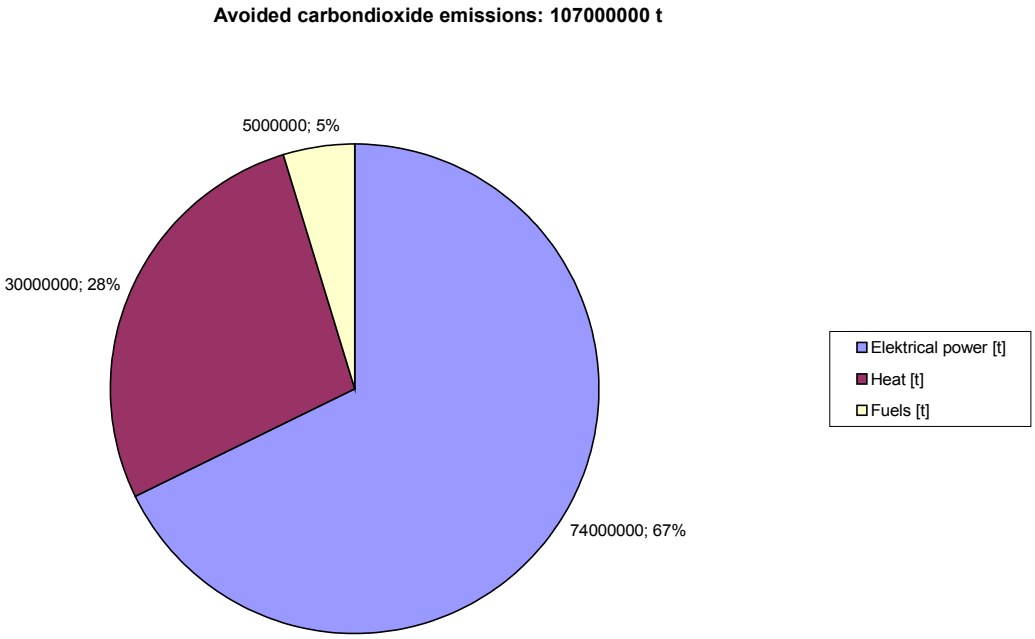
The general situation on renewable energy solution (RES) in Germany: some introductory remarks

The global climate change and growing demand for energy will transform the use of energy systems. A larger proportion of energy has to be obtained from renewable sources. The market for renewable energies is expected to grow 12 percent a year for the next decade. The market for offshore wind farms alone is expected to grow by more than 20 percent a year for the next five years. Growth in the demand for solar power is also expected to be substantial.

In Germany, the renewable energy sources contribute to 10,1% of the total energy consumption. While the production of energy has decreased in all non-renewable energy sectors, the production of renewable energy has increased from 236 billion kWh in 2008 to 238 kWh in 2009.

Renewable Energy has replaced other energy sources in all areas of using energy (electrical power, heat, fuels), thus reducing the production of ca. 109 Million t greenhouse emissions.

The diagram below shows that most carbon dioxide emissions (about two thirds) where avoided in the area of electrical power production.



The production of electrical power with renewable energy sources increased from 5,0 % of total production of electrical power in 2003 to 10,1 % in 2009.

The number of windmills increased in 2010, but due to a year with less wind than usual, this did not result in a higher production of power.

In the past decade, wind energy showed the highest capacity growth of all renewable energy forms. Installed wind capacity in Germany during this period had soared up to about 17130 MW by 2005 (in the first half of 2005). The growth potential for wind energy in the coming decade is also very promising. Wind energy, whether onshore or offshore, will play an important role in the change of course in power production.

The greening of occupations in Germany: VET and RES

Climate change and the ending nuclear energy phase-out require a comprehensive change of course in all field of energy production. Energy efficiency must improve on a massive scale and the contribution of renewable energy sources to power production has to increase in a massive extend.

Across the German economy, the occupations affiliated with the RES topic, have emphasised environmental awareness-raising as a central theme in the occupational profile and in the curriculum. Environmental protection always represents an advanced qualification to be incorporated into vocational education and training courses. Moreover, continuing vocational training courses provide the graduates from VET with the opportunity to upgrade their vocational skills and to receive advanced specialist certificates, which will open new prospects for career progression.

In this way, for example, electricians learn in a continuing training course more about the planning, installation and servicing (including customer information and advice) of a recent important RES product: the solar panels. In the initial vocational education this was already a more or less minor topic alongside the basic contents of the electricians' curriculum. But to develop more expertise in the field of RES additional and more in-depth knowledge and skills need to be acquired. But in the German VET context changes are also taking place across the crafts and trades. Electricians and the occupations for sanitary, heating and ventilation get renewed. Also in the field of the industrial production the way in which the products are manufactured is being reviewed from the perspective of using renewable energy solutions.

For example the solar manufacturer company Q-Cells[1] experienced a lack of suitable applicants for open vacancies in recent years. The traditional dual training courses were neither available for renewable energy nor for solar techniques. Moreover, there was no solar industry lobby to establish a national vocational training programme. Initial vocational training on renewable energy does not yet exist and the number of students in corresponding university studies is still limited.

Technicians employed by Siemens Wind Power[2] are usually electronic technicians or mechanic graduates. However, the high safety and technical standards of Siemens

[1] Since Q-Cells SE, Germany was established in 1999, it has grown into one of the world's leading photovoltaic's companies. Its extensive product portfolio ranges from solar cells, crystalline and thin film solar modules to turnkey photovoltaic systems. Q-Cells' products are developed and manufactured at its headquarters in Bitterfeld-Wolfen (Germany) and marketed via its global sales network. It also has a second production plant in Malaysia.

