficult to select suitable demand-side driven case studies. Nevertheless, three skills responses in the case studies were initiated by companies (i.e. Q-Cells, Siemens Wind Power and BMW).

Overall, the structure of this research study relied on the idea of a mainly demand-side driven adaptation of training. However, since this does not really apply to the German vocational education and training (VET) system, it was necessary to make some alterations to the report structure.

1.5. Re-skilling of jobs

The study aimed to identify occupations that became obsolete as a result of 'greening' the economy. However, it was difficult to find any incidence of occupations or occupation profiles completely disappearing. This is mainly a result of 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 competencies, with specialisation provided during the final part of training or as continuing training. Major elements of university degrees also impart a basic education, for example in engineering, natural sciences or economics, and give students the opportunity to focus on

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different areas. The majority of vocational training at intermediary and university level incorporates environmental aspects as far as is needed.

For the appropriate case studies in this area, retraining examples were chosen which resulted from sector restructuring (in response to environmental legislative demands). For example, the car industry is having to focus on low carbon propulsion techniques as part of a coordinated effort to reduce its collective greenhouse gas (GHG) emissions; and, the chemical industry has adjusted all their working processes to be intrinsically cleaner and more energy efficient as a result of a long-running Responsible Care programme.

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2. Policy context

Environmental policy making in Germany has been significantly affected by the foundation of the Green Party in 1980. Coming from grassroots level it represented the ideas of ecological sustainability, environmental protection and a halting of nuclear energy production. The party became part of the red/green coalition 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

2.1.1. Priorities

Broadening earlier environmental protection measures, German priorities regarding climate protection have come to the fore over the past 10 years, with a key goal of reducing GHG emissions. The coalition Agreement by the new Federal Government in October 2009 aims to achieve a reduction in GHG emissions of 40% by 2020 compared to a 1990 baseline, in order to global efforts to reduce warming to two degrees. Moreover, the Agreement outlines the following priorities:

(a) energy generation will be derived from a diverse energy mix that places a huge emphasis on the contribution of renewable energy. The Government therefore favours increasing the promotion and growth of this sector;

(b) energy generation from coal with low greenhouse emissions will be achieved through construction of modern, highly-efficient power stations, coupled with the ending of coal mining subsidies;

(c) energy efficiency will become a key priority of building renovation and will go hand in hand with environmental labelling of products;

(d) recognising its low carbon benefit, nuclear energy is defined as an important 'bridge technology' which may prolong its phase-out;

(e) research in energy generation, energy storage and transport will be fostered by a new 'energy research programme';

(f) in the wider economy waste reduction is also especially favoured by the government.

Overall, while these priorities imply a focus on energy efficiency and cleaner power production than previous policies, they also show that the broad thrust of German environmental policy making of the last few years has not radically changed.

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2.1.2. Challenges

The challenge of achieving a huge decline in GHG emissions means that industrial restructuring will be necessary and environmental considerations will influence both technological innovations (i.e. through ambitious standards and limit values) and people's lifestyles(i.e. so that growth, wealth, and social progress go hand in hand with environmental protection). Critical to achieving this will be the internalisation of negative externalities and the more efficient use of natural resources. At the moment the further success of the development is, however, mainly challenged by the following issues:

(a) a worldwide climate treaty is needed to avoid competitiveness disadvantages for local economic sectors. For example, 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;

(b) the setting of sustainable renewable energy subsidies. For example, according to some, the German solar power subsidy has lead to an 'over-stimulation' of capacity 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. Without careful development, a reduction in subsidies might restrict sector growth and produce job losses;

(c) sufficiently skilled personnel are needed to ensure further growth in the green economy. Germany suffers from demographic changes which negatively affect the number of young people enrolling for vocational education and training. Skills shortages might be prevented by exploring how environmental education and training measures and approaches (including pilot projects) can be used to reduce both the level of students dropping out of school early and improve the career prospects of youth from immigrant backgrounds –increasing the supply of workers not only for the environmental sector but also for the wider economy.

2.2. The response strategy

The following section summarises the general German environmental policy, goal setting and strategic responses to meet the requirements of increasing the protection of the environment and reducing GHG emissions.

2.2.1. General environmental strategy

The importance of climate protection has increased in recent years and has become an important element within the overall German environmental policy framework. Several measures and instruments have been implemented over the last few years including many measures within the National Climate Protection Programme of 2000 and 2005. The latter focused on measures covering transport and households. The German climate protection

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policy has also been influenced by the National Strategy for Sustainability of 2001. Even though there is wide consensus in Germany about the goals and the need for climate protection and lower emissions, there is still debate about how it should best be implemented.

2.2.1.1. General goal settings

As part of the Kyoto Protocol, the German Federal Government agreed to reduce GHG by 21% between 2008 and 2012 compared to a 1990 baseline, increasing to a 40% reduction in GHG by 2020. A good overview is given by the IEKP, published by the Federal Government in 2007 which comprises of 14 laws and regulations and seven additional measures. Besides the ambitious GHG emissions reductions above, other goals include:

(a) 3% per annum increase in energy productivity (i.e. efficiency will be twice as high in 2020 compared to 1990);

(b) increase in renewable energy, specifically due to:

(c) 18% of the overall energy mix being renewable in 2020, increasing to 50% by 2050;

(d) an increase in gross power consumption from 15% to 30% and of thermal energy requirement from 7% to 14% in 2020;

(e) a higher proportion of biofuels to reduce greenhouse emissions by 7%;

(f) a rise in combined heat and power (CHP) contribution to generate power to 25% in 2020.

2.2.1.2. Policy responses and measures

To achieve these goals, many measures and laws have been introduced. The most important policy areas are summarised in the following paragraphs.

2.2.1.3. Renewable energy

The expansion of renewable energy is successfully developing in Germany. Its contribution towards overall energy use has doubled since 2000 and reached 9.5% in 2008 ([2]). 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 three measures:

(a) Renewable Energy Law (EEG) of 2000 – determines a minimum reimbursement and an 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. Revised in January 2009, the updated EEG emphasises, for example, re-powering of older offshore wind stations and promoting improved access to the network grid for electricity generated by renewable energy;

([2]) BMU 2009: Renewable Energy in Figures, 2009.

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(b) Renewable Energy Heat Law (EEWärmeG) – requires that heat in new buildings be partly generated by renewable energy;

(c) Market Incentive Programme (MAP) – promotes the use of renewable energy by supporting investments in both new and retrofitted buildings which use renewable energy for their heat and hot water supply (i.e. solar thermal or efficient ground source heat pumps). Specific measures are investment grants, low interest loans and repayment grants. In 2009, 400 million Euros were provided for this programme.

2.2.1.4. Biogas and biofuels

The use of biomass reached 6.6% of overall energy use in 2008 – the largest contribution of renewable energy for fuels and heat, and ranking 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 promotion of biofuels is affected 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.

2.2.1.5. Energy efficiency

The Federal Government initiated several activities to anchor public awareness for energy efficiency. The German Energy Agency was established to communicate promotion programmes, technical matters and the economic benefits of energy efficiency. The Agency, in cooperation with leading companies in the energy sector, founded the Energy Efficiency 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 funded which renovate buildings to be more energy efficient. Due to the Combined Heat and Power Law (IEKP), the construction of CHP stations and district heating grids is also supported by around 750 million Euros per year. Another promotion programme subsidises (depending on the electrical power used and the planned hours of use) the installation of micro-CHP boilers for households.

2.2.1.6. Emission trading

In 2005, the EU emissions trading scheme began as a mechanism to raise incentives to increase energy efficiency amongst business and reduce GHG emissions. As a market-based instrument of the EU's climate protection policy, this was a first step in internalising the negative externalities from carbon emissions. It also provided a mechanism for EU companies

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to sell their permits if they emitted lower levels of GHG emissions. Whilst these permits were initially distributed for free since 2008 10% of permits were sold at auction. In 2013 all electricity generation permits and parts of the permits for industrial sectors will be auctioned.

Due to the permit sale in 2008 the 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 way, the BMU promotes measures which help increase energy efficiency and the use of renewable energy and support the protection of biodiversity in developing and emerging countries. To date, the national climate initiative includes six promotion programmes in total.

2.2.1.7. Sustainable transport

About a quarter of all German GHG emissions are derived from the transport sector, of which 90% are caused by traffic ([3]). At the beginning of the 1990's, regulations for carbon emission limits were implemented and continuously tightened. The last two regulations – Euro 5 and 6 – are valid from 2009 and 2014 respectively. The car tax was revised as a carbon dioxide oriented tax in July 2009. Car labelling has also 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 research and development (R&D) and market preparations for the introduction of electric vehicles. By 2020, it is envisaged that there will be one million electric vehicles registered in Germany. Given that there is currently a lack of qualified staff in battery technology research and trained technicians, the plan includes 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 lithium ion battery research, but there will be a higher need for qualified persons in the future ([4]).

2.2.1.8. Nuclear energy

Currently, 17 nuclear power stations operate in Germany contributing around 28% to electricity generation in 2009 ([5]). In 2000, the Federal Government decided to phase out nuclear power stations older than 32 years and in 2002 the law 'for the planned phase out of nuclear power for commercial electricity generation' was enacted. Overall, this means that nuclear energy generation will end in 2022. It might be possible that the new Federal Government –elected in September 2009 – will extend the duration of nuclear power in

([3]) BMU 2009: GreenTech made in Germany 2.0, S.174.

([4]) http://www.bmbf.de/de/11828.php.

([5]) BMU 2009: The World Nuclear Industry Status Report.

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Germany which might provide the baseload capacity to enable old coal power stations to be upgraded and roll out more CHP installations.

2.2.1.9. Further responses to greening

Besides existing measures and laws, the BMU published its 'New Thinking – New Energy Roadmap 2020' in January 2009. This shows how an integrated energy policy could be organised to ensure the Federal Government targets for 2020 are met. It focuses on ten action areas to guarantee a sustainable energy supply. For example it identifies opportunities to increase electricity generation from highly efficient power stations and reduce GHG emissions from transport using more efficient technologies, more electric vehicles and a greater use of environmentally sound public transport.

Environmental technology markets are important growth opportunities. Germany is one of the world leaders in developing and exporting environmental technologies. In a study by Roland Berger ([6]) 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 Germany's ecological industrial policy develops business profiles to succeed these growth expectations and to ensure the competitiveness of 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, in November 2008 ([7]) and in January 2009 ([8]), which together were worth around 100 billion Euros. According to 2009 study by HSBC the proportion of the German stimuli packages on green investments was around 13% – higher than other EU member states, even though the focus was not primarily on green issues. Both recovery packages set a focus on the promotion of energy efficiency ([9]).

Under the first package, three billion Euros are being used to foster energy efficient construction and reconstruction of buildings between 2009 and 2011. The Reconstruction Loan Cooperation (KfW) offers another 2.5 billion Euros of credit within the programme for

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([6]) 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.

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

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

([9]) Whilst there was no focus on renewable energy, as a world leader in solar and wind installations, Germany is already well established in these fields.

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energy-efficient building renovations. A further stimulus of 0.3 billion Euros is also 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 targeted at small and medium enterprises (SMEs).

The second package, worth 6.5 billion Euros, promotes education, especially in terms of energy efficient research and reconstructing within schools and universities. Energy efficiency is also being 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 reduce the burden on private households.

Both economic stimuli packages also focus on the promotion of low carbon cars with a tax exemption extended for one year if the cars meet either the Euro 5 or Euro 6 standard. As noted above, the car tax was also revised as a carbon dioxide oriented tax in July 2009. These two regulations increased the demand for new cars with lower carbon emissions. Furthermore, five billion Euros were provided for a 'scrappage' bonus. The purchaser of a new car received 2,500 Euros if he or she deregistered a vehicle older than nine years. Demand for the premium was high and the budget was exhausted by the beginning of September 2009. Another 0.5 billion Euros was allocated toward hybrid electric vehicle demonstration.

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. A study ([10]) by the DIW estimated the number of employees in the environmental protection sector to be around 1.8 million in 2006, equivalent to 4.5% of the labour force (a rise from on 3.8% in 2004).

Between 2005 and 2007 staff numbers of companies interviewed in the environmental technology sector was already growing by 14% on average ([11]). As this sector produces an average of 90% of its products in Germany, the employment impacts are focused on the German labour market.

The environmental technologies sector is expected to become much more important over time, rising from 8% to 14% of gross domestic product (GDP) in 2020 ([12]). This will lead to positive employment effects in the following years. Indeed, the number of employees within the renewable energy sector was around 235,000 in 2006 and this is expected to grow to

([10]) Scientific studies are used to determine exactly how many people work in the area of environmental protection since many environmental goods and services are provided within traditional industries (e.g. machinery, vehicle manufacturing).

([11]) BMU 2009: GreenTech made in Germany 2.0, S. 20.

([12]) Study by Roland Berger Strategy Consultants.

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500,000 in 2020 and 710,000 in 2030 ([13]). The high growth rates will clearly create an increased demand for skilled workers and this is already foreseen by the Federal Government. Some promotion programmes have been initiated and the subject of environmental protection has been included in dual vocational training programmes and university courses in recent years.

2.3.1. Policy initiated programmes

2.3.1.1. Environmental sector apprenticeships

In 2006 the Federal Environment Ministry started an educational initiative entitled 'Environment creates perspectives' in association with firms from the environmental technologies/renewable energy sectors. 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. As a result 6,000 additional apprenticeships were created in 2009. The initiative aims to identify the required apprenticeship trades, skills and competencies required by the environmental sector. One part of the initiative is the JOBSTARTER programme which aims to attract firms which are interested in training staff. Such firms could therefore offer apprenticeships to young people.

2.3.1.2. Environmental vocational training pilot projects

A range of environmental vocational training pilot projects and initiatives have been developed by various German organisations covering a range of specialist areas including resource efficiency, forestry and biogenic resources:

- 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, will aim to be rolled out across other sectors after the pilot project ends;
- 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;
- the BMBF together with international cooperation with BRIC countries and South Africa promote the DAAD project entitled 'studying and researching for sustainability: biogenic resources and value-added chain.' This aims to foster education and research to create solutions and competencies for sustainable production of biogenetic resources ([14]).

