6 Existing VET provisions

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This part of the report looks into how pre-VET education, IVET and CVET are structured in Germany. The focus is on defining the characteristics of the German VET (IVET and CVET) system and which institutions are involved in its development. This information is important for considerations regarding the development of a roadmap.

A preliminary conclusion can already be presented at this juncture, underlining the fact that for the building sector in particular - the sector this report focuses on - the dual / apprenticeship system (i.e. a combination of theory and practice) plays a dominant role. Looking at the 2012/11 school year with its 2,687,974 VET students, 60% of these decided to gain a professional qualification within the dual / apprenticeship system (Statistisches Bundesamt 2011a, p. 12). The core principle of combining base theoretical knowledge gained at a VET college and practice gained through working in a company gives students the opportunity of making direct practical use of their theoretical knowledge and gaining practical experience in a routine working environment. This interlinking of theoretical college and practical workplace training is based on the concept of providing students with an overall competence in a specific occupation (*berufliche Handlungskompetenz*), enabling successful students to work in a number of different fields within that occupation. In accordance with this principle, these basic sets of occupation-related skills are governed by standardised apprenticeship regulations applying throughout Germany. Having said this, due to Germany's federal structure the regulatory competences lie with both the Federal government (for company apprenticeships) and the *Länder* (for supplementary IVET programmes in VET colleges).

In the context of an apprenticeship, an apprentice can already be flexibly deployed during the apprenticeship, working in the different work and business processes within the company and thereby acquiring the ability to further develop their skills in many different fields on completion of their apprenticeship. VET course contents are permanently adjusted to the changing requirements of the individual trades, with the social partners (trade unions and employer associations) directly involved in drafting the new base specifications. Moreover, through neutrally worded apprenticeship frameworks reducing technological dependences, new technologies can be included in apprenticeships without further ado. In the skilled craft sector an important role is played by inter-company training centres (the so-called "*Überbetriebliche Lernorte*" or ÜLO for short). Equipped with the latest training facilities, these are in a position to support and guarantee the required breadth, depth and relevance set forth in the apprenticeship framework.

In line with the principle of dual state and market regulation, the state is responsible for establishing the necessary countrywide legal framework for VET, while market-driven supply-and-demand mechanisms have the task of bringing apprentices and companies together. In this respect, skilled craft companies with their 8.6% share of total gross value added and 29.1% share of the total number of apprentices clearly highlight the importance

of Germany's apprenticeship system (Deutscher Bundestag 2011, p. 3; Statistisches Bundesamt 2011b, p. 22; ZDH 2012a).