[2] Siemens Wind Power, or SWP, (formerly Bonus Energy A/S) is a wind turbine manufacturer with headquarters and main production facilities established in 1980 in Brande, Denmark. SWP is wholly owned by Siemens of Germany since 2004 through the Renewable Energy division in the Siemens Energy sector. In 2009, SWP had 5.9% share of the world wind turbine market and had installed half of all European offshore wind turbines by capacity and number.

wind turbines requires constant training on safety issues *and* technical developments.

New or modernised occupations at the level of dual apprenticeship programmes emerge due to revisions of training regulations in existing occupations or via introduction of new training regulations. Between 1996 and 2009, 82 occupations were created and 219 occupations modernised under the greening skill dimensions.

To give an example in terms of greening, four new dual apprenticeship trainings were established in 2002 on the basis of prior training programmes, namely:

(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-, Kanalund Industrieservice*).

Training rates for the renewable energy sector – the ratio between apprentices and total employees within a company – lies at ca. 5 %, compared to an average of 6.5 % across all sectors.

Renewable energy companies more often recruit qualified workers rather than offering new dual training opportunities. This implies a tendency towards “pull” from other sectors. As studies in the regional wind power sector in Bremerhaven show, there is a lack of proactive engagement of the wind power companies in dual vocational training (compared to other German industries).

At the level of training of skilled workers, environmental protection has been integrated into all initial vocational training regulations. Therefore, a tendency towards greening across all dual vocational training programmes can be confirmed. A good example of greening of an existing occupation (as a result of technological change) is the training of solar installation technicians.

There is a need for skilled craftsmen (e.g. from Heating, Installation occupations) to install these systems, especially in private households. The target group are craftsmen, plant mechanics for sanitary, heating and air conditioning and electronics, who learn the required competences through during their three year lasting vocational training and education programmes.

Skill adaptation at the side of skilled workers and engineers

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 ensure air pollution emission regulations were being met. While the former vocational training course provided general training, increased complexity and technological changes brought about by change in waste management law, required greater specialisation as well as intensive training in customer-orientation and service-orientation to meet the increasingly professional nature of the industry.

To illustrate skills adaptation as a consequence of new legislation (the EU energy performance in building directive) a case study on energy consultants was included. According to legislation, 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, e.g. technicians, skilled workers or engineers or Masters (Meister), who have completed continuing training and become an energy consultant, may issue an energy performance certificate.

For occupations outside the environmental sector, integration 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.

Approaches to anticipating skills needs

Low-carbon hybrid propulsion is a growing trend in the car industry. Car manufacturer BMW, for example, recently included two hybrid cars in its product portfolio, the X6 and its 7 series. Cars are equipped with both a combustion engine and additional electric motors and energy storage devices to reduce both fuel consumption and greenhouse gas emissions. Using up to 400 volts in hybrid systems creates obvious health and safety issues, which require technicians to have good overall technical knowledge of hybrid technologies. This means motor vehicle mechatronics technicians need to develop new skills. Indeed, due to legislation, only trained electricians or mechatronics technicians who have acquired the relevant knowledge may carry out work on hybrid cars.
Training regulations for chemical technicians and four other trades in the chemical industry were revised in 2002, as the concept of responsible care 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 of these subjects. Integrating this concept into dual apprenticeship training in this sector guarantees its implementation and its internalisation at all stages of work.

Business Environment Courses

There is an acknowledged need for new businesses and an actual gap in the training for business environment courses. The university believes 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.
Solar manufacturers such as Q-Cells have experienced a shortage of solar technicians with the range of requisite skills to guarantee production levels and growth targets for the solar industry.
As wind turbine technologies have become more specific and complex, special training for adapting qualifications were identified by the industry.

Car Industry

BMW decided in 2009 to meet the hybrid vehicle mechatronics skills gap by integrating this kind of training as a new training module directly into their dual apprenticeships. This means all motor vehicle mechatronic technicians are qualified to work with hybrid cars too.This also provides flexible training to enable technicians to change firms. The module has now been integrated into 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. Around 100 apprentices per year receive this training. As a result of the responsible care programme, the chemical industry has adjusted all its working processes to be intrinsically cleaner and more energy efficient.

University degree courses

In terms of new occupations, two new university degree courses are outlined:

- Technical 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, but primarily by solar manufacturing giant Q-Cells teaching a wide range of required disciplines and integrated specialist technical and production knowledge of photovoltaic from QCells solar cell production lines;

- Green business management was established at the private University of Applied Sciences BiTS (Business and Information Technology School) in Iserlohn (North Rhine-Westphalia).

- The new Siemens wind power training centre, designed to improve training of its own personnel and customers to improve health, safety, technical performance and perceived high quality in the marketplace of the overall Siemens wind power brand. The course contents were designed to have precise objectives to promote successful execution of service activities.

Future topics in the field of greening occupations

Further greening of occupations might occur in the following fields:

- Agricultural occupations that commit to organic farming;
- Energy near occupations, Electric, Mechatronic, HVAC[3] etc., that focus on renewable energy products and energy conservation, building trades, house painters, as well energy consultancies;
- manufacturing occupations, metal, that produce products in such an way which are less material rich and also use energy more efficient than before (for example use of light, cooling etc.);
- chemical occupations that use biodegradable substances;

In terms of greening existing occupations three examples of modernising the occupations based on the introduction of renewable energy product and their stronger use:

[3] HVAC: Occupations in the Heating Ventilation and Air Condition area

- Mechanic for sanitary, heating and air conditioning (HVAC): training has become more service-oriented as customer relations became more important in recent years. Knowledge of use of sustainable energy input was part of the revision.
- Waste management and recycling technician – established to meet the requirements of an increasing technical need in the waste sector. However, companies still complain about the low number of apprentices on the course as demand for apprentices is sometimes higher than supply.
- Training of specific energy consultants, with the main focus on energy performance certificates in buildings driven by new legislation and thus defining a very clear skills and training requirement for consultants.