([13]) Wissenschaftsladen Bonn 2007: Ausbildung und Arbeit für Erneuerbare Energien.

([14]) BMU 2008: Masterplan Umwelttechnologien.

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2.3.1.3. Environmental sector promotion

Some subsectors of the environmental industries, such as waste disposal and management, have image problems which put off potential new recruits. To overcome this problem, the BMU in cooperation with DIHK has published an information brochure about four trades in this area to improve the image and to motivate young people to take up an apprenticeship programme in the sector.

A promotion programme by the BMU, the so-called 'Powerado' (2005-08) and its successor 'Powerado plus', aims to find new ways to communicate renewable energy within education. With respect to vocational education, suggestions for new curricula for craft occupations have been developed to integrate areas such as photovoltaics, 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 motivate them to save energy. One programme point is the GHG 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.

2.3.1.4. Research

The Federal Government fosters research in energy storage for lithium ion batteries and bio energy in the German Centre for Biomass Research. A summary of these programmes is shown in Table 1.

Table 1: Summary of policy initiated programmes

Programme	Initiator	Targets
Environment creates perspectives	BMU, BMBF, DIHK, BIBB	In 2009, 6,000 additional apprenticeships were created in the field of environmental technologies /renewable energy
Pilot project for CVT	BMU, DGB	Increase employees' and work councils' awareness of resource efficiency in operational and production processes
Information brochure, IVT – environmental technicians	BMU, DIHK	Improvement of occupations' image, larger number of apprentices
CVT in forestry	BIBB	Promotion of young scientists and engineers in the field of bionics
DAAD – studying and researching sustainability	BMBF	Promotion of education and research to create solutions and competences for sustainable production of biogenetic

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		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 meet the demand for skilled workers in the environmental sector is the modification of educational provision. Environmental protection has been incorporated into the education system through both dual vocational training and university education. For vocational training, existing training frameworks are generally being modified and refined to incorporate new environmental training requirements. A few initial vocational training courses have also been introduced but to a much more limited extent. Specialist university courses have grown in number over the years with a few focused purely on environmental disciplines. However, a larger number of university courses continue to take account of environmental management issues ([15]).

2.3.2.1. Initial vocational training

The education system (Ausbildungsordnung) provides for basic qualifications in environmental education to be incorporated into every dual education. Even though environmental issues are often only discussed to a limited extent, informative course units on waste/recycling, working safely with hazardous materials and energy issues have been added. Additionally, special elements are included such as environment days, excursions or projects to raise environmental awareness.

Due to new environmental legislation and environmental technologies, a greater range of environmental issues besides those covered in basic qualifications are now required within initial vocational training. Existing initial trainings have therefore either been extended or new occupations developed, to cover these emerging environmental themes.

Examples of extended trades include:

(a) plant mechanic for sanitary, heating and air conditioning systems. These mechanics operate modern heating, ventilation and air conditioning systems (HVAC) with minimal energy inputs. Moreover, they may now being work for companies that also install solar

([15]) 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.

PV and thermal technologies – and which can be linked into the HVAC system to provide a low carbon energy source;

(b) chimney sweeps must now integrate environmental supervisory and consultancy tasks into their work.

Existing occupations are generally extended by continuing vocational training (see below) or through additional degrees in specialist qualifications as the complete initial training is renewed.

In general existing occupations are being modified and refined to incorporate new environmental training requirements, rather than completely new occupations being established. However, new vocational trades include:

(a) recycling and waste management technician (Fachkraft für Kreislauf- und Abfallwirtschaft);

(b) water supply engineering technician (Fachkraft für Wasserversorgungstechnik);

(c) sewage engineering technician (Fachkraft für Abwassertechnik);

(d) pipe, sewer and industrial service technician (Fachkraft für Rohr-, Kanal- und Industrieservice);

(e) environmental protection technique assistant (Umweltschutz-technischer Assistent);

(f) biological technique assistant (Biologisch-technischer Assistent).

2.3.2.2. Continuing vocational training

Environmental protection has been included in existing continuing vocational training over the last 10-15 years, mostly due to the continuing vocational training regulation (Fortbildungsordnung) being renewed. This has lead to a huge proportion of qualifications integrating environmental protection issues. Integrated updates comprise environmental legislation, knowledge on the consequences of environmental protection measures for firms, recycling possibilities, and ways to control air and water pollution.

Pursuing a continuing vocational training course provides students with the opportunity to gradually build up their training competencies and receive additional specialist certificates or higher degrees which will enable them to develop in their chosen vocation. In this way, for example, a Sewage foreman can train and build on a completed initial vocational training to pursue the following four stage career pathway:

(a) foreman training (e.g. Sewage Foreman);

(b) technical training (e.g. Technician waste engineering);

(c) other continuing trainings, if applicable with certificate or chamber exam (e.g. Environmental Advisors, Specialised Clerk for Commercial-Technical Environmental Protection);

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(d) 'Aufbau' (postgraduate) and contact study paths (in environmental legislation or European environment management).

There is a very wide range of continuing vocational training courses which cover, to some extent, environmental management and protection issues. An illustration of professions and vocational training courses is shown in the Box below:

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);
- 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).

In the area of energy, continuing vocational training has been initiated by cooperation between different Chambers and organisations. These cover :

- service Technician for Wind Turbines (Servicetechniker für Windenergieanlagen);
- a nine 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.

2.3.2.3. University studies

Environmentalism has led not only to the development of environmental products and technologies by the environmental goods and services industry and the application of more

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effective product processes within industry, but also the introduction of environmental management systems in business to help better target and reduce environmental burdens arising from production processes. These areas generally require a high level of qualification and competency which are usually acquired from university studies.

To meet demand, several degree courses have been modified to take account of environmental issues and new degree courses have been developed. Graduates of these courses are in high demand, especially students from universities of applied sciences since these offer a more applied and practice-oriented education.

The amount of environmental courses is hard to count. In 1999, 501 courses referring to the environment were offered ([16]). Few of them were 'pure' environmental studies; most only offered several environment focused classes. The majority of the studies (55%) were in engineering. The studies were differentiated in the following fields:

(a) autonomous environment referring study courses (99);

(b) environment referring focus within study courses (265);

(c) environment referring 'Aufbau' study courses/postgraduate studies (53);

(d) environment referring classes (76);

(e) environment referring interdisciplinary study offers (eight).

Since 1999, the number of study courses has changed due to modifications, renewals and extensions. In 2004-05 the Institute for Environmental Research ([17]) found around 80 study courses 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:

(a) integration in existing studies;

(b) postgraduate courses;

(c) 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.

([16]) Umweltstudienführer 1999.

([17]) http://www.infu.tu-dortmund.de.

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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 masters 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:

(a) environment technologies;

(b) environmental engineering;

(c) environmental protection;

(d) 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 engineering. Thereby the first two to four terms focus on basic education and the last terms focus on practical experiences ([18]) 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:

(a) disposal and recycling techniques

(b) energy techniques

(c) renewable energy

(d) water and waste management

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. Therefore, companies focus on the different levels of the system to meet the demands of their employees. Some companies nevertheless realise their own training initiatives to adapt the skills of their employees. These initiatives are generally limited to the establishment of a company's own training centre, extra modules in existing training or cooperative university studies. Examples include:

(a) Siemens SE established its own training centre in Bremen to increase the supply and quality of their service staff for wind power turbines and wind power plants;

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

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(b) the Juwi Group, one of the world's leading companies in the renewable energy sector with focus on solar, wind and bioenergy, opened their own training academy. The training programme comprises basic specialised modules in wind, solar and bioenergy, in which all new employees have to participate during their employment probation period. Employees who work at the company for a longer time may also participate in the training ([19]);

(c) 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 techniques and machine building can participate in the training to become a Service Technician for Wind Turbines (Servicetechniker für Windenergieanlagen);

(d) 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;

(e) 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 rearranged 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. Over the next few years the evaluation of training contents of electronics and metal constructions will also be included. The project is being promoted by the German Federal Environmental Foundation (DBU) with 85,640 Euros ([20]).

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

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

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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

The drive to improve energy efficiency across the economy, coupled with growth in renewable energy capacity and broader carbon emissions reductions targets, are greatly influencing the behaviour of both manufacturers and consumers. Suppliers of consumer and industrial products are vigorously pursuing reductions in GHG emissions by using optimised production processes and energy efficiency measures. Good examples of this trend include more fuel efficient vehicles, low carbon buildings, and renewables being used in ever more imaginative ways (e.g. to power air conditioning systems). Even the agricultural sector is now following more environmentally sustainable production, reducing its waste generation and water consumption.

All these areas generate economic opportunities and influence employment levels and resulting training requirements. German environmental technologies companies in particular are well placed to capitalise on these markets, both domestically and in rapidly expanding global markets.

3.1.1.1. Reduction of greenhouse emissions

The reduction of GHG emissions has a large impact on both technological innovation and employment across different sectors of the economy:

Fossil-fuel power generation

Coal-fired power production remains the most important part of the German energy mix at 56% ([21]). Whilst there will inevitably be a shift towards renewable energy generation, coal power plants with carbon capture and storage (CCS) systems are now being demonstrated in Germany (e.g. by Vattenfall) and elsewhere in a bid to decarbonise the coal power sector. Despite a decision by the Federal Government to stop coal mining subsidies by 2018, which might in itself precipitate a large reduction in jobs ([22]), CCS has the potential to help maintain German production of hard and brown coal as well as employment levels across mining and power plants. Enormous efficiency savings can also be made in energy production from the use of modern and sustainable power plant technologies. Modern gas and steam power

([21]) BMWI 2009, BMWI Energiedaten, Tabelle 3.

([22]) 52,000 people were employed in the German coal mining sector in 2007 - BMWI 2008, 'Der Bergbau in der Bundesrepublik Deutschland 2007', S. 78.

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stations have efficiency levels of around 60% with lower GHG emissions per kilowatt hour than coal power stations; CHP stations are more efficient still.

Renewables and nuclear energy

Renewables capacity is growing rapidly, achieving 9.5% of overall energy usage in 2008 ([23]) and for example preventing 115 million tons of GHG emissions being produced in 2007. Growth rates for solar thermal energy, solar photovoltaics, wind energy and biogas are estimated to increase worldwide by 20% per annum until 2020. Technologies to enable energy storage are also being investigated (e.g. compressed air energy storage). Given their strong positioning in all these markets ([24]), German firms are expected profit enormously from this growth. Job creation has rapidly developed in the renewable energy production and storage sectors with employment rising 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. Between 2008 and 2010 the sector is expected to employ an average of 30% more employees. The highest increases have been estimated for geothermal, solar and bioenergy production (see Figure 1 below).

With Germany's decision to phase out nuclear power in the next few decades, some jobs will be lost from power stations (although as seen in countries like the UK, decommissioning also entails significant long term employment to monitor and remediate sites). There is therefore likely to be a certain amount of job shift to other energy generation areas.

Low carbon vehicles

Reducing GHG emissions from vehicles is also important since a quarter of all GHG emissions across the EU15 countries are traffic-related (excluding ship and air traffic). Car manufacturers counteract GHG emissions by reducing fuel consumption through various measures (e.g. engine downsizing, new electronics and controls systems such as automatic speed regulators, start-stop devices for engines, new types of tyre etc) ([25]). Increasingly, manufacturers are looking to develop ultra-low carbon vehicles such as full hybrids and electric vehicles. Intelligent traffic telematics and management to optimise traffic flows are also now being used to reduce GHG emissions – an area where German manufacturers have a 20% global market share. All these novel systems to reduce GHG emissions are creating new market opportunities for technology suppliers and hence major employment areas.

([23]) BMU 2009: Renewable Energy in Figures.

([24]) German companies hold high market shares worldwide: 90% in biogas, 25% in wind power, 35% in hydroelectric power, 21% in solar PV and 23% in solar thermal energy.

([25]) Filter systems and catalytic converters are also used by car manufacturers to reduce particulate emissions and NOx - German manufacturers have a 44% global market share in this pollution control area.

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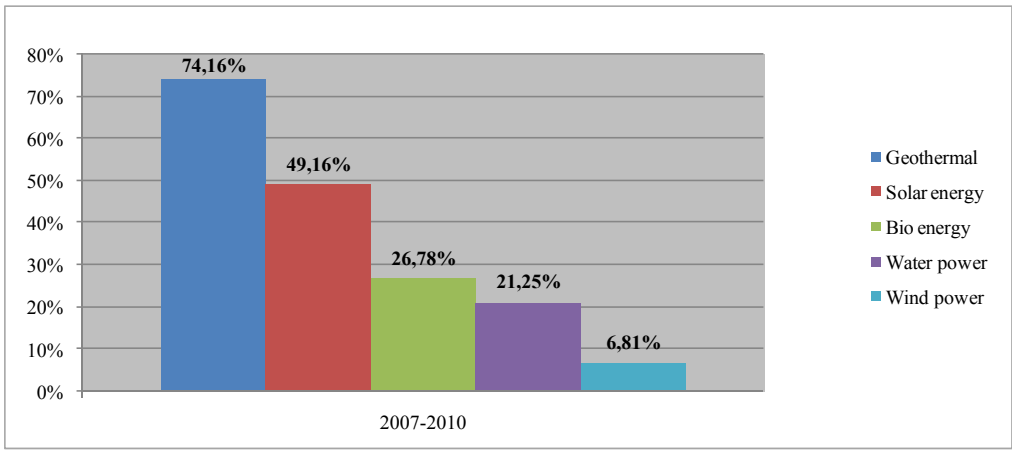
Figure 1: Employment expectations for renewable energy markets % change (2007-10)



Source: Wissenschaftsladen Bonn (2007)

Energy efficiency

With increased energy costs and a drive to reduce carbon emissions, the efficient use of energy in production processes, consumer goods and buildings has risen up the agenda. The use of technical standards has driven performance standards, particularly for domestic white goods since these appliances account for around one third of electricity use in households. Energy efficiency in buildings is being enhanced through better insulation, modern heating systems and the use of solar energy and ground source heat pumps. Consumer awareness of the need for better energy efficiency is improving, helped through government awareness raising programmes.