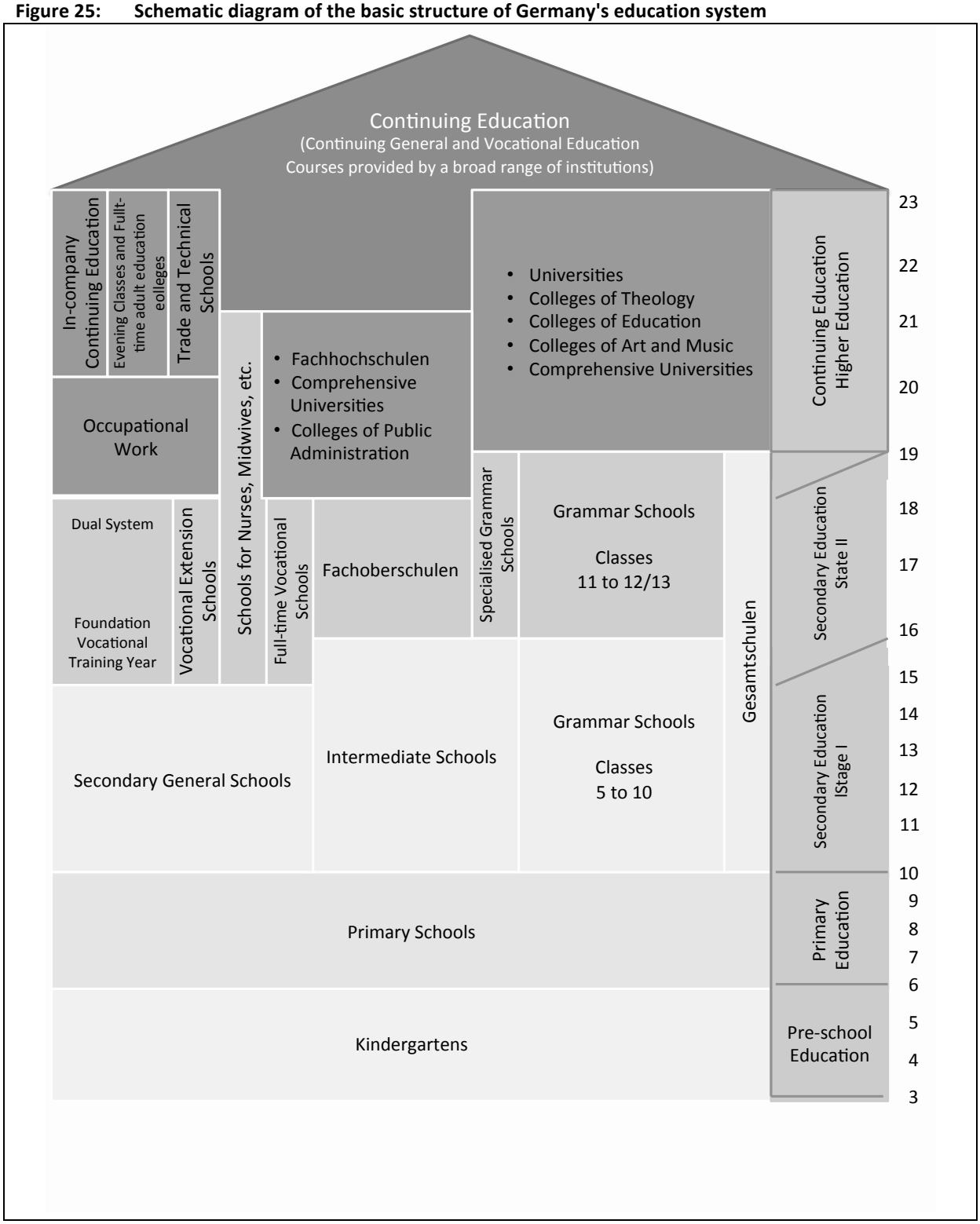
To provide a better understanding of the following description of Germany's VET system, we would like to start by outlining the basic structure of Germany's educational system and the main institutional framework conditions. This will be followed by an insight into Germany's VET structure, going into the aspects of occupational diversity, the legal basis, responsibilities and the examination and certification system in greater detail. In line with the project's overall objective, the focus will be on VET in the building sector, looking at the initial and continuing training of employees in the skilled craft sector and industry in the field of energy efficiency and renewable energy.

6.1 Basic structure of the German educational system

Based on the proposals for structuring the German education submitted by the German Educational Council (*Deutscher Bildungsrat*), Germany's educational system is characterised by six layers. On leaving the primary layer (4 years at primary school), an initial selection takes place at lower secondary level (*Sekundarstufe I*), with children going on to a secondary modern school (*Hauptschule*), a middle school (*Realschule*) or a grammar school (*Gymnasium*). Each type of school has its own school-leaving qualification. Due to the declining school population, certain German states are experimenting with merging secondary modern and middle schools. Alongside this system comprehensive schools are also available, offering all school-leaving qualifications.
Once the respective basic school-leaving qualification has been achieved, a pupil is deemed to have finished compulsory schooling, lasting either nine or ten years dependent on the state and its respective education law. After achieving their basic school-leaving qualification, pupils then become subject to compulsory vocational training at upper secondary level (*Sekundarstufe II*). Such training can take place either in a school (the upper secondary level at a grammar school) or in a VET college, whereby courses at the latter can be full-time or part-time. (Schanz 2006, p. 7 ff; KMK 2009).[37] Alongside the VET system in general and the apprenticeship system in particular, pupils can also stay on at grammar school and acquire the Abitur, the school-leaving qualification entitling students to move to the tertiary level and study at a university or polytechnic. The area of continuing vocational education and training (CVET) belongs to the topmost level of Germany's educational system, alongside academic training.
Figure 25 provides an overview of this basic structure.