Summary: change on skills due to the greening of jobs

Skills implications and development – New and changing skills needs by sector/occupation

Most occupational profiles of skilled workers have been modified to take account of environmental considerations, in line with the overall German policy changing the economy for stronger use of renewable energy. There are sectoral image issues especially in the areas of waste; sewage and sanitary, heat and air conditioning where apprentice numbers are too low, leading to problems recruiting apprentices in craft businesses.

Pace of change in defining new and emerging skills needs

Modernisation of dual apprenticeship training or establishment of new apprenticeship training programmes is decided by all stakeholders involved and this rather on a consensus basis. Such decision making is time consuming and therefore the change of occupations will be a long lasting process.

Cooperation between the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), and the agencies responsible for education and training, particularly the Federal Ministry of Education and Research (BMBF) and the Federal Institute of Vocational Education and Training (BIBB) could be improved. The tripartite system is regulated at *Länder* level which decelerates cooperation, as 16 *Länder* governments have to be included in the process. The BMBF and BIBB are mainly responsible for the education and training system. The BMU can only offer learning and teaching materials, which include a lot of expert knowledge. Use of these materials should be guaranteed with better cooperation.

Good practice lessons in relation to identifying, anticipating, and responding to skills needs

According to the Vocational Training Act a specific skill need has to be identified in the economy for modernisation or establishment of a new training regulation. In 2006, the Federal Environment Ministry started an educational initiative entitled Environment creates perspectives in association with firms from environmental technologies/ renewable energy sectors. As a result, 6 000 additional apprenticeships were created in 2009. The initiative aims to identify the apprenticeship trades, skills and competences required by the environmental sector. BMW received the Innovation prize 2009 from the Federal Institute of Vocational Education and Training (BIBB) for the exemplary function of its hybrid training

module, its close connection to the dual apprenticeship programme and its labour-market relevance.

For the future agenda of the vocational programmes it is still important to follow up the needed green skills and competences. One possible way of deepening needs analysis on the required competencies could be done by work and organisational studies, as well as being able to quantify green jobs more systematically to help shape more targeted training provisions.

Also the job-creation effect of any kind of environmental expenditure is to be followed. It seems to be difficult to measure the net effects of green investment. Probably the vocational policy underestimated the environmental sectors growth and hence skills needs, which has led to some skills shortages. There is need for a skill requirements identification system and which is able to define the need for green skills or green jobs. Further VET research is needed to ascertain demand for additional jobs or other training forms as well as for continuous training arrangements to educate older workers in this demanding and growing new sector. It has to be found out whether shorter two-year apprenticeship training programmes are useful for this field or more special apprenticeships in renewable energy. Evaluation of the adequacy, however, has not been conducted yet in an satisfactory extend.

The future development of the German VET systems

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 lifelong learning system; nevertheless declining skills supply, caused by demographic changes, requires much greater emphasis on this area. 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.

A higher level of occupational specialisation will be needed to improve the competitiveness of environmental goods and service suppliers. Supply of professionals will be pivotal to success particularly if future growth forecasts in the sector turn out to be correct, driving demand for skilled workers.

A higher level of knowledge integration of green competences will be needed for both application of environmental technologies and implementation of higher environmental standards in many non-environmental occupations. This is required to achieve the ambitious environmental protection goals of environmental policy. Social partners play an important role in forming training courses, both in dual and university training. They are active in shaping the content of new training programmes.

The importance of wind energy for Germany as one of the key RES resources to be used in the near future (main source: Hammer, Röhrig Qualification requirement analysis offshore wind energy industry, 2005, IAW, Bremen)

Due to higher, more consistent wind speeds at sea, offshore wind turbines can generate substantially more energy than onshore wind turbines. Offshore wind farms may reach capacity factors in the range of 50%. Even considering the planning constraints relating to shipping lanes, fishing, bird migration, and the like, the world has abundant space for offshore projects (www.energy.siemens.com).

In the past, the expansion of wind energy use has taken place mainly on the country side; this was concentrated on the North, West and Eastern parts of Germany. Most of the efficient wind areas have now been captured by wind mills and wind parks. Therefore the RES strategy for Germany is changing, that in so far, that old wind parks and particular wind mills have to be modernised. This in such a way, that the main increase of the energy production output is coming mainly from re-powering strategies.

What means re-powering? Old wind energy plants are replaced by new and more powerful types of wind mills: higher, bigger and more efficiently controlled by new electronic devises. Also their service gets easier and they can produce much more electrical energy. With a life cycle for wind mills of approximately 20 to 25 years, this replacement of still functioning plants is still profitable.

The other field in which onshore business can be expanded is in the export of plants. Particularly the Eastern and Southern European countries are key purchasers of exports since they have to manage the modernisation of their national energy supply. But also the export of Wind mills to Asia in special to China and India is expanding.