German companies are leading providers of technologies and services to improve energy efficiency. For example, in air conditioning and heating systems, German firms have a 15% global market share whilst in white goods and insulation German manufacturers have a 10% market share. The majority of small companies work in the energy efficiency field offer energy consulting and services to optimise buildings, whereas 80% of larger firms are manufacturers. Employment growth of around 15% on average was achieved across the sector in the period 2005-07, with a further average increase of 21% expected between 2008 and 2010.

Waste management

Depending on the development level of any particular country, the amount of waste generated per person per year will vary from between 200 and 800 kilograms. Around 12 billion tons of waste is produced every year worldwide leading to a high demand for waste management and treatment technologies. In 2005, for example, Germany recycled 87% of building waste and 63% of urban and production waste. Demand for recycling and sorting facilities globally is forecast to increase significantly, benefiting German companies who hold market shares of

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around 24% for recycling technologies and 64% for sorting facilities. Employment in the German waste sector has increased by around 24% on average with continued growth expected in the near future.

Various methods are being used to reduce waste at the outset, for example through more sustainable designs, resource-efficient production methods, the use of waste as raw materials in products and reusable products. Residual waste is also now increasingly being used to generate energy, either through burned to provide electricity and heat for production methods or in 'waste to energy' power stations to produce electricity.

Sustainable water management

Continued increases in water consumption and increasingly stringent regulations are driving large investments in the production, distribution and disposal of residual wastes from the water sector. At the same time, ageing public sewage systems have to be repaired, renewed and monitored. In the EU alone, 170-230 billion Euros will be invested to meet sewage regulations. This is creating demand for innovative technologies e.g. for monitoring and special filter systems to enhance water purification and conditioning at least cost. Water efficiency improvements are also cutting across industrial production, home appliances and in the agricultural sector.

German companies have global market shares of 20% in distributed water management, 20% in efficiency improvements and 12% in wastewater treatment. New market potential is expected around improved flood defence technologies. The sector overall has achieved high employment growth rates in recent years and this trend is expected to continue. Medium sizes companies with 10 to 50 employees generally have the highest growth rates of 17% between 2008 and 2010.

Restricted sectors

Environmental protection regulations impact on all sectors of the economy and may not necessarily lead to growth in sales or employment. For example, in 2007 the REACH ([26]) Regulation was introduced governing the manufacture and supply of chemicals. The main emissions from the chemical industry which impact on the environment are chemicals contained in products (e.g. ingredients in washing powder, cosmetics, biocides, pesticides, medicines and paints etc.). Many of these chemicals take time to degrade and if they build up may end up polluting the environment. Manufacturers and importers now have to register the quantity of substances processed with the European Chemical Agency (ECHA). They also have to guarantee the responsible usage of these substances across the entire supply chain. Hazardous substances such as carcinogenic or mutagenic substances may be prohibited. To achieve this, they must evaluate production processes. The chemical industry is the fourth

([26]) REACH means registration, evaluation, authorisation and constraint of chemicals.

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biggest industrial sector in Germany. All in all around 437,000 were employed in the chemical industry in 2006 ([27]).

The agricultural sector is another example of a sector which, whilst helping to preserve landscapes, plant species and animal species, may also impact negatively as a result of pollution to water, air and soil. The Common Agricultural Policy (GAP) does however promote measures to protect the environment and financial incentives are offered to farmers who use environmentally friendly working practices.

Impacts on the labour market

3.1.1.2. Employment in the environmental sector

The environmental technology and services sector is now one of Germany's major economic sectors, employing 1.8 million people in 2006 or 4.5% of the labour force ([28]) – see Table 2. The majority of workers (64% or 1.1 million people) are engaged in the operation and support of environmental protection facilities (e.g. waste facilities, wastewater treatment plants), 13% in renewable energy, 10% in the production of goods and a further 10% in the production of raw materials and supplies (e.g. chemicals, new filters etc.). Between 2004 and 2006 employee numbers increased by 290,000, a rise of around 20%.

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

Employment effects of environmental expenditures on	**Employees**		**Difference**	**% change**
	2006	**2004**	**2006-04**	**2006-04**
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)

The foreign demand for environmental protection goods supported only 49,000 employees – 49% of these were directly affected since they are employed in the environmental protection sector; the remaining 51% work for supply firms.

([27]) www.vci.de.

([28]) German Institute for Economic Research (DIW), 2009 – estimates of environmental job numbers have calculated the employment effects on the basis of expenditures with the help of input-output models.

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Employment in renewable energy has increased by 47% from 160,500 to 235,600 people. The biomass sector experienced the highest growth (+38,400) and also employs the most workers (95,400) out of all renewable energy sectors. Other sectors also developed positively however: solar thermal (40,200, +60%), wind power (82,100, +29%) and geothermal (4,200, +130%) established. Only water power decreased by 1% due to increased labour productivity.

3.1.1.3. Employment effects in net terms

The presented estimate of 1.8 million environmental jobs takes into account only the gross employment created due to environmental protection. It ignores 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 on net effects in particular sectors were conducted, but an estimate of net effects for all employment does not exist:

(a) a study by the German Aerospace Centre (DLR) calculated the net effect of the existing promotion of renewable energy to be 120,000 additional jobs by 2030 ([29]);

(b) the Federal Environmental Agency (UBA) estimated a net gain of 30,000 jobs for shifting subsidies for coal into building retrofits ([30]);

(c) another study calculated a net plus of 260,000 jobs due to energy efficiency in 2020 ([31]).

3.1.1.4. Future employment expectations

In the next decades the amount of people working in environmental protection is likely to increase. According to a study by the BMU in 2008 the policy measures included in the IEKP will lead to a decrease of 35% of GHG 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. Investments will support employment growth and lead to 500,000 additional jobs in environmental protection by 2020 and 800,000 by 2030 ([32]).

Regarding the IEKP the employment effects for 2020 were also estimated by a study of the UBA in 2008 ([33]). The authors used the PANTA RHEI ([34]) method for the analysis. Employment impacts compared to a reference scenario were investigated for five points of the IEKP:

(a) promotion programmes for climate protection and energy efficiency beyond buildings;

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

([30]) BMU (2009) Umweltwirtschaftsbericht.

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

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

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

([34]) PHANTA RHEI is a model for simulation and forecast used for analysing environmental economics issues (Lutz 2008).

(b) CO_2 building renovation programmes;

(c) switching car taxes to a carbon dioxide based tax;

(d) improved control of lorry charges;

(e) inclusion of air transport into emission trading.

Estimates of employment impacts for 2020 are presented in Table 3.

Table 3: Estimated employment impacts of particular IEKP measures 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 estimate employment growth in renewable energy with a rise to 400,000-500,000 employees by 2020 and to 710,000 by 2030 ([35]).

According to estimates by Roland Berger Consulting, an even more favourable job performance is likely: 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 by 2020 ([36]).

3.1.2. Identification of (re)training needs

German environmental technology firms are well established and often market leaders. Continuous investment in R&D of new products and processes helps Germany to maintain its competitive advantage as well as an appropriate supply of qualified workers (particularly those with a technical focus). Indeed, beside demand for their products, qualified personnel are the single most important factor in determining a firms' location ([37]).

The environmental technologies sector (which includes the renewable sector) has some of the highest employment potential of any economic sector and this will inevitably required a widespread and coordinated training system to meet future demand. For example, the

([35]) Wissenschaftsladen Bonn 2007. Note the estimates for 2020 come from a study by the DIW (2007) and the Federal Association for Renewable Energy, whereas the estimate for 2030 is from Roland Berger.

([36]) 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.

([37]) Companies interviewed by Roland Berger Consultants in 2007.

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renewable energy sector is set to experience high growth and to employ around 700,000 people by 2030, creating high demand for people with suitable qualifications. Professionals have usually followed a classical education path, e.g. as technicians, engineers or craftsmen. Initial vocational training which concentrates on renewable energy does not yet exist and the number of students on corresponding university studies is still marginal. Therefore, companies are having 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, accumulating information about the education and employment structure in the sector. The workforce could be classed into discrete groups with different education levels: 41% were skilled labour (Facharbeiter), 19% academics (mostly engineers and represented in 80% of firms), 27% commercial clerks (kaufmännisch Angestellte), 8% foremen and 5% semi-skilled labourers (Angelernte) ([38]).

For the renewable energy sector, apprenticeships in 40 different trades are offered, the majority being in mechanics, mechatronics, electronics and electrics. Besides engineering, these occupations are in high demand. Training rates for the renewable energy sector – the ratio between apprentices and total employees within a company – lies at around 5%, compared to an average of 6.5% in Germany. This means that renewable energy firms more often than not recruit qualified workers rather than offering dual training courses. This situation might be explained by two facts: first, the sector has experienced very high growth rates whereas dual training programmes take time to become established. Second, the education system has yet to integrate suitable initial training for renewable energy. As a result, firms have to recruit qualified workers and then train them further to meet their own internal 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.

Renewables firms have also evaluated current initial vocational training and university courses to ascertain how successfully this training is building sectoral knowledge that will satisfy company requirements. The results show that 56% of firms are satisfied with current provision, whereas 44% felt significant improvements were needed. 51% of firms would prefer to see a higher number of sector specific subjects incorporated into existing education.

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.

([38]) Wissenschaftsladen Bonn 2007.

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Across the environmental sector, the demand for skilled workers focuses on graduates of the so-called MINT subjects (mathematics, engineering, natural sciences and techniques). Low graduation rates in recent years in MINT subjects has created a shortage of highly qualified engineers and technicians of around 165,000 ([39]) in 2006. According to firms, 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 is assumed that environmental industries are now more easily able to fill recent job vacancies.

However, the largest problem for the environmental sector is the availability of engineers since graduation rates have also been low in recent years and near term prospects have not changed. The German 'engineer replacement rate' is low compared to other European countries at only 0.9 in 2008 (i.e. for every ten retiring engineers only nine entrants are coming through universities). Many experienced engineers will also retire in the next years, worsening the situation. Other factors affect recruitment into the environmental technology sector. First, the sector has to compete with other sectors such as the car industry – the largest employer of engineers. Second, environmental firms are generally still small in terms of sales making them less attractive on working conditions and overall career prospects. As a result, companies have difficulties competing with companies like BMW etc.

The 'Environmental Creates Perspectives' initiative, launched by the BMU, supports 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 be partly attributed to the demographic change in German society but also to image problems of different areas (e.g. waste management, sewage treatment etc).

3.1.3. Skills response

Retraining across the economy in response to green restructuring is mainly focused on the education and training system. In contrast, given their limited scale, initiatives by firms are seen as marginal. Education and training promotion programmes have been established, technical qualification trainings are offered and new study courses and further training with environmentally relevant subjects have been developed. For example, the range of continuing vocational training courses related to environmental protection is now substantial. Beyond new types of training, many existing training courses are becoming intrinsically greener due to the incorporation of environmental training elements. Furthermore, companies can help apprentices by allowing them to participate in an 'education-integrated' study pathway, i.e. undertaking initial vocational training whilst at the same undertaking a university course.

The growth in the environmental technology sector has created a large demand for specialists which is being met by universities, vocational training and research institutes:

([39]) IWD 2007 Ingenieure deutsche Mangelware, iwd Nr.20, 17.05.2007.

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(a) universities: German universities have established new degree courses focused on environmental technologies to meet this need and student number have steadily grown. In 2009, around 7,000 students studied environmental engineering (comprising various disciplines) ([40]);

(b) vocational training: 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 areas and have adapted skills to operate the facilities in this area. All together around 2,500 apprentices were employed in these trades in 2008;

(c) research institutes: the increasing number of environmental research projects being undertaken is greatly enhancing the specialist knowledge within research institutes. This improves the overall labour market and provides a pool of professional labour which may well move into the industrial sector at a later date.

The greening of skills is to a large extent captured by the education and training system. The three main channels – initial vocational training, continuing vocational training and university studies – are systematically organised and the companies are involved at each of these levels. A further assessment of skills responses is presented in Section 3.2.3.

3.1.4. Retraining case studies

Retraining case studies were based two economic sectors that have been affected by environmental protection measures and where work tasks have changed substantially. They include:

(a) mechatronics technicians in the car industry who have to develop their knowledge of hybrid propulsion systems (i.e. within hybrid, electric and hydrogen cars);

(b) chemical technicians from the chemical industry (which has adjusted all its working procedures to conform to the Responsible Care programme, which effectively integrates environmental protection into every day working practices).

3.1.4.1. BMW: motor vehicle mechatronics technicians

Motor Vehicle Mechatronics Technicians (MVMTs) work in the planning, servicing, inspection, diagnosis, repairing, equipping and refitting of motor vehicles in the areas of cars, commercial vehicles, and motorcycle and communications technology. The initial vocational training to become a MVMT is an approved trade and lasts 3.5 years in Germany. Training venues are in companies and at part-time vocational schools. For the continued training of

([40]) Statistisches Bundesamt 2009, Fachserie 11, R4.1, WS 2008/2009.

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young skilled workers, instruction courses at inter-company training centres have been agreed by social partners ([41]).

Around 74,800 people did an apprenticeship in this trade in 2006 (57,600 in 2005), an increase of 30% compared to 2005. Only 2.2% of these were women. The average age was 18.5 years old. The majority (44.7%) had previously completed an intermediate school (Realschulabschluss), 34.5% had a secondary school certificate (Hauptschulabschluss) and 5.4% had a general qualification for university entrance (Abitur/Fachhochschulreife). The remainder either had other qualifications or no school leaving certificates ([42]).

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 only 0.9% had a general qualification for university entrance ([43]).