[37] For a comprehensive presentation of the German education system, readers may like to study the following publications: European Commission (2011), European Commission (2009/10) and the European Centre for the Development of Vocational Training (2007).

Figure 25: Schematic diagram of the basic structure of Germany's education system



Source: Own presentation based on KMK 2009.

The established structure shows how the different areas of education - general education, vocational education (IVET), higher education and further training (CVET) interlock with each other, highlighting the principle of permeability in Germany's education system. Back in 1970, the German Educational Council (1973) was already calling for no educational path to end in a cul-de-sac (p. 38), meaning that students should always have the opportunity of progressing further up the educational ladder, possibly revising previous educational choices. Permeability is achieved in a number of different ways within the German education system, though it first needs to be pointed out that in all areas of VET teaching always involves a combination of vocational and general knowledge. Subject to certain performance criteria being met, everybody has the opportunity of achieving a higher school-leaving qualification, using this as a stepping stone to mover further up the educational ladder. As a concrete example, a school-leaving certificate issued by a secondary modern school (*Hauptschulabschluss*) entitles a young person to start an apprenticeship. This in turn allows him not just to gain a vocational qualification but also to gain a higher-grade school leaving certificate (*Realschulabschluss*). This in turn qualifies him to attend a technical college (*Fachoberschule*). When this is successfully completed, the student can then move on the tertiary level.[38]
This permeability principle reflects rights enshrined in the German Constitution (*Grundgesetz* or GG): the right to free development of one's personality (§ 2.1 GG) and the right to freely choose one's occupation or profession, one's place of work, and one's place of training (§12 GG) (BMJ o.J.).

The entire German school system is under state supervision (§7 GG). Due to Germany's federal structure, the exercise of state powers and the discharge of state functions in the area of culture policy and cultural administration is placed in the hands of the individual federal states (Bundesländer) unless otherwise provided for (§ 30 GG). This sovereignty of the *Bundesländer* in cultural affairs is reflected for example in education policy, where each *Bundesland* has its own education laws and in certain cases a different terminology for the various educational paths or subjects. The cultural policy of Germany's 16 *Bundesländer* is coordinated by the KMK, the Standing Conference of Ministers of Culture of Germany's Bundesländer. Dating back to 1948, its main task consists of "guaranteeing maximum mobility for pupils and students, ensuring the same level of living conditions and representing and promoting the joint interests of the Bundesländer in the cultural field . . . through consensus and cooperation" (KMK 2012).

[38] An overview of the different educational paths available in North Rhine-Westphalia (NRW) is to be found in the brochure published by the NRW Ministry of Education and Training VET schools in North Rhine-Westphalia. VET programmes and diplomas (*Das Berufskolleg in Nordrhein-Westfalen. Bildungsgänge und Abschlüsse*) (2008, p. 42-46 in particular) as well as in similar documents from the education ministries of the other *Bundesländer* (cf. section on federalism in Germany).

6.2 The German initial vocational education and training (IVET) system

Looking at the German VET system, we see that vocational education is often equated with the apprenticeship system (Berger / Pilz 2009, p. 6). However, apart from the apprenticeship system, a large number of other programmes are available at upper secondary level, offering full-time schooling. Of the total of 2,687,974 VET students, 1,613,579 were apprentices under the apprenticeship system (60%), while the remaining 1,074,395 were taking full-time VET courses at VET colleges (Statistisches Bundesamt 2011a). These non-apprenticeship programmes range from programmes for fulfilling compulsory vocational training and acquiring basic vocational skills, via college-based VET programmes (e.g. to become a state-certified assistant civil engineer), to CVET programmes for journeymen. [3940] This range of full-time VET courses is intended to give VET students and people already working the opportunity of individually deepening and extending their skills and knowledge. All IVET programmes end with successful participants acquiring a vocational qualification. Generally speaking, these allow at least lower secondary school-leaving certificates to be acquired, with upper secondary certificates issued when IVET achievement reaches the required standards (cf. Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen 2012 / NRW Education Ministry).[41]