The use of windmills offshore: the Future at Sea

But is has to be considered that offshore wind power has its huge challenges, however because of total other thermal and grounding and wind conditions. But not only that the conditions during the installation, operation and maintenance of wind power plants may be really harsh, especially e.g. in the German North sea bay, this means that the wind mills must be very reliable and consist out of top material. There is great need for special suppliers and equipment providers to provide stable, long-term offshore renewable energy solutions. This is very much based on the skill and knowledge of the work force employees in these branches and wind industries.

The greatest growth potential for the wind energy industry is at the North and Baltic Sea. The nearly never wind still sea offers from average to high wind speeds, continuous wind directions and makes it possible to produce much more electrical energy than on land.

These are other advantages over onshore operation. The disadvantages of wind energy on land, such as noises and the making of shadows, do not apply due to the fact that the wind parks are a long way from the coast line. But there are still also negative impacts from the offshore Wind systems. Because the Sea is an important habitat for many species of animals and plants, habitats which have be protected. The construction of offshore wind parks can affect these habitats, and it is therefore imperative that flora and fauna are protected when erecting, operating and decommissioning the turbines. For this reason, the German government is financing comprehensive research into the impact of wind parks on the marine environment. The findings will be taken into account in the approvals procedures for wind parks.

Therefore, the requirements in terms of planning, construction and operation of wind energy plants at sea are as much greater than on land. On the one hand, numerous conservation, fishing and seafaring rights have to be taking into account during the planning phase. On the other hand, the offshore plants are planned mainly in very deep waters of 20 to 40 metres, far from the coast. There, they are exposed to far greater stress from the wind and high sea waves than onshore plants. The salty sea air makes heavier demands on corrosion protection. Maintenance and service work depends heavily on weather conditions at sea and is very cost intensive.

All in all, however, these more difficult operating conditions are balanced out by the greater efficiency of larger, more innovative plants which have two to three times the on shore capacity of a windmill and are expected to produce an output of 5 MW in the future.

With few exceptions, wind parks at sea require an great investment volume which can only be provided by large banks, energy groups and other global players. The profile of companies involved in offshore development is changing accordingly.

Offshore Wind Energy Use in Europe: Status and Prospects

The expansion of the offshore wind energy industry in the five European partner states analysed in this study is at different stages of development. While Denmark and Great Britain play pioneering roles with regard to wind parks already constructed or under construction, Germany brings up the rear in this respect. However, the size of the capacity projected here, which is in the planning and approval phase, is extraordinary. The Netherlands has also already completed offshore plants, while a showcase project in Belgium is still under construction.
The European Wind Energy Association, EWEA, estimates that by the end of this decade 10,000 megawatts of wind energy in European territorial waters will flow into the grid. By 2020, this output is expected to rise even further to 70,000 megawatts..

Climate protection policy decision as the general trigger for investment into renewable energy solutions (RES)

Broadening earlier environmental protection measures, German priorities on climate protection have been increased over the past 10 years, with the key goal of reducing greenhouse gas emissions. The challenge of achieving a huge decline in greenhouse gas emissions implies focus on energy efficiency in all fields of its use and cleaner power production of electrical energy. It also means that industrial restructuring will be necessary and environmental considerations increasingly influence both technological innovations and peoples lifestyles. Investments into RES will support employment growth and lead to 500 000 additional jobs in environmental protection by 2020 and 800 000 by 2030.

Environmental protection at the centre of public policy

In Germany for decades, environmental protection has been at the centre of public policy development. Combining legislation and incremental awareness influenced restructuring of economic sectors and occupational competences. Policies on environmental protection have not only been perceived as a step to combat climate change, but also as a key factor to develop new markets. This means that the industrial market opportunities for technology manufacturers on environmental technologies, like renewable energy services shall increase and not only work for domestic us but also work international markets and supports to export RES Systems to other countries. 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).

Political support to stimulate investment to combat the financial 2008 crisis and in particular by investment into energy efficiency

The central government introduced in November 2008 and January 2009 specific investment packages, together worth around EUR 100 billion. The proportion on RES investments was around 13% – one of the highest in the EU. Both programmes focused on promoting energy efficiency. A reconstruction loan offered another EUR 2.5 billion credit for energy-efficient building renovations and this by using renewable energy. This was also promoted by a higher tax deduction for craft services for maintaining and modernising buildings. Both measures should stimulate the use of RES and create new jobs.

In the next 20 years, 50% of all power station capacity in the Federal Republic of Germany will be replaced by new plants. Wind energy will play an key role in this. In particular offshore wind energy investment will be the primary source for producing renewable energy.

Therefore the German central government has set itself the goal of doubling the proportion of renewable energy in the electricity supply by 2010. Thus, approximately 12.5% of electricity would come from renewable energy sources by 2010. This proportion has prospects of increasing to as much as 20 % in 2020. In the long term, if this strategy is continued into the middle of the century, 50% of the total energy requirement would come from renewable energy sources.

An important instrument to increase the use of RES and reach the environmental protection targets: the Renewable Energy Law.

In 1990, the German Federal Government undertook to reduce carbon dioxide emissions by 25 % by 2005. This strategy corresponds to the guidelines contained in the Kyoto Protocol. This policy has created an important tool for the promotion of the wind energy industry in particular in the *Erneuerbare Energien Gesetz (EEG)* [Renewable Energy Law]. According to the amended EEG law in 2003, the support for onshore plants was continued, albeit at a lower level.