Skill gaps and identification of skill needs

Low carbon hybrid propulsion is a growing trend in the car industry. German car manufacturer BMW, for example, recently included two hybrid cars in its product portfolio, the X6 and its seven series. Cars are equipped with both a combustion engine and additional electric motors and energy storage devices in order to reduce both fuel consumption and GHG emissions. With the right use of hybrid cars a reduction in fuel consumption of up to 15% is possible ([44]).

The use of voltages up to 400 volts within hybrid systems creates obvious health and safety issues which require technicians to have good overall technical knowledge of hybrid technologies. This means MVMTs need to develop new skills. To meet this skills gap, BMW implemented a new training module in 2009 in its existing dual apprenticeship for MVMTs. The module comprises technical knowledge for hybrid car technologies. On completion, apprentices receive a special certificate – an extra qualification as an 'Electro Technician for Specified Tasks on Hybrid Vehicles' (Elektrofachkraft für festgelegte Tätigkeiten am Hybridfahrzeug) ([45]).

([41]) www.bibb.de, www.berufenet.de.

([42]) www.bibb.de.

([43]) IAB, Berufe im Spiegel der Statistik.

([44]) Helmut Kroneder, BMW.

([45]) Manfred Theunert, Head of initial and continuing vocational training at BMW in Munich.

Due to legislation the trade association only allows trained electricians or mechatronics technicians who have acquired the relevant knowledge may carry out work on hybrid cars. Thus, BMW decided to integrate this training directly into its dual apprenticeship as an extra module. This means all MVMTs who complete their training at BMW will be qualified to work with all hybrid cars ([46]).

Existing provision of education for the occupation

MVMTs who completed their training prior to the new module being integrated obtain further training in hybrid technologies if necessary. This means that the training and the selection of required training modules are decided individually and depend on work experience and specific work tasks in the production process. For example, engineers involved in the development of hybrid cars need extra training, as well as technicians responsible for error analysis after the cars have been assembled. However, since the cars are not energized during vehicle assembly, voltage training is not required for all workers in the production process.

The skills response

In 2008 the new MVMT module was examined by a pilot project in BMW's Munich production plant. 32 apprentices participated in the training which lasted one week.

Since 2009 the module has been integrated in the dual apprenticeship programme for apprentices at other BMW production plants in Regensburg and Dingolfing. From 2010 all BMW 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:

(a) hybrid and high voltage techniques: facts, potentials and functional principles by comparison;

(b) mode of action and theoretical structure of high voltage components;

(c) electromagnetic compatibility: explosion control;

(d) standards, technical rules and regulations for hybrid cars;

(e) internal practice – handling of hybrid cars and high voltage components at BMW;

(f) safety concepts and secure component evaluation;

(g) measuring hybrid cars and/or high voltage components;

(h) practical work with hybrid cars and/or high voltage components;

(i) exemplary creation/handling of diverse specified tasks;

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

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(j) 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 MVMTs. BMW received the Innovation Prize 2009 from the BIBB for the exemplary function of the module, its close connection to the dual apprenticeship programme and its labour market relevance ([47]). Compared to other car manufacturers only BMW has integrated the hybrid module in the dual apprenticeship. All other car manufacturers only offer their employees continued training in hybrid techniques.

After completing the training module MVMTs 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 to 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 MVMTs after their training. However, 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 apprentices might also be employed by international plants in the UK, China or USA.

Outlook

BMW expects hybrid cars to be a successful product line in the future. Demand for low carbon vehicles is also increasing due to a newly introduced carbon dioxide oriented tax. At the moment BMW only offers two hybrid models but they plan to increase supply over the next few years after learning from experiences with existing models as well as optimising the technology for mass production.

Experts also forecast an increase in electrical vehicles in the future. Research in the fields of electric mobility is promoted by the 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

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

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order to ensure cars can be recharged. BMW has already developed this technology for Mini cars. The company is testing electric motors in 500 Minis in a pilot project in the US. Thus, MVMTs will also have to acquire knowledge in electric propulsion and electronics as well as in the maintenance of batteries for future tasks.

3.1.4.2. The chemical industry: chemical technicians

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 ([48]).

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 ([49]) (5,700 in 2007), a decrease of 1.5% compared to 2007. 14% of these were women. Apprentice numbers also declined in previous years by 12% compared to 2003 while the number of all apprentices in Germany slightly increased by 0.6% over 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 either had other qualifications or no school leaving certificates.

In 2007 around 160,000 people worked 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. Overall, only 15.8% of workers in 2007 were women. The majority (49.9%) were 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 of these only 1.7% had a general qualification for university entrance ([50]).

([48]) www.bibb.de, www.berufenet.de.

([49]) The number for 2008 is preliminary.

([50]) IAB, Berufe im Spiegel der Statistik.

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Skill gaps and identification of skill needs

Training regulations for Chemical Technicians and four other trades ([51]) in the chemical industry were revised in 2002 as the concept of Responsible Care ([52]) was introduced. This means that apprentices continuously receive training in work safety, health and environmental protection over the whole training period to increase their awareness in these subjects. The integration of this concept into the dual apprenticeship training in this sector guarantees its implementation and its internalisation at all stages of work.

The chemical industry continues to be heavily influenced by environmental protection via many channels. For example, the sustainability of chemical products is researched, both in production and over the product life cycle (e.g. the extent to which degradability of the products after being released in the environment). The European Parliament and EU Commission supports this approach through the 6th Environmental Action Programme which states that chemicals may only be produced and used if they have no negative effects on the environment. Therefore, the growth in environmentally sound substitutes and products is expected in the medium to long-term ([53]).

Chemical regulations were upgraded by the REACH ([54]) Regulation in 2007. Quantities of used substances have to be registered at the European Chemical Agency (ECHA) by companies in the chemical industry ([55]). In addition, in 2009 the 'Globally Harmonised System of Classification and Labelling of Chemicals' (GHS) came into force. GHS creates a global control framework to harmonise the classification, labelling and data sheets. It also creates an extra burden for the sector ([56]).

Existing provision of education for the occupation

Chemical catastrophes such as in Basel, Chernobyl and India discredited the image of the chemical industry and made a rethink necessary. The chemical industry was the first sector that promoted the integration of environmental protection aspects in the dual apprenticeship training in the 1980s. In 1987 the regulation for apprentices programme in the chemical industry was revised. The duration was extended from three years to 3.5 years. The integration of environmental protection was the main argument for the prolongation.

([51]) These production trades are: Chemical Production Specialists and Pharmaceutical Technicians, Chemical Laboratory Technicians, Biological Laboratory Technicians and Lacquer Laboratory Technicians (source: www.bibb.de.).

([52]) Responsible Care is an international and voluntary initiative adopted by the chemical industry. It expresses the willingness of the sector to continuously improve work security, environmental protection and health protection.

([53]) Kümmerer 2009, Nachhaltige Chemikalien, Stabil und abbaubar.

([54]) REACH stands for registration, evaluation, authorisation, and constraint of chemicals.

([55]) Lahl 2009, Chemikalienpolitik, REACH-Neue Standards in Europa.

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

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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

Around 2000, training regulations for apprentices in laboratory and production areas in the chemical industry were revised. 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:

(a) laboratory technical basic operations;

(b) mechanical chemical engineering: mechanical processing of reagents and products;

(c) installation techniques, maintenance and installation engineering;

(d) instrumentation, control and automation;

(e) thermal chemical engineering: thermal processing of reagents and products;

(f) 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 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 ([57]).

Assessment of effectiveness and organisation of this response

Today, the idea of integrating environmental protection measures into the chemical industry has to a large extent been achieved. As a result of energy efficiency GHG emissions have been reduced by 36% compared to 1990 while energy production has increased by 57%. Moreover, chemical products save twice as many emissions than what is required for their production ([58]).

([57]) www.berufenet.de.

([58]) ICCA 2009, Innovations for Greenhouse Gas Emission Reduction.

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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 ([59]).

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 processes and the resulting need for maintenance, repair and operations of machines and facilities, a major proportion of Mechatronics Technicians are now being trained.

REACH and GHS have lead to increased administrative requirements and higher labour costs, especially in SMEs, since all used substances now need to be registered. Thus, it could be argued that jobs in the chemical industry are threatened by these regulations ([60]).

Outlook

Over the last 50 years, the chemical sector has seen an increase in the number of highly qualified workers – a development mostly affected by the rise in technological improvements and the integration of environmental protection measures, which both lead 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 environmental standards. The problem is an, as yet, absent global climate agreement. There is therefore a danger of losing both market share and jobs to countries with less stringent regulations than Germany which would negatively influence the climate and employment in Germany.

([59]) VCI 2009, Responsible Care 2009.

([60]) Hans-Günther Glass, BVCI.

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3.2. New and changing skill needs

This section gives an overview of new occupations and the greening of existing occupations in the context of greening the economy. In Germany technical qualifications to perform an occupation are created by three main channels:

(a) completion of an initial vocational training;

(b) continuing vocational training;

(c) 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. These channels will mainly be investigated for the further assessment of new and greening occupations.

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 (in response to a perceived business need) and Solar Techniques (initiated primarily by Q-Cells in response to an actual shortage of technicians with the range of requisite skills). A third case study outlines the new Siemens training wind power training centre designed to enhance the training of its own personnel and customers, to improve health, safety, technical performance and the perceived high quality in the marketplace of the overall Siemens Wind Power brand.

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 to meet the requirements of an increasing technical need within the waste management 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 distinction might be difficult. In the given methodology of classifications new occupations arise if the required change in 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 for example a solar thermal system. In this way the occupation profile has become greener. Conversely, a Solar Technician is a new occupation as the specialisation in this field did not previously exist and the occupation focuses on the production of solar cells.

All occupations have integrated environmental protection to a certain extent in recent years. Environmental protection always represents an additional qualification integrated into

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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 higher demands on 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 ([61]) published by the Federal Labour Agency, 36 job descriptions can be found covering 'Occupations in environmental and nature protection'. These are differentiated by types of training (i.e. initial vocational training, continuing vocational training, etc.) as presented in Table 4.

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

([61]) www.berufenet.arbeitsagentur.de.

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	• expert on environmental matters • environmental management officer • laboratory yechnician in environmental protection
Civil servant	• civil servant in environmental administration

Source: Berufenet/Economix

The form of training for occupations classified under the 'Specialisation' category may either be through university studies or continuing vocational training or a mixture of both. While Table 4 only provides a few insights into the classification of new jobs or greening jobs, it does illustrate the range of environmental protection jobs which training is focused on.

Indeed, within any one environmental job area there are likely to be different occupations. An example is the occupation area covering 'Techniques in the field of renewable energy' which comprises six occupation profiles (as summarised in Table 5). These can be classified as new since the renewable energy sector was, to a great extent, established only in recent years.

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 composed wholly or partly of renewable resources. They mainly work in companies which generate renewable energy or produce biogas or biofuel. Moroever, they are employed by manufacturers who use renewable resources.	The need for this occupation can be explained by the increasing use of renewable energy and regenerative resources for production. A major advantage is a training duration of only two years.
Technical assistant – regenerative energy techniques/management	Initial vocational training	Technical assistants for regenerative energy techniques/management are involved in research and development as well as in the production/preparation phase of renewable energy techniques. They mainly work as energy suppliers, e.g. in wind, water or solar plants. Additionally, they are employed by electronic motor pump 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	Solar technicians acquire technical knowledge in the installation of solar

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		and electrical/technical facilities as well as in planning offices and utility companies	plants for private use. Solar plants are often installed by companies in sanitation or roofing 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, provision and application of techniques for the use of regenerative energy sources. They mainly work in technical investigation and consulting. Moreover, they are employed by manufacturers of machines and facilities who use environmental techniques, especially renewable energy. Additionally, they work with energy suppliers and environmental protection agencies.	Energy management is becoming more and more important, especially in terms of cost digressions due to energy conservation 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 such 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, in universities or in consulting companies.	As the amount of renewable energy used in energy supplies has increased rapidly in recent years, high skilled workers are increasingly needed for work in production plants and for researching new technologies. Due to the further increment of renewable energy a wide range of work tasks will arise for these engineers in future.
Service Technician for Wind Turbines	Specialisation	Service technicians for wind turbines are responsible for assembling, disassembling, repairing and maintaining	The number of wind turbines used to generate energy is

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		wind turbines and their components. They are, in general, workers who have completed apprenticeships as electrical technicians, or hold university degrees as mechanical engineers. They work in the construction of wind turbines or in engineering offices for technical planning. Moreover, they are employed by wind turbine manufactuers.	rising. For both construction and service, technical knowledge is required.

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 ([62]) website around 257 courses of study at different universities can be found, all relating to renewable energy. This 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 courses train people to work in the renewable energy sector. University studies focused on environmental protection were also established in other sectors. A selection of relevant new courses of study differentiated by 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 sciences	A mandatory study module in this course comprises environmental and resource economics. Students learn to interpret environmental problems, specialities of environmental goods, national and European environmental policies and environmental targets and instruments from an economic perspective.
Architecture	Energy efficient design	In general, architects have to acquire knowledge in energy efficient planning and construction. A masters degree would be possible, for example, in energy efficient design. The course imparts knowledge on how to remediate existing buildings and how to plan and construct energy efficient buildings.
Automobiles	Automobile techniques	Over the bachelors in automobile techniques, students learn how to develop and construct an automobile. Thus, a lot of

([62]) www.wila-bonn.de.

Unedited document available only electronically

		engineering knowledge is imparted. One of the courses addresses environmental aspects of construction, and deals with recycling and production-integrated environmental protection.
Building industry	Construction engineering	In the masters degree, students have the option of focussing on environmental techniques. The module imparts theoretical basic knowledge as well as knowledge for the practical realisation of infrastructural measures in industrial effluent disposal, sewage sludge disposal and waste management. Taking up a combination of construction engineering and environmental engineering is also possible.
Chemical industry	Environmental chemistry	The programme comprises basic courses in chemistry with a focus on environmental chemistry. Students obtain knowledge about processes in environmental chemistry, synthesis concepts to minimise waste generation and environmental pollution, hazardous materials and their disposal and the complexity of environmental processes. The programme focuses on training in computer-based measurement techniques and skills in practical laboratory work.