Apart from a few exceptions (cf. Chapter 6.1) the vocational education and training of people working in the skilled craft sector takes place within the apprenticeship system. Of the 344 recognised apprenticed occupations (as of August 2011) in the categories of industry and commerce, the skilled craft sector, the public sector, agriculture, the professions, home economics and the maritime sector, a total of 45 occupations have been identified in the first two areas mentioned that can be assigned to the building sector (cf. Chapter 7.1) For all apprenticed occupations within the apprenticeship system, the basic principles governing federally regulated apprenticed occupations under §5 BBiG apply. At the same time, implementation is guided by the four design concepts characterising Germany's VET system: (1) the 'occupational principle' (*Berufsprinzip*), (2) Germany's federal system, (3) joint state and market control and (4) corporatism. As the whole concept of Germany's federal structure and its consequences have already been outlined in Chapter 6.1, the following pages are intended - after briefly outlining items 3 and 4, to provide deeper insight into the *'Berufsprinzip'* notion and associated formal design aspects of the VET programmes, such as standardised (Germany-wide) content specifications, course duration, responsibilities and examination procedures. In doing so, great importance is attached to the close link between VET college and workplace.

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[39] For a detailed presentation of the different VET programmes, diplomas and qualification possibilities, readers may like to study the brochure published by the NRW Ministry of Education and Training: VET schools in North Rhine-Westphalia. VET programmes and diplomas (Das Berufskolleg in Nordrhein-Westfalen. Bildungsgänge und Abschlüsse). Similar information material is available from the education ministries of the other *Bundesländer*.

[40] The integration of CVET in the IVET college system does not take place in all *Bundesländer*. The reason is to be found in each *Bundesland's* individual responsibility for education.

[41] IVET programmes taking place fully in a school environment are not considered here.

In Germany VET as a whole is under dual market and state control. In the field of IVET companies are basically free to decide whether they take on apprentices, and if so, who (the market model), while at the same time being subject to state regulations / measures guaranteeing an adequate supply of apprenticeships.

Corporatism is to be understood as the "influence of interest groups on politics" (Sloane / Twardy / Buschfeld 2004, p. 218 ff.). Looking specifically at company apprenticeships, this is to be understood as an "advisory and support function of trade union and employer association representatives in the compilation / modernisation of an apprenticed occupation or in the design of the regulations governing a master craftsman qualification (cf. Chapters 6.3 and 4.2). The idea behind this opportunity to actively shape VET programmes is that it helps orient IVET and CVET programmes towards market needs. Moreover, through the involvement of the social partners, acceptance for new regulations is increased in the sectors concerned.

In Germany the *Berufsprinzip* forms the basis for the standardised implementation of the apprenticeship system throughout the country. As the counterpart to modularisation, [42]skill sets are taken from a "compendium of work activities" (Sloane / Twardy / Buschfeld 2004, p. 121) for each apprenticed occupation. These skill sets describe the "occupational skills, knowledge and capabilities needed to exercise a skilled occupational activity in an ever-changing working environment" (BBiG §1). The goal is thus to promote and develop a basic set of professional capabilities (*berufliche Handlungskompetenz*), to be understood as "the willingness and ability of an individual to behave in a well-considered, personally and socially responsible manner in all professional, social and personal situations" (KMK 2007, p. 10. The focus is therefore on developing "professional, personal and social skills" (KMK, 2007, p.10). The realisation of this *Berufsprinzip* is intended to ensure vocational training providing a long-term perspective and marketable skills (cf. Kremer 2005, p. 3).

The term duality refers to the dual training in two different locations, the company employing the apprentice and the VET college. The apprentice spends on average 4 days a week at the company, learning occupational practice and being introduced to company work processes. On average one day a week is spent in a VET college, where the focus is primarily on learning occupational theory. This focus is complemented by general education courses, for instance in a foreign language.[43] In addition, especially in the skilled craft sector, company training is supplemented by instruction in inter-company training centres (ÜLU) (§26.2.6 HwO). The goal here is to "support the goal of promoting the acquisition of a basic set of professional capabilities inside a company and at a VET college by providing specially developed training measures" (Hauptausschuss des Bundesinstituts für Berufsbildung 2002,