Energy suppliers are obliged to purchase electricity from wind energy at a state-defined feeder price, which the amended law reduced by 0.1 cent to 8.7 cents per

kWh. A price which was then further in the coming years reduced to 5.5 cents per kWh. At the same time, however, the amended EEG law increased support for offshore energy. The law classifies wind parks as offshore plants to be given financial support if they are erected at least three nautical miles from the coast. Remuneration is 9.1 cents per kWh and is granted for a period of 12 years. This period is extended according to the distance of the plants from the shore, by 0.5 months per nautical mile and by 1.7 months of financial support per additional meter of water depth.

By this decision, the legislators wish to do justice to the higher costs of constructing and operating wind parks as well as promoting their economic efficiency. Here, the potential regions for erection of wind parks, as is the case with the European neighbours, are also part of the communal waters for fishing, the use of mineral resources (oil, gas), seafaring and other purposes, while not forgetting the interests of nature conservation and the protection of birds. In the German exclusive economic zone (EEZ), prospecting for offshore plants must take into account the rights of other user interests.

Wind energy in Germany has now become an important branch of industry which provides clear stimulus for employment. 50,000 people work in turbine construction. Nevertheless, after exhausting land regions for onshore plants, the expansion of the offshore industry is still in its infancy.

Various factors are responsible for this. Firstly, the legal process of approval is very complex and time-consuming. Secondly, the planned parks are so large that they can probably only be financed by large banks or global players in the energy and oil sector. Many questions are still to be answered. The German projects are to be implemented in extremely deep waters at a depth of up to 30 meters and are often 40 km from the shore. This presents new challenges in terms of foundation technology, the robustness of the turbines, the logistics and the erection of the turbines (for example done by specific windmill erections ships).

The calculations on the cost and return side are still regarded as risky because out of these technological and environmental challenges. Cable connection and grid feeding will result in costs of €1.15 billion, feeding into the German electricity supply system is considered by experts to be problematic according to the most recent ”network study” by the German energy agency DENA, commissioned by the German Federal Government.

This contributes to uncertainty in the sector. A clear direction is needed if the expansion of wind energy is to progress quickly. For example in Bremerhaven (50 km from the city of Bremen, North West Germany) and in the port of Emden, 5 MW demonstration plants are in operation. They are, however, on land, i.e. dry. Regardless of this, the expansion of offshore wind energy use in Germany is still a project on paper, albeit an enormous one, as the following overview shows.

Project Name[4]	**Project Developer**	**Number of turbines (in brackets expansion phase)**	**Output in MW (in brackets: expansion phase)**	**Status**

[4] See Hammer, Röhrig Qualification requirement analysis offshore wind energy industry, 2005, IAW, Bremen

North Sea (Nordsee)				
Emden 1	Enova	1	4.5	Built 2004
Butendiek	OSB Offshore-Bürger-Windpark	80	240	Approved 2002
Borkum West	Prokon Nord	12 (208)	60 (1,040)	Approved 2001
Borkum Riffgrund West	Energiekontor	80 (458)	280 (1,800)	Approved 2004
Amrumbank West	Rennert Offshore/Eon Energy Projects	80	400	Approved 2004
Nordsee Ost	Winkra	80 (250)	400 (1,250))	Approved 2004
Sandbank 24	Sanbank Porjects	120 (980)	420 (47250)	All in planning phase
Dan Tysk	Geo	80(300)	400 (1,500)	
Meerwind	Windland	75 (234)	265 (819)	
Weiße Bank 2010	OSB Offshoe	540	2,700	
Forseti	Prokon Nord	1750	17,500	
Globaltech I	Nordsee Windpower	80 (320)	360 (1,440)	
Offshore North Sea Windpower	ENOVA	45 (251)	202 (1,255)	
Godewind	Plambeck	80(224)	320 (896)	
Uthland	Geo	80	400	
Weiße Bank	Energiekontor	80-90 (170)	280 -315 (595)	
Jules Verne	Plambeck	3000	13,500	
Ventrotec Nord 1	Arcadis (German Bank, GHF, VESTAS)	50 (200)	150 (600)	
Ventotec Nord 2	Arcadis	50 (200)	150 (600)	
Nördlicher Grund	Geo/ ABB/ Global renewable Energy Partners	87 (402)	360 (2,195)	
Hochsee Windpark Hedreiht	EOS Offshore	119	535	In the phase of planning
TGB North	Ep4 offshore	287 (596)	1,004 (2,549)	
H2-20	GEO	80 (800)	400 (1,600)	
Nordergründe	Energiekontor	25 (45)	125 (270)	
Riffgat	ENOVA	44	220	
Austergrund Offshore	Rennert Offshore	80	400	
Deutsch Bucht	Rennert Offshore	80	400	
BALTIC Sea (Ostsee)				
Arcona Becken Sued	AWE (Eon, Borckmüller)	80 (201)	400 (1005)	Realized
Pomersche Bucht	Winkra	70 (200)	350 (1,000)	Approved
Adlergrund	OWP	80(160)	280 (720)	Approved
Beltsee	Plambeck	25 (59-83)	75 (415)	Approved
Kriegers Flak	Offshore Ostsee Wind AG	40 (80)	140 (320)	Approved
Ventotec Ost 2	Arcadis	50 (200)	150 (600)	Approved
Sky 2000	GEO / Eon Energy Projects	5(50)	10 (100)	Approved
Baltic I	Offshore Ostsee Wind AG			Approved

The wind energy sector relies on resilient political conditions in order to be able to implement the projected wind parks.

Overall, about EUR 75 billion will be invested to develop the offshore wind power by 2030 target to 25 GW. This capital should flow, especially in offshore wind farms (OWFs) and their grid connections, in areas of marine installations, service industries and in port infrastructure.