Source: KURSNET ([63]) /Economix

It is hard to identify new occupations arising from continuing vocational training since this form of training is generally used to green existing occupations. Nevertheless, in Table 6 above, three different continuing training programmes are presented in the renewable energy sector. Other continuing training programmes which lead to new skills and qualifications regarding the support of GHG 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 ([64]). The qualification development and skills need in renewable energy were examined ([65]), covering solar energy, geothermal energy, wind energy and biofuels. The study defined occupations appointed to work processes and the competencies required. Skills needs for personnel in different processes were determined and are summarised in the sections below:

Solar energy: R&D, manufacturing, consulting and sales, installation

([63]) www.kursnet.arbeitsagentur.de.

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

([65]) The combined heat and power sector was also examined as part of the study.

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Foremen in chemical engineering, electro techniques or precision engineering are needed to support academics' work in solar research. The practical knowledge of a solar sector foreman helps to find solutions which are practically applicable, so it is important that the foreman can cooperate with academics and tries to fill in 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.

For the manufacture of solar cells, a low supply of qualified workers existed in the years before the study was conducted. Recruited workers (Chemical Technicians, Electro Technicians, Fitter or Automation Engineering Technicians) had to undergo 'learning by doing' to integrate missing knowledge. All of them had certain skills needed for solar cell production but an occupation which included all required skills did not exist. The new occupation would combine cross-sectoral qualifications from four above named occupations. Workers need to integrate the following competencies:

(a) IT-knowledge, since all facilities are computer-based;

(b) knowledge in sensor technology and pneumatics;

(c) basic understanding of mechanics, acids, gases and electronics.

For the further qualification of employees it would be necessary to develop missing knowledge with further training. A preparation of modules with technical and basic knowledge of the named occupations would be possible. 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 (see Case study later in this report).

For consulting and sales of solar facilities, only sales from manufacturers to distributers (installation businesses) are specified, meaning that 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. Conversely the installation of solar facilities is mainly carried out 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: Hydrothermal systems, geothermal systems

The work tasks involved in geothermal energy mainly comprise energy distribution, i.e. generating, transforming and using energy. As a result of high plant automation, control supervision is only required roughly every three days so that employees maintain other plants across the business portfolio. Employees do not only need technical knowledge in electricity and heat generation for geothermal plants but also for conventional plants such as fossil fuel

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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.

Ground source heat pumps 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: Production of wind turbines, technical services

Wind power has been used to generate electricity for the past 15 years. To manufacture wind turbines one can draw on knowledge from the areas of steel production, mechanical engineering and metalworking industries. Traditional occupations in these fields are Fitters, Cutters, Polishers and Electrical Technicians. These have mostly been recruited and trained further for wind turbine production. Specialist knowledge is needed for rotor blade production, especially in the field of polymer processing. An apprenticeship in this field would be necessary as this knowledge is only learnt through a training programme for Mechanics in Plastics and Rubber Processing. For the production of 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: Biogas plants, production of biodiesel

In bigger plants higher gains can be achieved due to improved raw material inputs and reuse of materials. In this area Chemical Engineers and Process Engineers are mainly employed, often supported by Fitters and Laboratory Technicians who investigate the quality of the used rapeseed oil. No new developments in the qualification profile could be defined.

The production of bioethanol 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: Installation of CHP plants

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

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knowledge in power and exhaust behaviour of renewable energy and connections of technical systems.

3.2.2. Greening existing occupations

3.2.2.1. Initial vocational training

At the dual apprenticeship training level, environmental protection has been integrated in all initial vocational training regulations and therefore a greening of the whole dual vocational training can be observed. As noted in the case study above, the chemical industry has played a leading role in integrating environmental aspects into apprenticeship training, starting as early as 1987. For occupations outside the environmental sector, environmental training focuses on basic knowledge in waste recycling and energy conservation. The companies nevertheless are free to extent the environmental knowledge of their apprentices according to their needs. 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
Environmental technicians	2002	This category emerged from four training programmes under the 'Provider and Disposer' (Ver- und Entsorger) training theme. It is an instance of a modernised apprenticeship with greening character. These apprentices hold standard technical qualifications and, additionally, integrate a wider knowledge base regarding environmental protection. They work mainly in waste and sewage disposal and recycling.
Plant mechanic for sanitary, heating and air conditioning	2003	It was especially for this trade that the increased use of sustainable energy inputs formed part of the revision. Apprentices adapt knowledge to use regenerative energy and to conserve energy through efficient energy use. They will be able to 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 energy conservation.
Electronic technician for energy and building services	2003	For this trade the same extended work tasks apply as for the plant mechanic for sanitary, heating and air conditioning.

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engineering		
Builder of stoves and air heating systems	2006	For a builder of stoves and air heating systems, again, the integration of increased use of sustainable energy dominates the greening part of the training revision.

Source: Economix

3.2.2.2. Continuing vocational training

Greening existing occupations within a continuing training framework comprises additional skills which can be adapted by the training. These include basic training which imparts environmental protection aspects such as waste and recycling, energy conversation and environmental legislation as well as specialised training for further work as an environmental specialist, energy consultant or environmental engineer. A wide range 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 a case study on energy consultants was included. According to new legislation (i.e. the EU Energy Performance in Building Directive) landlords and others who sell buildings and homes require an energy certificate that defines the energy needs of the building. Only a designated group of specialists who have completed a continuing training and become an energy consultant may issue an energy performance certificate.

A good example of greening an existing occupation as a result of technological change is Solar Installation Technicians. On top of technical production requirements (as mentioned in Section 3.2.1. which has lead to a new solar technician occupation being developed), there is a need for skilled craftsmen to install these systems, especially in private households. The target group are craftsmen, i.e. Plant Mechanics for Sanitary, Heating and Air Conditioning and Electronics, who learn the required competencies with the help of continued vocational training. In this way, craftsmen who previously only worked on fossil-fuel based systems are retraining for low carbon systems.

3.2.2.3. University studies

An overview of university courses with curricula either adapted to environmental issues or supporting the greening of occupations are presented in Table 8, differentiated by economic sector.

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

Economic Sector	Study course	Contents/Skills
Agriculture	Agrarian	A mandatory study module in this course comprises

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	sciences	environmental and resource economics. Students learn to interpret environmental problems, specialities of environmental goods, national and European environmental policies and environmental targets and instruments from an economic perspective.
Architecture	Energy efficient design	In general, architects have to acquire knowledge in energy efficient planning and construction. A masters degree would be possible, for example, in energy efficient design. The course imparts knowledge on how to remediate existing buildings and how to plan and construct energy efficient buildings.
Automobiles	Automobile techniques	Over the bachelors in automobile techniques, students learn how to develop and construct an automobile. Thus, a lot of engineering knowledge is imparted. One of the courses addresses environmental aspects of construction, and deals with recycling and production-integrated environmental protection.
Building industry	Construction engineering	In the masters degree, students have the option of focussing on environmental techniques. The module imparts theoretical basic knowledge as well as knowledge for the practical realisation of infrastructural measures in industrial effluent disposal, sewage sludge disposal and waste management. Taking up a combination of construction engineering and environmental engineering is also possible.
Chemical industry	Environmental chemistry	The programme comprises basic courses in chemistry with a focus on environmental chemistry. Students obtain knowledge about processes in environmental chemistry, synthesis concepts to minimise waste generation and environmental pollution, hazardous materials and their disposal and the complexity of environmental processes. The programme focuses on training in computer-based measurement techniques and skills in practical laboratory work.

Source: KURSNET/Economix

The greening of existing occupations in Germany has affected a very wide range of occupations. Clearly, however, the extent to which environmental issues are integrated differs widely according to job type. In general, three main green themes (of which GHG emissions reductions are an intrinsic issue) are integrated into the training across different economic sector:

(a) energy efficiency;

(b) energy conservation;

(c) recycling/avoidance of environmental pollution due to waste, sewage, hazardous materials.

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Energy management plays a crucial role in many companies in order to evaluate current energy consumption and to assess the savings potential from buildings, work and production processes and to optimise energy use. Craft sector skills are required and adapted to insulate buildings, integrate energy efficient measures as well as increasingly use energy from renewable sources. In the future energy management will become more important to avoid cost and competitive disadvantages.

3.2.2.4. Skills shortages

Whilst the integration of environmental protection will continue to play an important role, it is unlikely that special green occupations will be pursued at the initial vocational training level. According to the BIBB ([66]), it is more efficient to integrate greening and maintain basic training qualifications in their current form. This is because demand for specialised environmental apprenticeships is low and apprentices are at risk of being trained too narrowly, which may be a disadvantage for them in the future. Therefore, environmental protection will mainly be included in future as a cross-sectoral aspect while specialising depends on other qualifications.

Further greening of occupations might occur in the following fields ([67]):

(a) agricultural occupations that commit to organic farming;

(b) traffic occupations that support an environmentally friendly mobility act;

(c) energy occupations that focus on renewable energy and energy conservations;

(d) manufacturing occupations that produce products from recycled materials;

(e) chemical occupations that use biodegradable substances;

(f) motor vehicle occupations that invent alternative propulsion technologies.

3.2.3. Identification of skill needs

3.2.3.1. Initial vocational training

New or modernised occupations at the level of dual apprenticeship programmes arise due to revisions in the training regulations of an existing occupation or the integration of a new training regulation. Between 1996 and 2009, 82 occupations were created and 219 occupations modernised ([68]).

([66]) Marion Krampe, BIBB.

([67]) GTZ 2003.

([68]) BIBB 2009: Neue und modernisierte Berufe, Stand 23.07.2009.

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The creation of a new initial training regulation or modernisation of an existing initial training regulation and the corresponding curricula adjustments (Rahmenlehrplan) of the Federal Länder is conducted in a multilevel process involving employers, trade unions, the Federal Government and the Länder. According to legislation (§§4 and 5 of the Vocational Training Act) a specific skill need has to be identified in the economy for a modernisation or the establishment of a new training regulation. In the case of environmental topics which might be developed by the Federal Ministry of Environmental Protection, Nature Conservation and Nuclear Safety, the particular environmental training modules are then determined by consensus between employer and employee associations and the Federal Ministry for Education and Research. This will form 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 ([69]).

As an example, revisions to Waste Providers and Disposers training programme in four environmental technical occupations (see Case study 6 in Section 3.2.6.) was mainly influenced by the Association for Recycling when the need for a specific recycling trade arose in the 1990s due to stricter waste disposal laws ([70]).

3.2.3.2. 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 there were between 28,000 and 35,000 suppliers of continuing vocational training in 2002 ([71]). There is no law which regulates this market and an evaluation of quality is seldom provided.

The establishment of new continuing training courses or modernisation of existing training courses is mainly determined and organised by company need. For private suppliers the training programmes 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 its training centre for wind turbines to train its own staff but also to offer safety and product training to its customers' employees, who operate either single wind turbines or wind farms.

3.2.3.3. University studies

Demand for new university courses either occurs in response to visible demand in the economy or cooperation between the university and companies with a demand for specially

([69]) www.bibb.de/de/4963.htm, 15.01.2010.

([70]) Marion Krampe, BIBB.

([71]) Severing and Fitz 2002.

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trained students. Universities may decide to establish courses because they are aware of a potential demand but there is no analysis of this. The content of university courses is decided by universities. Quality is often evaluated by ranking the courses and the universities. Insights into this process are illustrated with the university courses 'Green Business Management' and 'Solar Techniques' (see 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 a similar image problem in recruiting apprentices in craft businesses, especially in the areas of waste, sewage and SHK (sanitary, heat and air conditioning) where apprentice numbers are low as the image of these working sectors is poor. Demographic changes are also reducing the supply of adequate workers.

The Federal Office of Statistics publishes student numbers undertaking university courses directly connected to environmental protection ([72]) over the period 2003 to 2009 (see Table 9). Compared to the total number of students in Germany (around 2.2 million in 2009) ([73]), the numbers presented in the university courses overall is only marginal (i.e. less than 15,000 by 2009). However, a clear feature is the large growth in technology courses covering energy (+74%) and environment (+37%). A decline in student numbers for waste management might be explained both by the sector's image and by the fact that the sector is not expected to expand its workforce over the next few years.

Table 9: Number of students in environmental-related university courses (2003-09)

University studies	Number of students						% Difference
	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2003-09
Nature conservation in agrarian sciences	482	484	449	442	393	455	-5.60%
Waste management	224	272	261	239	274	132	-41.07%
Energy techniques	1.753	1.681	1.902	2.172	2.139	3.049	73.93%
Environmental	5.150	5.441	5.862	6.603	6.739	7.039	36.68%

([72]) Note: these courses do not include all ecology students as these issues have been integrated in various other courses.

([73]) Statistisches Bundesamt 2009, Fachserie 11, R 4.1.

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techniques: including recycling							
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

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 prove correct, the supply of skilled workers must to be secured. However, the shortage of skilled workers seen in recent years might continue for some years to come. German educational policy is believed to have missed the opportunity to increase capacities sufficiently because the sector's high growth was underestimated. As in previous cases of rapid transition, the education and training system was slow to avoid skills shortages.

Furthermore, renewable energy firms have yet to show many efforts 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 sufficient however 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

3.2.5.1. Bachelor of engineering: solar techniques

Since October 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) has offered a specialist solar techniques degree course. The dual bachelor course combines knowledge in natural sciences, engineering and theoretical knowledge in solar techniques ([74]) and results in a Bachelor of Engineering in solar techniques. A special feature of the course is the combination of theoretical knowledge taught at university and the practical and technical experiences acquired at the companies. Therefore a precondition to participate on the course is a work contract at a solar company. Students are employed by the companies and matriculate at the university at the same time. When there are no lectures, students work in their sponsor companies, gaining experience across different departments. Overall the dual study course lasts six terms (three years).