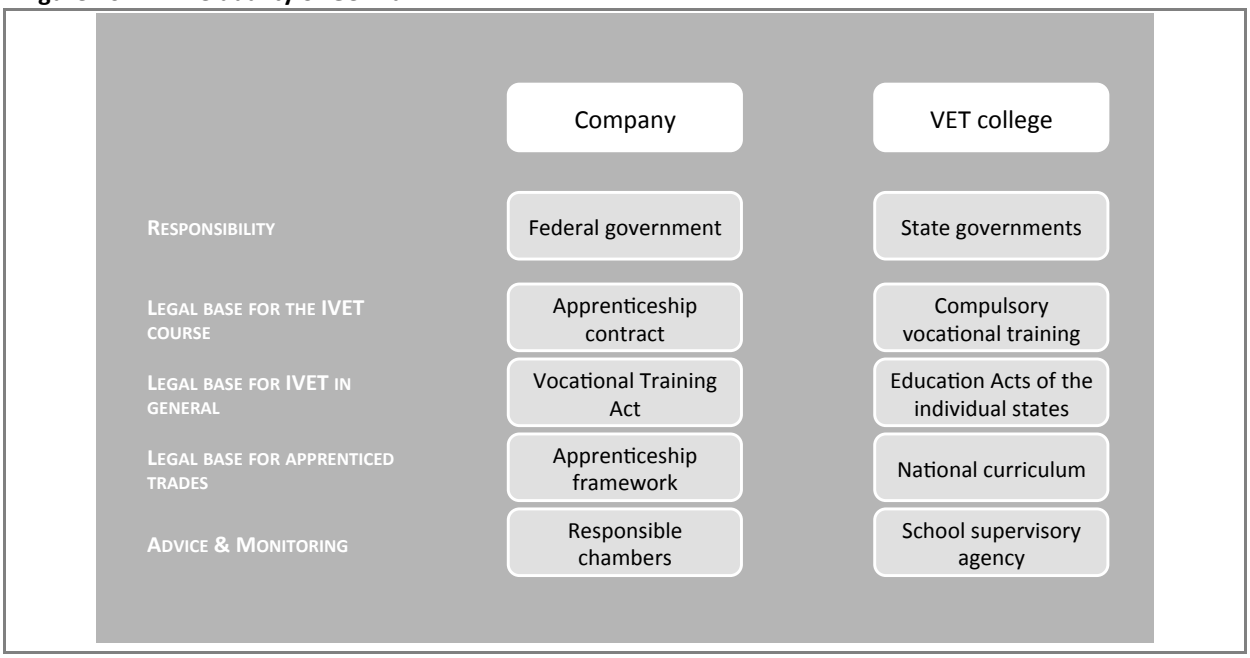
[42] The concept of modularisation is based on the idea of modules being independent units that can be used in different combinations in different educational programmes (cf. Sloane/Twardy/Buschfeld 2004, S. 277 ff.).

[43] The teaching of general knowledge subjects also plays an important role in all upper-secondary courses (i.e. not just in VET programmes).

p. 2). In practice this involves providing courses for specific occupational subjects for apprentices from different SMEs, which, due to their size and the cost involved, are not in a position to provide systematic training in such subject matter - i.e. complementing company-based training). Moreover, such courses fulfil the role of introducing new technological developments into training.

This duality of theory acquired in a VET college and practice acquired at the workplace results in different legal bases and different agents being responsible for designing, teaching and reviewing course content. These are summarised in Figure 26 and discussed in greater detail in the following pages.

Figure 26: The duality of German IVET



Source: Own representation based on BIBB (2003) and BIBB (2011).

Looking first at companies, an apprenticeship begins with the apprentice concluding an apprenticeship contract with the company in question (§10 BBiG). The BBiG further specifies that the BMWi (or the competent ministry) is responsible, in consultation with the BMBF) for adopting an official apprenticeship framework for each apprenticed occupation (§4.1). Pursuant to §5 of the Act, this framework includes:

(1) the name of the state-recognised apprenticed occupation,
(2) its duration (not less than 2 years and not more than three years),
(3) a description of the content, defining the minimum skills, knowledge and capabilities to be taught (minimum requirements),
(4) the framework curriculum (*Ausbildungsrahmenplan*), indicating timeframes and subject matter considerations to be taken into account when teaching the occupational skills, knowledge and capabilities, and
(5) last but not least the requirements for intermediate and final examinations.