The following measures will be pursued (http://www.offshore-wind.de):

- Support of the first 10 offshore wind farms to gain necessary experience and cope with technical risks of offshore wind. For this, the “Kreditanstalt für Wiederaufbau” (KfW) will initiate a special program "Offshore wind energy" in 2011 with a loan volume of € 5 billion at market interest rates.
- As part of the amendment of the Renewable Energies Act is to be examined whether, as an alternative to the current feed-in tariffs for offshore wind is a no-cost option to facilitate investment (increased initial support and shorter duration).
- Development of the legal basis for the approval of offshore wind farms and amendment of the sea facilities-regulation in order to avoid "stockpiling" of permits for offshore wind farms. In the future, permits are only renewed if the investors demonstrate concrete realisation steps (construction, financing, schedules, etc.). Otherwise, the areas should be awarded to other market players with specific requirements for implementation. The final decision on the permits will be concentrated so that a permit includes all other approvals (concentrationeffect).
- The spatial development plan for the German Exclusive Economic Zone (EEZ) should be extended, to ensure the long term development of the offshore activities. Basis for the continuation will be the evaluation report to be submitted in early 2012.

Skills development strategy in response to RES (source CEDEFOP report on skill requirements)

Environmental technology firms are now well established in Germany and often market leaders (e.g. Solar World, Enercon, Siemens wind power[5] etc.). Continuous investment in R&D of new products and processes can help Germany to maintain its competitive position in the field of RES as well as an appropriate supply of qualified workers (particularly those with technical focus). Indeed, beside demand for their products, qualified personnel are an important factor in increasing the production of renewable energy products.

Retraining across the economy in response to green restructuring is mainly focused on the education and training system, where technical qualification training courses are offered and new study courses and further training with environmentally-relevant subjects have been developed. The range of continuing vocational training courses related to environmental protection is now substantial. This is mostly due to the

[5]

continuing vocational training regulation (*Fortbildungsordnung*) being renewed, which makes it a priority to integrate environmental protection issues.

In contrast, given their limited scale, initiatives by firms are seen as marginal. However, training centres for in-company training or integration of green modules supplementary to formal training programmes are being developed. Three skills responses in the case studies were initiated by companies (e.g. Q-Cells, Siemens Wind Power and BMW). Skill needs in the environmental sector have mainly been covered by creating formal training courses within the system of dual training and of higher education course training; in particular at Universities of applied sciences. This follows a long tradition of German industries organising dual training rather than company-based continuing training. The modernisation of existing occupations by the implications of renewable energy system has affected a very wide range of occupations (from the electrician, the mechanic, the plumber etc.). Clearly, however, the extent to which environmental issues are integrated differs widely according to job type.

Low graduation rates in recent years in mathematics, engineering and natural sciences have created a shortage of highly-qualified engineers and technicians of around 165.000 in 2006. According to firms, skills shortages were already limiting growth of the environmental sector. However, the recent economic crisis has reduced labour shortages and environmental industries are now more easily able to fill recent job vacancies.

The largest problem for the environmental sector remains availability of engineers, since graduation rates have also been low in recent years and near-term prospects have not changed. This goes also for skilled technicians and skilled workers which are trained too little. Even though the demand for skilled labour in RES is still huge and will rather increase in the next decade. Because the situation is increased by such a way that fewer school graduates are applying a bit less for apprenticeships due to demographic changes and of more young school leavers head for Universities.

While such shortages can hardly be avoided in boom periods, VET 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.

What are the new skill requirements in Germany which will emerge out of the use RES and in specific out of offshore wind power investment?

To understand the new requirements emerging from the use of offshore wind energy field the global business process chain was analysed based on interviews with the companies involved in the subsequent steps needed to plan, erect and serve wind parks in the North Sea[6]. Following aspects of the chain are analysed:

[6] **Main source, plus additions by the author, used for this summary: Hammer, Röhrig, Qualification requirement analysis offshore wind energy industry, 2005, IAW, Bremen**

1. Planning/Development/Finance/Insurance
2. Foundation technology and tower construction
3. Mechanical engineering and plant construction (e.g. gears)
4. Plastics and fibre composite technology (e.g. rotor blades, nacelle cladding)
5. Electrical engineering (e.g. construction of generators)
6. Assembly and logistics
7. Service, maintenance, repairs

The experts in the wind energy field were interviewed by the following five questions:

1. What is the current qualification profile of your employees?
2. What new qualification requirements arise from use of offshore wind energy?
3. How are company personnel expected to develop further in the face of the offshore expansion?
4. What concrete further education requirements can the company express?
5. From the point of view of the companies, is it necessary to make changes to professional education?

1. Planning, Development, Finance and Insurance

The planning process starts with the identification of possible locations in the North Sea on which wind parks can be erected. What are the parameters influencing this:

- Studying national and international legislation is one important planning data source. This can vary from country to country!
- Bird protection, fishing and extraction of oil and gas as well as rights of use for civil and military purpose are other conditions which have to be studied for the location in question. Only those locations which are not subject to conflicting rights an wind farm can be built on.
- In a further step, wind-technological as well as marine-geological and marine-biological investigations are needed. By wind measuring the predominant wind directions are investigated. This data paves the ground for selecting the best suitable area of the sea to aloe most energy efficient operation of the offshore parks.
- *Marine-geological investigations* investigate the condition of the ground in order to assess its suitability for foundations. External specialists and experts are often commissioned to do this by the planning companies.
- Also the finance is complex which does not allow a lot of small private investor because of too many risks to loose money quickly. Nowadays the banks want greater security and risk reduction measures than possibly for on-shore wind farms.
- Countries in which offshore technologies have not yet been tested to any great extent face problems with the banks and credit provision in the planning stage because the banks insist on reliable calculations. The *insurance* situation is comparable.