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

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The first course comprised 16 students from Q-Cells and two from the Fraunhofer Centre. During their work experiences within the companies the students had already supported different research projects with their technical knowledge ([75]).

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

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Initiators

Founded in 1999, Q-Cells SE is now one of the largest global manufacturers of solar cells with 2,700 employees. The company is quoted on the Frankfurt Stock Exchange (QCE; ISIN DE0005558662) and also listed in the TecDAX, the German technology index ([76]).

In 2008 the company produced monocrystalline and polycrystalline silicon solar 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 work on technology development to achieve Q-Cells' twin aims: driving down the costs of photovoltaics (PV) quickly and permanently, and making the technology affordable and competitive. Alongside its crystalline silicon core business, Q-Cells produces now PV modules using CIGS and CdTe thin-film technologies. Furthermore, Q-Cells International specialises in solar project development, planning, constructing and maintaining large solar parks and rooftop arrays, while Q-Cells Clean Sourcing has established a new business providing industrial customers with green energy. Q-Cells has therefore become a vertically integrated conglomerate with branches in Italy, France, Hong Kong, China, Japan and the USA.

The Fraunhofer CSP in Halle is a specialist R&D centre for silicon crystallisation and material evaluation. The centre was initiated by the Fraunhofer Institute for Material Mechanic (IWM) and for Solar Energy Systems (ISE); the ISE being the largest solar power research institute in Europe ([77]).

Skill gaps and identification of skill needs

The German solar sector has achieved one of the highest growth rates in recent years, with German firms realising a worldwide market share of 21% in PV and 23% in solar thermal energy in 2007. Thus, suitable trained staff was needed to a large extent. PV is a specialist area and workers need technical knowledge in natural sciences, electrical techniques and process engineering. This combination of disciplines did not exist at German universities, and before the 'solar techniques' degree, theoretical knowledge about PV was not taught in any existing university course. Furthermore, high skilled workers are needed to optimise technologies and to develop them further in order to stay competitive – another benefit of such a course being developed.

Given the number of people experienced in the theoretical background and the practical work of PV is still limited and there has been continual higher demand for trained staff ([78]). Q-Cells faced a lack of suitable job applications for open vacancies in recent years. Additionally, dual

([76]) www.q-cells.de.

([77]) www.csp.fraunhofer.de.

([78]) Leich, Q-Cells.

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training courses did not exist either for renewable energy or for solar techniques and there was no solar industry drive to establish a national-wide training programme. In order to guarantee a suitable number of skilled workers to reach required production levels and growth targets, Q-Cells was forced to initiate a new solar techniques course which taught the wide range of required disciplines and integrated specialist technical and production knowledge in PV from Q-Cells' solar cell production lines.

Existing provision of education for the occupation

Graduates from the solar techniques course will go on to work in R&D, process optimisation and facility maintenance. Given the number of students is expected to be low and the first students will graduate in 2011, the existing Q-Cells workforce has to be trained to required qualification levels. The current work force employed in the above mentioned areas consists mainly of postgraduates from different fields of natural sciences and engineering. To a certain extent, all of them face PV skill gaps. Thus, they receive continuing vocational training to reduce these skill gaps. The type and need of training is decided between the employee and the superior in appraisals. Some employees perceive the need to undertake a master degree in physics or chemistry. Others obtain training with varying contents depending on their skill needs. Training is selected individually for every employee. Some examples for continuing training are:

(a) basics, dimensioning and use of PV energy;

(b) process and plant trainings for wet chemistry, metallisation, diffusion and SiN deposition;

(c) technology for silicon production;

(d) types of solar cells and solar cells with high level of efficiency;

(e) technology for silicon solar cells;

(f) measurement techniques and cell testing.

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 training takes place at external locations. As a result of external training, employees gain experiences from other companies in the sector. The training courses help to adapt the employees' qualification to follow the development of PV technologies as they precisely meet the requirements. Nevertheless, a study course with the required content 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

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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 plan has a modular structure and consists of both optional and obligatory modules. The content has been compiled by Q-Cell technologists and the university. Some modules were completely developed by the company.

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 PV, processes of silicon production, solar cell production and solar module production. Knowledge of foreign languages, presentation techniques and business knowledge are also taught. An overview of the course is presented in Table 10.

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 first four terms at university are structured rather similarly, 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 term students have a longer company work experience of 18 weeks, and in the sixth term they also have to write their bachelor thesis.

At university the lectures are all given 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.

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Students receive 500 Euros per month from the company as a kind of training salary. The company pays no extra fees for students as there are no tuition fees in Saxony and universities in the federal state are paid 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 sector.

Assessment of the effectiveness and organisation of this response

The degree is a good way of obtaining skilled workers with adequate qualifications since it promotes the availability of qualified workers. Moreover, it is not necessary to train them further. This is a disadvantage for employees who lack competencies in working with PV 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 growth. The company also 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 and make its production process more environmentally sound and resource-efficient. Q-Cells supported 16 students in the course's first year. However, in 2009 due to the economic downturn they employed no new students. In 2010, Q-Cells plans to support 10 students. There is a high demand for these places and 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 solar techniques degree course only had five new students in October 2009, its second year of operation. This low number was mainly a result of organisational problems between the University Köthen and Q-Cells. Q-Cells' decision not to employ new students meant that the university had problems finding new solar firms to collaborate with. This situation has now been rectified and new solar firms have been found and the university will also try to integrate other firms before the next course starts in October 2010. Demand for the study course remains high especially amongst students. As a result the university is implementing a system to enable students to apply directly to the university. The university will then try to place them into corresponding firms. The university plans to have at least 18-25 students but

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has the capacity to incorporate up to 50 or more. The number will be dependent on cooperating firms which can offer work contracts to the students ([79]).

Q-Cells SE and the Fraunhofer Centre work closely with the Martin-Luther-University in Halle-Wittenberg and a focus on PV started within the physics masters course. It comprises relevant lectures and seminars which are partly given by training staff from Q-Cells. Additionally, the company offers students internships, jobs as working students and postgraduate research jobs.

3.2.5.2. Green business management: BiTS Iserlohn

Since October 2008, the private University of Applied Sciences BiTS ([80]) (Business and Information Technology School) in Iserlohn (North Rhine-Westphalia) has run a degree in Green Business Management ([81]). The course, which combines lectures in management, economics and environmentalism, lasts six terms (three years) and results in a Bachelor of Science qualification. The first year of the course comprised 11 students, of which four were women. In the second year, this dropped to nine students, of which three were women ([82]).

Green Business Management was initiated by the university's president, Dr. Walther, who expects green business to be a growth area for graduates specialising in environmental protection – not least because firms that do not fully integrate environmental protection into their operations (particularly in light of energy and carbon cost considerations) will suffer competitive and cost disadvantages in the future. As a private university, this niche study market also provided a good business opportunity. Dr. Walther cooperated with Professor Dr. Meuser, an expert in ecological and management aspects, who helped establish the course. Since 2009 the course patron is the former Environmental Minister, Sigmar Gabriel – a sign of the profile the course has achieved.

Skill gaps and identification of skill needs

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 level of interest after discovering that such a course existed. At the moment companies get involved in this area other through offering internships and bachelor thesis themes to students. Demand for qualified environmental managers is

([79]) Information was collected from an interview with Prof Dr. Andrea Jurisch, Chair of the study commission for the solar techniques degree at the University Köthen.

([80]) Founded in 2000, the BiTS University of Applied Sciences offers studies focused on management and entrepreneurial aspects. Since February 2009 BiTS has been part of the Laureate International University network comprising 45 different universities in 20 countries with around 550,000 students.

([81]) www.bits-iserlohn.de.

([82]) Professor Dr. Meuser, Dean of the course.

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already well known at bigger firms like BMW or Daimler, but will – according to Professor Dr. Meuser – also increase in SMEs in the future.

In recent years there has been a growth in courses which combine technical studies and the environment. Nowadays the training of specialists to undertake consultancy and provide advice, for example on energy efficiency in firms from various economic sectors broadens this course demand. The Green Business Management course therefore seen as essential for further integrating environmental training into the educational system. The students of the course also work at the interface of environmentalism and management, helping firms to achieve cost savings whilst supporting firms in fulfilling both regulations and voluntary emission reduction targets.

Existing provision of education for the occupation

Companies interested in recruiting employees who have acquired good knowledge in both management and environmental protection generally need to recruit graduates of management sciences who have partly focused on the environment or else they have to train them further. A combination of both subjects did not exist before the Green Business Management course started.

The skills response

The course lasts three years. In the first three terms the course 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 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 curriculum was developed by Professor Dr. Meuser who, together with 8-9 other professors, provide all the lectures. All the professors had to be newly recruited for the course.

Table 11: Course contents of Green Business Management

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, Sustainable, Entrepreneurship, Logistics	Eco Techniques, Sutainable Finance,
Economics I and Law I	Economics II	Economics III and Law II			
Soft Skills–	Soft Skills –	Soft Skills –			

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Basics	Advanced	Special			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. This is primarily designed to improve awareness of environmental pollution and environmental protection solutions in countries where environmentalism is not as advanced as in Germany. The event takes place in the fourth term before the students start their internship. Students from the first course intake will visit Quito, Ecuador, in January 2010. Quito is a good example since it is close to rainforest and has considerable waste and housing problems in the city.

The course costs 24,015 Euros per student not including costs for living and dwelling. The students can apply for a studentship. Altogether only two 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 the university expects student numbers to increase. Potential reasons why not many students have chosen the study course include the fact that, according to Prof. Dr. Meuser, young people who have recently finished school are often not that interested in environmental protection and thus choose to study other subjects such as Sport & Event Management or Business Psychology. Environmentalism is also still seen as 'alternative' not that popular yet.

Since this degree course has only been in operation for 1.5 years, an evaluation of the graduates' prospects in the labour market are not yet available. Nevertheless, there are positive expectations that all students will find a job. The university is also trying to build networks with regional and inter-regional companies to promote their course and to enhance the job search for their students.

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

Outlook

The university in also interested in introducing a masters degree in Green Business Management, to capitalise on increased awareness and interest in environmental issues in older students. This would comprise an occupational degree for employees who are aware of the importance of environmental protection and therefore willing to train further. There is no firm start date as the university is waiting for their bachelor course to evaluated and further refined. Nevertheless, as a private university, BiTS could rapidly develop the new masters programme if necessary.

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3.2.5.3. Siemens wind power training centre, Bremen ([83]): service technicians

In 2009 Siemens established a new wind power training centre, as an important part of the Siemens European Service Headquarters for Wind Power in the city of Bremen. Sitting alongside three other training facilities in Europe and the USA, the centre helps Siemens to meet training needs for wind power services ([84]) and the company now offers a broad-based qualification programme for customer personnel and service technicians.

Siemens focuses on three key sectors, industry, energy and healthcare. The wind power business segment is part of the renewable energy division, which sits within the Energy division and its headquarters are located in Denmark.

Training is targeted 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 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 competency network for onshore and offshore wind power in the region. Bremen also supported the realisation of the training centre.

Currently, Siemens build nine types of large scale wind turbines, between one MW to 3.6 MW (together with other sub-1MW turbine types). In Germany, 1400 Siemens wind turbines (totalling 1500 MW have been installed), leading to a GHG emissions reduction of around three million tonnes CO_2.

Skill gaps and identification of skill needs

Siemens established the training centre to guarantee a high quality service for Siemens wind power facilities. The centre is part of an international programme which comprises health, safety and environment. Technicians employed by Siemens Wind Power are usually electronic technicians or mechanic graduates. However, the high safety and technical standards of Siemens' wind turbines requires constant training regarding safety and technical developments. This is because wind turbines are often located 80 metres above the ground or the sea and are being continually upgraded.

([83]) The information was collected from an interview with Nils Gneiße, manager of the training centre.

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

Every Service Technician learns to organise their daily work in wind farms in a safe and efficient way. Newly employed technicians may not start work on the wind turbines before they have completed seven days of safety training. They then have to obtain continual technical training in safety and technical know-how as part of their job.

The training centre was established due to the massive training needs of both experienced workers and new recruits. The training modules have been developed within Siemens and there is no dependency on external suppliers for the training.

Existing provision of education for the occupation

Before the training centre was established Siemens employees only received product trainings on small simulators at the Danish headquarters. Training included features and the functionality of the turbines. As technologies of wind turbines and its modules became more and more specific and complex in recent years, special training for adapting qualifications was required.

The skills response

The training programme comprises technical and safety trainings such as construction, service and maintenance of Siemens turbines or specific offshore safety training modules. Training courses provide 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 ([85]).

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 one (tower and nacelle). Course participants learn how to use the climbing protection system up to 14 metres above the ground. Moreover, they will intensify their skills in rescuing colleagues and themselves at heights	• 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.

([85]) Siemens delivered information brochures about the training centre and training contents.

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	while considering a wind turbine's special conditions and surroundings.	
Advanced safety training	The heart of the training centre is an original nacelle from a 2.3MW 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 one to three 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 casualties 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 equipment	The greatest challenge for service technicians working on wind turbines is 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.	• maintenance and testing of personal protective equipment • 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

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		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, with a focus on safety and quality of services of Siemens wind turbines. The contents were designed to have precise objectives in order to promote successful execution of service activities.

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 already employed at

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Siemens obtain new training modules according to their work experience and existing qualifications.

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

Assessment of effectiveness and organisation of this response

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

The training comprises practical and theoretical modules with effectiveness measured by education objective accounts for staff. Overall, the organisation of continual training at Siemens Wind Power has improved and the new training courses have enhanced employees' qualifications. This is also visible in product trainings which employees still receive. Appreciation for training has improved and has lead to increased effectiveness and efficiency of both product training and services.

Compared to other turbine manufacturers, Siemens conducts a large amount of training. This has both improved the product image and demand for Siemens wind turbines. The additional training also ensures the efficiency, quality and availability of facilities since well qualified service technicians can more easily detect faults as they have detailed technical knowledge of wind turbines.