All in all, there is a larger complexity in the planning process of offshore projects which results for new qualification requirements for the planners.

- Planners or project managers planning a wind farm will need some basic knowledge of national and international laws.

- They must be able to cooperate with banks and insurance companies to provide a good understanding of the inherent engineering measures and how they can be managed by the companies and its personnel.

- A planning company looking for investors for its wind field projects must have a project manager which can sufficiently explain the entire project as an integrated whole and make all important technical, official and financial factors transparent.

- Project managers must understand Quality assurance processes well and have to show skills in providing knowledge of a strong quality assurance**.** This means certification in line for example with DIN ISO 9000 ff but also EFQM processes.

- English is not only an expert technical language but also the language for communication with the various stakeholders. Technical English and English for negotiation are part of the requirement profile for transnational planners and developers.

2. Foundation Technology and Tower Construction

Firstly, offshore wind energy plants are considerably higher and more powerful, therefore also heavier than onshore plants. For example a 4.5 MW prototype recently erected in Germany in the near shore area has an imposing hub height of 108 meters with rotor blades 53 meters in length. The mill weights easily above 440 tonnes and is under stress by loads from wind, waves and the effects of salty air. All in all, these are very strong requirements with regard to the steel and its processing. It has to be stated that classical and well known welding techniques do not work well and provide enough connection mass because the fission masses of the steel giants increase. New visual methods of flange measurement are used to assemble the segments together with a perfect fit.

Of key importance is the foundation technology and account for 30 to 50% of the costs of an offshore tower.

Various procedures can be used depending on the nature of the seabed. If the seabed is rocky, axle tubes are bored and driven into the bed depending on the degree of hardness of the stone. If the bed is soft, consisting of sand, clay or marl, the basic construction is driven. This type seabed, which occurs frequently around the Baltic Sea, may become a problem for the project as a whole, as was recently observed in a German project. Instead of hard stone, the technologists came across thick silt at 20 meters.

Very common are the so called monopiles which mean that a large steel pile is driven into a drilled hole into the seabed, depending on the nature of the seabed. The majority of offshore wind turbines presently realised in the North Sea is equipped with monopiles.

For setting up mills in deeper water new methods for grounding are required. The plinth, which is carrying the turbine pile, is foreseen as tripod legs which must be well constructed and be best protected against sea water corrosion. Large structural engineering and civil engineering companies are doing this job, whose traditional field of business is not wind energy, become general contractors for foundation.

Occupational safety gains new significance in the case of offshore projects. While conditions for all activities are much more dangerous than on land the training of everybody at the building site requires special training on safety issues.

3. Mechanical Engineering and Plant Construction

The windmills are equipped by important mechanical components such as gearboxes, yaw system, generator as well units to control the speed of the rotor blades.

Gearbox is one of the crucial components of a windmill and its construction is demanding on respect to its layout and robustness. There some wind miller producers who don't have gearboxes due to their demanding quality. For example the windmills from the wind mill company ENERCON[7], Aurich, North Germany. Another important part is the generator. He must be able to work under these sea and extreme wind conditions. As well he must be laid out in way that service intervals are minimized.
In addition sensors are uses to measure all kind of conditions of the windmill in order to make control and service manageable. The might measure vibrations, temperature and other parameters which allow better monitoring of the windmill and the wind farm. The intention is to make the recognition of damages in a preliminary stage possible.
Departing from these developments the industrial mechanics, the engineers and electricians involved in the production of mills require additional qualification such as mechatronic system knowledge as well as an advanced understanding of the materials in use. They need a good overlook of the whole function of the mechanical parts of the mill in order to understand the specific requirements better and understand the increased importance on quality and robustness of the whole plant construction. Also the integration of mechanical and electrical parts must be well understood.
Especially the engineers which might be from here background either mechanical or electrical engineers need knowledge of the specific aerodynamic requirements of the plants.

4. Rotor blade technology

Most blades are glass fibered materials. The blades have a life cycle of 20 years and make up to 20 % of the cost of a windmill. There are different forms of production methods for the blades in use. One is manual laminating of glass fibre textiles in built up fashion and coating them with polyester resin. Second variation is the so called vacuum infusion method which inserts the fablers stored in the build up pattern into a vacuum through film coverings. Third process uses pre impregnated glass fibre textiles which are tailored by machines and are delivered frozen. By warming up the material is adapted to the shape of the blade. Because ot the high cost of the last type of blade production most manufactures use the vacuum infusion method.
The design intention is to reduce weight of the blades and on the other side providing high degree of strength. All blades are tested before they get mounted to the mill this by means of vibration. Other problems to be sorted are the risk of lightning strikes which can seriously damage the mill and the blade. Here specific lighting protection measures are taken. Another problem is condensation inside the blades the water is drawn of through openings.
Other than that sensors positioned all over the blades give information for the control of the blade and to provide lasting protection. Therefore monitoring systems are provided to avoid any kind of damage on the rotor blade and delivers also information on the remaining life of the blade.

For the workers producing the blades there is knowledge needed about the plastic and fibre composite technology. Also safety instructions are important as well as all information out of which components such a blade exist.

[7] ENERCON is the biggest Wind Mill producer in Germany with nearly 60 % of the national market shares in Germany. Enercon began its fast growing when graduate engineer Aloys Wobben founded the company in 1984. A small team of engineers developed the first E-15 / 16 wind turbine with a rated power of 55 kW. To start with, ENERCON systems still featured gearboxes. However in 1992, the changeover to gearless technology came about with the first ENERCON E-40 / 500 kW. This innovative drive system with few rotating components ensures nearly friction-free energy flow providing outstanding performance and reliability. Mechanical stress, operating and maintenance costs are reduced, and the system's service life is increased. Since then ENERCON has been setting new standards in technological design with more than 17,000 wind turbines installed in over 30 countries, ENERCON is also recognized as one of the leading manufacturers at the international level. Research and development, as well as production and sales are constantly evolving. The company's objective for 2010 is an export share of more than 60 %, gradually increasing over the years to come. http://www.enercon.de/en-en/

5. Electrical Engineering on components, cables and other connections

All these components have to meet high requirements on connectivity as well as from sea water and spray. Therefore tests on land are done to simulate the extreme conditions.
The installation of an monitoring system is included in nearly all cases. The cables connection the plant with the cable supply must meet a number of special requirements. The Cables at a mill are rather thin (small diameter) and run by rather low current and with high voltages, this to reduce the energy loss in the transport. The skill of the technian's must be aware of all this and doing these jobs with great care to avoid dysfunction and failures. Any kinks and twist must be avoided as well as protection against corrosion.
Wind energy specific knowledge, safety training as well as good knowledge of all the technical instruction in English must be capable by the engineers and electricians involved in the part of the tower provision.

6. Assembly and logistics

In many cases the complete towers are produced very close to the sea shore to avoid difficult land transport. The transport of the farm is operated by special constructed ships which are specially equipped for the transport and assembly of the major components. The ships are equipped with pillars at they board sides and can be lifted to provide stability for the assembly of the critical components during uploading and other assembly operations. The assembly of a plant takes something like one day.

The crew of these ships must be especially skilled to these operations. At least six to 10 skilled seamen must be onboard. The rest of the crew covers the specialists for the construction of the mill and the assembly of its parts.
In this area the new qualification requirements are concentrated around the following points: There is obligatory offshore training for the sailing people. Knowledge of good English to cooperate to cooperate with the different experts involved in these job.

7. Service, Maintenance and Repair

The service people must have a good understanding of the functions of all the wind plant and mill components. The function of the service technicians is for example to test the brakes; they have to change the gear oil. In regular intervals they have to check the condition of the wind mill plant.

The service company are often in charge of the monitoring of the condition of the plant. The companies manage this service by hosting measurement data, like the vibrations of the plant, checking electrical functions, temperature, noise conditions as well as much more other data. Target values exist for parameters and are compared with actual data so that in case of deviations the plant can be stopped immediately and service can take place.

There are new qualification requirements for the service technicians, like offshore security training which is obligatory; vocational skill and knowledge on servicing the plant like the mechanical and electrical components, as well hydraulic systems and a good understanding of the conditions needed for the fibre technology of the plant. Also they must be able to interpret the data they receive from the monitoring systems either on the control room on land but also be able to measure at the plant itself.

Summary:

Electrical power from offshore wind energy farms and wind generators will make an important contribution to energy and climate policies in Germany. This is even more urgent after the atomic power station catastrophe in Fukushima, Japan. This has lead to the decision, by beginning of 2020 in Germany, that all atomic power stations will be reconstituted by other energy generating forms and to a big extends by renewable energy solutions. About one-third of German electricity is currently produced in nuclear power plants. This will need to be replaced by environmentally friendly alternatives over the coming years. The time plan has even to be speeded up as originally decided.

The political intention, as said by the federal government Christian Democrat (CDU) environmental Minister Norbert Röttgen, is that by 10 Years the proportion of renewable energy generated electricity shall increase by 130 % - from 17 % at the moment up to 40 %. Electricity out of Wind, Sun and Biomass should compensate the decline of atomic energy. Energy makers who produce this kind of energy will receive extra funds. The entry compensation guarantee will increase for the above discussed offshore energy from 13 up to 15 cent per Kilo Watt per hour. This programme shall run for eight years and should make it for energy producing investors to expand in this kind of energy production market.

But on the country side for wind power generators new cost reduction measures were formulated by the ministry. Time reduction should come from a much quicker process to get the agreement by the pubic and local bodies! The general intention is that in the long run the RES technology should be able to be implemented without any subsidies from the state. Whether this kind of modification on a subvention free RES future in Germany will work there are also some skeptical remarks to be noted from the national wind support and development association “Bundesverband Windenergie” (see Weser Kurier Newspaper from 6.5.2011).

Here the wind energy plays an crucial role to redefine the German energy policy for the near future. Average wind forces at sea are high enough to offer an enormous potential in energy. Modern wind power technology, now so reliable and cost-effective on land, will enable us to exploit this potential.

As we have said this is based on sufficient and highly skilled work force on all sites, the making of wind mills as well as on the installation and servicing of this kind of renewable energy systems. It is clear that the topic of RES needs to be integrated into the curriculum of general as well as of VET schools. This understanding must be illustrated in such a way that is project based and children and young people motivating. Therefore in the general school it has to start as early as possible: say Kindergarten and Primary school that children think about how they could influence in their private house context, how energy can and should be consummated. This can start with little solar panels who deliver energy for radios or other energy consumption devices. But the key elements in these industries are the VET occupations that might get greener, on the one hand and on the other create new occupations, see the example of the “Solateur”!

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