Outlook

Even though the training modules have improved Siemens' service offer, continuous improvement is being pursued. The training structure is always extended and trainers are trained further.

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 cooperation between the different wind power service centres and headquarters is due to be strengthened in the future.

3.2.6. Case studies on greening existing occupations

3.2.6.1. Recycling and waste management technician

Recycling and Waste Management Technicians (RWMTs) ensure that waste is correctly handled and disposed of, through proper collection and distribution of waste and recycled products. They mainly work in disposal firms, utilisation and treatment facilities, for example,

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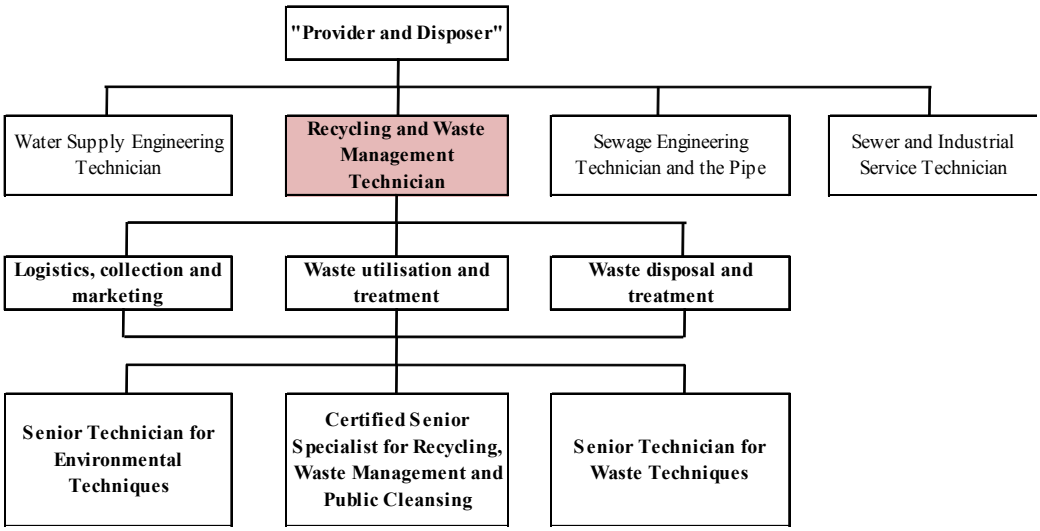
glass and paper recycling facilities, landfills, composting facilities, and chemical and physical treatment plants. In public cleansing authorities they organise the service of waste collection vehicles and optimise collection rounds. In disposal firms they ensure that waste and sewage does not pollute and harm the environment. They also accept, identify and assign waste to disposal systems or repair waste utilisation, treatment and disposal plants. RWMTs work in a pro-environmental manner ([86]).

The dual training course to become a RWMT is an approved trade. The apprenticeship lasts three years and covers logistics, collection and marketing or waste utilisation and treatment or waste disposal and treatment.

The RWMT trade was newly implemented in 2002. Before that an existing initial vocational training, the 'Provider and Disposer' (Ver-und Entsorger), covered the field. However, as work tasks became more complex, a specialised qualification was required and the initial training was revised into four environmental technical training specialisms: Recycling and Waste Management Technician (RWMT); Water Supply Engineering Technician; Sewage Engineering Technician and Pipe, Sewer and Industrial Service Technician ([87]) – see Figure 2.

Figure 2: Recycling and waste management technician: history of trade



Source: Economix

In 2002, 1,258 people were trained as 'Providers and Disposers'. In comparison, by 2008, apprentice numbers on these four new environmental technician courses had reached 2,500.

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

([87]) www.berufenet.de.

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In 2002, 102 apprentices were undertaking the new RWMT trade, the number increasing to 553 in 2008. The proportion of women is low, at 9-10%. In 2006 the average apprentice age was 19.4 years old. 24.4% of apprentices had the equivalent of the secondary general school (Hauptschulabschluss), 50.2% completed an intermediate school (Realschulabschluss) and 11.7% had a general qualification for university entrance (Abitur/Fachhochschulreife). The remainder had either other qualifications or no school leaving certificates.

Companies mainly train to meet demand so the chances of being employed after completing the apprenticeship are high and unemployed RWMTs is therefore low.

In 2007 around 54,800 people (of which 3% were women) worked in Waste Disposal and Street Cleaning, a marginal decrease on 2005 (54,900) – part of a long term trend which has seen an employment reduction of 9.4% since 1999. The majority of workers (53.6%) were 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. 55.9% held a degree in a dual vocational training, but only 0.7% had the general qualification for university entrance. 33.6% had not completed any dual vocational training ([88]).

Skill gaps and identification of skill needs

The need to revise the existing 'Provider and Disposer' trade came about mainly due to discussions, influenced by the Association for Recycling, as to whether a special trade in recycling was needed. New and stricter waste disposal laws implemented in the 1990s impacted on the waste sector, leading to greater waste recovery and recycling. This required qualified staff who understood the new legislation. Furthermore, as the waste management sector became more complex and technically sophisticated, a trade in special areas was needed to help prevent facility breakdowns and to help ensure air pollution emissions regulations were being met. Whilst the former 'Provider and Disposer' trade provided a general training, the increased complexity and technological changes brought about by the change in law required greater specialisation (e.g. technical qualification and skills in environmental techniques, natural sciences and emissions protection techniques) ([89]).

In cooperation with the Ministry for Environment, the BMBF initiated an investigation to define the need for a revision. Experts conducted the study and interviewed firms in different sectors (mainly in the areas of paper, electronics and scrap metal disposal). These experts suggested different contents for the revision of the training.

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

([88]) IAB, Berufe im Spiegel der Statistik.

([89]) http://www.bibb.de/de/1573.htm.

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The new RWMT trade was designed to give apprentices after completion the ability to both use their technical knowledge to help run waste facilities and also be aware of environmental protection issues during their day to day work, which helps improve sector performance and overall environmental protection.

Existing provision of education for the occupation

The training regulation for the 'Provider and Disposer' trade was implemented in 1984. In the first year of three, this earlier trade comprised wide training in natural sciences followed in the second with technical knowledge training. In the third year apprentices could decide to specialise in water supply, sewage or waste. Apprentices worked after completion of the training in the areas of:

(a) waste treatment including recycling;

(b) water production, water conditioning and distribution;

(c) waste water draw-off.

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 different types of environmental technicians are taught the same basic contents. This comprises 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' course communicated the same contents over two years before apprentices specialised. A key change in the new technician courses is the intensive training in customer-orientation and service-orientation.

In the second part of their training the apprentices acquire technical knowledge and become specialised into their respective disciplines. The RWMT learns, amongst other things, measures for occupational safety during the collection, transportation and treatment of waste, hazardous materials and special waste. They also learn how to operate, monitor and service appliances and facilities.

Training targets vary with respect to individual specialisation:

(a) apprentices who focus on logistics, collection and marketing concentrate on road and freight traffic laws, the calculation of cost and benefits, and how to conduct stationary and mobile collection;

(b) apprentices who focus on waste treatment and reuse concentrate on sampling, preparation, record management, and the recognition and correction of appliances and machines;

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(c) 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 operated, 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 Basic qualifications 1. year	Economic processes, work organisation	Planning an environmental concept
	Information and documentation and quality management	Use of environmental chemicals
	Environmental protection techniques, ecological circulation and hygiene	Examination of water and waste ingredients
	Basics 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 2.-3. year	Customer-oriented and business-oriented actions	Waste disposal
	Recycling processes	Waste investigation
	Safety and operation instructions	Waste treatment
	Logistics and disposal	
	Information technology	

Source: Berufenet

Continuing vocational training

Continuous training and deepening of specialist knowledge including new technological developments are critical to a successful career for a RWMT. The subject area for continuing training is wide and ranges from waste disposal to recycling. RWMTs 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. They might also study engineering at university with a focus on waste management, environmental protection/techniques or processes. In the waste sector it is quite common that apprentices proceed with further training, especially with a 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.

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Assessment of effectiveness of response

As revisions to the 'Provider and Disposer' trade were implemented in cooperation with authorised experts of employers and employees, many new requirements were incorporated. Firms in particular favoured the option of three different specialisations so that they only need to train what is required for their work tasks.

Discussions are on-going as to whether separate training is needed for the recycling sector. As the initial training for the RWMT meets the minimum requirements, recycling companies 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.

Outlook

The RWMT is a trade with a sound future. Experts forecast a growing demand for waste, including for reuse in products and a as fuel for generating energy. In this context the term 'urban mining' has emerged, which has enhanced the added value of the waste management sector and emphasised the importance of waste recovery and reuse rather than disposal.

3.2.6.2. Plant mechanic for sanitary, heating and air conditioning systems

In general, a Plant Mechanic for Sanitary, Heating and Air Conditioning Systems (PMSHACS) plans, installs and maintains complex plants and systems in supply engineering. They mainly work in installation firms or for heating and air conditioning manufacturers. Nowadays, an increasing number of them install energy-saving systems which work with renewable energy sources, e.g. solar power. They also renew old heating systems ([90]).

In 2003, the 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 PMSHACS is an approved trade. The apprenticeship lasts 3.5 years in Germany. Training occurs within the company and at a part-time vocational school. The training focuses on special areas of water and air techniques, heating techniques and environmental techniques/renewable energies.

Around 33,000 people (0.8% women) did an apprenticeship in this trade in 2006 (2005: 25,500), an increase of 30% on 2005. 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

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

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(Hauptschulabschluss), 31.9% completed an intermediate school (Realschulabschluss) and only 2.1% had a general qualification for university entrance (Abitur/Fachhochschulreife).

In 2007 around 177,000 people were employed as pipe installer, who includes installer of gas, water, heating and conditioning technologies ([91]). 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 only 0.6% had the general qualification for university entrance (Abitur).

Skill gaps and identification of skill needs

In 1989, trainings in metal finishing fields were revised and the dual vocational training frameworks for both central-heating and ventilation construction and gas and water installer, plumber and constructors (Gas- und Wasserinstallateur) were reworked and adapted to meet new occupational requirements. These two frameworks were combined in 2003 and converted into the PMSHACS. 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 more service-oriented as customer relations became more important in recent years. Moreover, knowledge about the use of sustainable energy input was part of the revision since at the time there was limited technical knowledge in this area. The sector also recognised that a PMSHACS would increasingly have to install solar facilities, heat pumps and wood burning systems for heating. Together with a better understanding of how to conserve energy through efficient use of facilities, this lead to a requirement to include training modules covering renewable energy facilities and energy efficiency in the revised training.

Regulations have also been introduced in recent years covering the energy use of sanitary systems in buildings and energy efficient facilities combined with energy sources from renewable energies became mandatory in new buildings. According to the Energy Saving Regulation (EnEV) old heating systems had to be renewed as they exceeded limit values for GHG emissions. Renovations of existing buildings are therefore needed and tailored solutions found. For example, where office buildings require extensive measures for building service engineering and utility engineering, PMSHACSs will be appointed to do the work. They will plan reconstruction options and install the required facilities. To do this required a lot of new training.

([91]) IAB, Berufe im Spiegel der Statistik.

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New requirements in the future

Since January 2009 according to the revised Energy Saving Regulation, sellers and landlords need an energy pass (Energy Performance Certificate) for their buildings and dwellings if they were built after 1966. The obligation also applies to commercial buildings since July 2009. In 2012 revisions to the regulation are planned which will mean energy requirements being tightened for new buildings and building renovations.

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 PMSHACS. They will also support the planning and development of new energy-saving facilities. The demand for these systems is likely to increase now that the energy pass is implemented.

Skills response

Initial vocational training

Training to become a PMSHACS is structured in two sections: basic training and technical training (Fachausbildung). Basic training takes places during the first year of the apprenticeship, thereafter the focus is 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.

Table 14: Plant mechanic for SHK – contents of initial vocational training

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
	Planning and regulation of working tasks, control and evaluation of results	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 drainage 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 physical, ecological and economical conditions relating to construction	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

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Source: Berufenet

Various modules cover, for example, customer relations; planning, regulation and controlling work tasks; quality management etc. Depending on the different companies in which the apprentice is employed the focus may be on water, air or heating technologies or on environmental techniques/renewable energy. The sphere of activity is decided by the company that trains the apprentices.

Continuing vocational training

The occupational career depends on the maintenance of technical knowledge, the continuous update and deepening of specialised knowledge, and understanding how to integrate new developments. Subjects for continuing training for technical adaption are wide and range from advances in measurement and control technology to the use of new materials. The PMSHACS 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. 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.

An example of further special training in the field of renewable energy is training in solar thermal energy plants – an area in which a further training programme to become a Solar Technician exists. Solar technicians design 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. They also install and service solar systems and integrate them into the existing sanitary technical supply devices. The training lasts four months (8-12 months part-time) and focuses on solar PV, solar thermal energy, and overvoltage. An overview of modules is shown in Table 15. The training ends with a final exam.

Table 15: Plant mechanic for SHK – contents of initial vocational training

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

Source: Berufenet

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Entry requirements 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.

Assessment of effectiveness of response

Renewable energy sector firms train apprentices from 40 different trades. One of the technical trades is the PMSHACS. The main trades, however, are mechatronics technicians, mechanics, electrics, electronics, office clerks and industry clerks (Büro-und Industriekaufleute) ([92]).

High employment growth rates was expected in 2007 in the fields of service, maintenance and renovation (+27.2%), especially in the solar sector (+28.6%). Skilled employees with work experience are in particularly in demand, opening up opportunities for a PMSHACS. 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

Demand for regenerative heating systems and energy consulting has increased, opening up wide work opportunities for a PMSHACS who already have the basic competencies. The segment offers new fields for installation crafts. A quarter of all sales in the sector are derived from ground source heat pumps, solar thermal or wood-fired heating systems ([93]). 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. Employees with this type of training therefore 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.

3.2.6.3. Energy consultant with focus on energy passes

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 ([94]). They monitor the technical conditions of heating, sanitary, ventilation and air conditioning systems and work out energy concepts, for example advising on solar PV systems. Therefore, they are also well informed about home appliances and systems so that they can consult the private households on energy use. In councils they

([92]) Wissenschaftsladen 2007.

([93]) Research Institute EuPD, based on 2007 research

([94]) www.bibb.de, www.berufenet.de.

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compile regional energy concepts in order to enable the use of district heating with regenerative energy sources.

Energy Consultants mainly work in energy consulting 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 for manufacturers of solar cells, heating systems and at water conditioning plants.

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 (3% women) worked as consumer advisors, which also include Energy Consultants ([95]). The number of workers declined by 3% between 2005 and 2007 (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. 26.6% of the consumer advisors in 2007 had a degree from either a university or an applied university of sciences. The majority (58.9%) held a degree in a dual vocational training, of which 6.6% had the general qualification for university entrance (Abitur).

Skill gaps and identification of skill needs

In 2007, the Energy Saving Act (2007) introduced the energy pass for new non-residential buildings and their sanitary, conditioning and heating systems and for renovations. The energy pass identifies the energy performance of buildings and provides basic information about insulation and reconstruction improvements. The revised Energy Saving Act of 2009 has, since January 2009, extended this requirement, requiring sellers and landlords to obtain an energy pass for their buildings and dwellings built after 1966. A revision of the Act is planned in 2012 tightening energy requirements further for new buildings and building renovations. As a result, trained workers are needed who have the technical knowledge to evaluate energy use and GHG emissions of buildings. Paragraph 21 of the Energy Saving Act 2009 ([96]) regulates those who may issue an energy pass for existing buildings:

([95]) IAB, Berufe im Spiegel der Statistik.

([96]) BAFA 2009, Verordnung zur Änderung der Energieeinsparverordnung.

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(a) persons with a 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;

(b) other technical or scientific fields with a focus of training in the fields named above;

(c) 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;

(d) 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:

(a) 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;

(b) 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;

(c) 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 issue energy passes.

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 issue 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. The following investigation of Energy Consultants refers to Energy Consultants needed for issuing energy passes according to legislation.

Skills response

The continuing vocational training to become an Energy Consultant takes place at the Chambers of Craft or at private educational providers. Participants acquire knowledge in energy consulting, construction and building physics and installation engineering. The whole training comprises around 240 hours of lessons. An overview is shown in Table 16.

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Qualifying occupations who may participate in training are foremen in crafts, engineers or technicians with corresponding qualifications.

Continuing training energy pass

Specialised seminars/trainings for energy passes are also provided. The following example refers to the training offered by the Centre of Green-Minded Building at the University Kassel ([97]).

Table 16: Energy consultants – example overview of training contents

Contents	Hours
Basics of energy consulting: Environment and energy economy Basics in legislation, technologies and physics Software for on-site consulting Promotion options Structure of an energy consultancy Calculation of profitability	48
Constructional engineering, building physics: Basics in construction 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	76
Installation engineering, technical building services: Heating and ventilation engineering Electrical engineering	80
Project work, group work, final exam: Preparation of an energy pass Features of exemplary energy consulting Elaboration of an exemplary report Preparation and implementation of a presentation Final exam	36
Sum	240

Source: Berufenet

The training is a four day module costing 699 Euros which ultimately enables participants to issue energy passes for residential buildings. Project work and a final exam are mandatory.

([97]) http://www.zub-kassel.de/weiterbildung.

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The target group comprises foremen, technicians and Energy Consultants. The training contents include:

(a) preparation of demand-oriented energy passes for residential buildings;

(b) preparation of customer-oriented energy passes;

(c) investigation and evaluation of geometric sizes and energised characteristic values of the building envelope;

(d) investigation and evaluation of service plants;

(e) simplifications for the record of geometric sizes and the investigation of energised characteristic values;

(f) empirical values for building and plant components;

(g) recommendations for modernisations.

On the first day of training an excursion to see an exemplar building and 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 qualified people are authorised to issue the certificates. This ensures that only persons with the appropriate knowledge of energy-saving buildings are permitted and there is no misuse. Suitable training programmes have been implemented to develop this new knowledge.

Demand for further training in the area of energy passes and energy efficiency in buildings is the result of an environmental protection Act by the Government which aims to promote reductions in GHG emissions from the building sector. It has not been brought about through the demands of companies or any one sector. Therefore, this example differs to other cases in this report in which greening or adaption of an occupation or skill occurred because of company needs.

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 ([98]). The study led to modernisation recommendations by energy consultants who suggested a 30-40% reduction in primary energy use was achievable. The majority of participants noted that they could better evaluate energy use with help of the energy pass.

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

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The certified people who issue the energy passes were evaluated regarding their technical abilities to objectively assess the energy use of buildings and to give advice for improvements to reduce energy use. All of them were consistently assessed as having good technical know-how and service.

Outlook

New regulations covering building automation have been developed which take weather data into account and introduce these into the programming of heating, ventilation and conditioning systems and sun protection mechanisms. This innovation can achieve up to 40% energy savings. When Energy Consultants inform consumers of the possibilities and technologies for saving energy, they have to consider the new regulation concepts for building automation. To ensure the required knowledge is communicated, they also have to extend their own knowledge with continued training.

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4. Conclusions

4.1. Main 'greening' shifts in economies and labour markets

4.1.1. Greening of the economy

Restructuring toward a green economy appears to generally follow an integrated approach, whereby existing processes are modified and redesigned rather than the invention of completely new solutions. This concept applies to many different aspects including manufacturing of environmental technologies, the application of more environmentally friendly techniques, implementation of environmental standards, image creation and marketing, consumption and mobility behaviour etc. One obvious exception is a sector like renewable energy which is creating significant new technologies and systems. Overall, greening of the economy is going to change economic activities at multiple points, creating large environmental training requirements across the economy.

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 increasingly 'greener' or cleaner production. Similarly, an occupational approach indicates the specialisation of workers on environmental issues rather than the full range and scope of green activities in the economy. Since environmental aspects have to be considered in most, if not all, activities, a cross-sectoral or cross-occupational perspective is seen as being more important. Clearly some sectors are more affected than others but all sectors generally need to tackle environmental challenges and therefore need certain environmental competency levels in their workforce.

The main factors driving this widespread integration of environmental know-how are:

(a) energy from fossil fuels is becoming more expensive and CO_2 emissions are now starting to become increasingly factored into price, leading to rising energy costs, but also importantly helping to subsidise the roll out of renewable energy. Energy efficiency across the economy also supports cost saving and improved competitiveness;

(b) 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 in consumer markets to avoid damaging their image and incurring competitive disadvantages;

(c) 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 car industry, mechanical engineering, transportation and logistics, the chemical industry, metal production, agriculture etc.

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4.1.2. Green industries

The greening of the economy has led to the creation of a thriving domestic environmental goods and services that is a global leader. Key sectors that have emerged on the back of progressive regulations and market stimulation measures include renewable energy, recycling and waste management, and energy consulting.

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. Specialist industries are also growing in the course of technological and economic development, as can be seen with information technology.

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 solar PV 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 unavoidable. The solar sector will thus experience a restructuring process with less production and more knowledge-intensive work.

The opportunities for further growth in environmental technologies are large and the expectation is that, as noted above, environmental performance will continue to become more integrated into mainstream business, driving investment in cleaner technologies and requiring workforce upskilling.

4.1.3. 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 major creator. 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 between 400,000 and 500,000 by

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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

Alongside economic restructuring, environmental protection has affected the skills composition of the German workforce in two ways. First, new environmental occupations have been established by the education and training system. Second, many occupations and workplace activities have adapted their competencies to embrace environmental protection and management requirements. This adjustment has been achieved by continuous reforms of the dual training system, continuing training, and university courses. In principle this type of adjustment can be expected to continue. A multi-channel policy of competency 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.

For producers of environmental goods and services, a higher level of occupational specialisation is likely to be required to improve German competitiveness. However, international competition is rapidly rising as new suppliers emerge in developing economies, notably Asia. A higher degree of knowledge integration will be needed if the implementation of higher environmental standards is the target. Particular skill needs can be identified:

(a) extension of the renewable energy sector requires an adequate supply of skilled workers in the areas of manufacturing and plant servicing as well as consulting, marketing and sales;

(b) the installation, repair and maintenance of environmental plants will require a rise in intermediate workers, especially in craft businesses;

(c) restructuring in the solar sector will reduce the need for cell manufacturing skills but there will be increased demand for R&D, value chain management and marketing. Engineers, scientists and marketing experts will be needed;

(d) to enhance Germany's environmental technology sector competitive advantage in the world market, a highly qualified R&D segment and efficient production is required. 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.

Germany has the opportunity to continue what it does best, i.e. develop progressive environmental regulations, let its domestic supply side meet this demand (including through

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new technology innovation) and then let other countries mimic the approach – creating large export opportunities in the process.

Many occupations in sectors outside the environmental industries will have to accumulate further skills in energy efficiency, 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 skills needs covering environmental protection in Germany has been pursued for over two decades. Laws regarding waste and pollution control have greatly influenced sectoral approaches to training; and sector specific responses, such as the chemical industry including environmental protection as an inclusive part of their working practices has created valuable exemplars for how industry and business can integrate environmental protection in their training. This has led to overall awareness for environmental protection being high across the economy and environmental protection becoming a standard element that is always considered during the establishment or revision of training regulations or university curricula.

The skills response follows mainly an integrated approach to incorporating environmental considerations rather than focusing on specific 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.

However, there is no 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 – due demographic changes – points to a need to rethink an approach in this area.

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 integrating environmental protection elements.

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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 the 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 the environmental industries sector lack efficient social partnership. The inadequate supply of training in the renewable energy sector for example could make greater use of social partners as they 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.

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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 failing to adapt would 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 environmental 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 workforce skills. Due to the rapid growth of environmental industries skills shortages have emerged in recent years, especially for engineers. Moreover, fewer school graduates are applying 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.

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German public authorities in particular have to counteract skills shortages by better integrating young people from migrant backgrounds. This has been on the agenda of labour supply policies for many years. In addition, the number of school drop-outs has to be reduced to increase the overall supply of trained workforce. So-called 'production schools' have been established e.g. in Hamburg, which aim to solve this problem. Following the Danish model, the participants gain practical knowledge in production and services and heighten their chances of success in the labour market. Such initiatives need to be expanded. Modular vocational training is another tool to address disadvantaged youth problems. The ideas are there; now it is time for training institutions to 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 includes a lot of expert knowledge. The use of these materials should be guaranteed with better cooperation.

The non-existence of social partnerships 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.

5.2.1. 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 company needs, but these tend to focus 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. This would have the advantage of modules being tested practically and if the need for an adaptation of skills increases, the module could be included in the training regulation.

Moreover, pilot projects need to be developed (also in initial vocational training) to explore efficient methods to adapt to rapidly changing technologies. The projects should be divided up and focused on specialisations in regions, sectors and technologies. Additionally,

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continuing vocational training could be extended by the supply of internships. Employees could thus make experiences in other companies, work tasks or knowledge areas.

5.2.2. 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 environmental 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

5.3.1. Green employment

Regarding 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.

5.3.2. 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:

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(a) 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;

(b) the adequacy of existing skills responses within the education and training systems need to be evaluated.

5.3.3. Research outlook

(a) a study has recently been conducted on behalf of the BMU which offers practical examples of energy and resource efficiency within apprenticeship training. The study aimed to offer BMU a template for the preparation of materials which provide instructions for optimised integration of energy and resource efficiency and should be used by companies in all economic sectors ([99]);

(b) DIHK in cooperation with the BIBB will investigate the sustainability of apprenticeship training in the future.

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

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

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List of key resource people

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

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Acronyms and definitions

BIBB	Federal Institute for Vocational Education and Training (Bundesinstitut für Berufsbildung)
BiTS	Business and Information Technology School
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)
BWE	Federal Association of Wind Energy
CCS	Carbon Capture and Storage
CHP	Combined Heat and Power (Kraft-Wärme-Kopplung)
CSP	Centre for Silicon and Photovoltaic
DBFZ	German Research Centre for Biomass (Deutsches Zentrum für Biomasse Forschung)
DBU	German Federal Environmental Foundation
DGB	German Federation of Trade Unions (Deutscher Gewerkschaftsbund)
DIHK	Association of German Chambers of Industry and Commerce (Deutsche Industrie- und Handelskammer)
DIW	German Institute for Economic Research (Deutsches Institut für Wirtschaftsforschung)
DLR	German Aerospace Centre
ECHA	European Chemical Agency

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EEG	Renewable Energy Law (Erneuerbare Energien Gesetz)
EEWärmeG	Renewable Energy Heat Law (Erneuerbare Energien Wärmegesetz)
EnEV	Energy Saving Act (Energieeinsparverordnung)
EU	European Union
GAP	Common Agricultural Policy (Gemeinsame Agrarpolitik)
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HVAC	Heating, Ventilation and Air Conditioning Systems
IBU	Institute for Environmental Protection in Eductaion (Institut für Umweltschutz in der Berufsbildung)
IEKP	Integrated Energy and Climate Programme (Integriertes Energie- und Klimaprogramm
IWM	Institute for Material Mechanic
KfW	Reconstruction Loan Cooperation
MAP	Market Incentive Programme (Marktanreizprogramm
MINT subjects	Mathematics, Engineering, Natural Sciences and Techniques
MOT	Ministry of Transport
MVMTs	Motor Vehicle Mechatronics Technicians
PMSHACS	Plant Mechanic for Sanitary, Heating and Air Conditioning Systems
PV	Photovoltaics
R&D	Research and Development
RWMTs	Recycling and Waste Management Technicians
SHK	Sanitary, Heating and Air Conditioning Ssystems (Sanitär-, Heizungs- und Klimaanlagen)

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SME	Small and Medium Enterprises
UBA	Federal Environmental Agency
VCI	Association of the Chemical Industry
VET	Vocational Education and Training
ZUB	Centre for Green-Minded Building (Zentrum für umweltbewusstes Bauen)

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