Complementing the BBiG, the Skilled Craft Code (*Handwerksordnung* or HwO) is the second important legal base for IVET in the skilled craft sector, regulating the company-based part of the training within the apprenticeship system. Similar to the BBiG, §§ 21-23 HwO start by defining who is entitled to hire and train apprentices. §25 then goes on to specify the above-mentioned apprenticeship framework for each apprenticed occupation issued by the BMWi in consultation with the BMBF, repeating the regulations governing the content of such apprenticeship frameworks. Last but not least, the BBiG defines who is responsible for monitoring IVET in Germany. Occupations in the skilled craft sector come under the responsibility of the Chambers of Skilled Crafts (*Handwerkskammern* or HWK) (§71.1 BBiG), while responsibility for non-craft trades is given to the Chambers of Industry and Commerce (*Industrie- und Handelskammern* or IHK) (§ 71.2 2 BBiG), on the basis of the compulsory membership of companies / employers. Monitoring involves both an advisory and examination role, with the regionally organised Chambers designated as being responsible for organising and conducting the intermediate and final examinations (§ 38.1 HwO; §47.1 and 2 in connection with §47 BBiG).

Turning to the VET colleges, apprentices fulfil their compulsory vocational training by attending VET colleges on a part-time basis (as for instance set forth in the §38 NRW Education Act). Alongside the apprenticeship framework for each apprenticed occupation, a framework curriculum (*Rahmenlehrplan*) for each occupation is published by the KMK for VET colleges. With Germany's federal structure giving VET responsibility to the Bundesländer (cf. Chapter 6.1), the latter have the possibility of either accepting the KMK framework curriculum for a specific apprenticed ocupation on an "as-is" basis, or tailoring it to their specific requirements (cf. KMK handouts). All framework curricula consist of five sections. The definitions found in Sections 1 -3 are binding for all KMK curricula:

(1) Preamble
(2) A school's educational mission
(3) Didactic principles
(4) Occupation-related preamble
(5) Course content

While Section 1 explains the development and organisation of the framework curriculum, Sections 2 and 3 deal with teaching the basic set of occupational capabilities via corresponding lessons. The *occupation-related preamble* contains information on how to formulate specific occupational requirements. Finally, curricula are implemented on the basis of the course content, defined as modules targeting specific occupational tasks and activities (cf. KMK 2007, p. 17).

With regard to VET college examinations, we need to first differentiate between the vocational diploma issued by the respective Chamber on successful completion of the apprenticeship (*Berufsabschluss*) and the diploma issued by the VET college (*Berufsschulabschluss*).

Both the HwO and the BBiG designate the respective Chambers (Craft Chambers or Chambers of Industry and Commerce) as being responsible for setting up examination panels and supervising examinations. According to Annex A of NRW's IVET Code (*Verordnung über die Ausbildung und Prüfung in den Bildungsgängen des Berufskollegs or APO-BK*), the VET college diploma is recognised independently of successful completion of an apprenticeship, subject to appropriate grades being achieved (§9.1). In a recognised apprenticed occupation, a VET college diploma corresponds, insofar as the relevant requirements are met, to a lower secondary diploma (a "*Hauptschulabschluss*") issued on successful completion of Grade 10) (§ 2.1). In certain cases, diplomas higher than the lower secondary diploma can be awarded on successful completion of a VET college course (see above.). The grade awarded at the end of a VET college course is calculated on the basis of all grades achieved in all subjects in the final year, possibly including grades from subjects completed in previous years (§9.2).

6.3 Creation and content design of apprenticeship frameworks

For each apprenticed occupation, §4.1 BBiG / §25.1 HwO stipulates that an apprenticeship framework is to be adopted.[44]

Due to their key importance in vocational education and training, a separate chapter is devoted to the way these frameworks are developed and coordinated. We start by briefly describing how the frameworks are initially created and later updated. We then move on to looking at how their content is designed, taking into account the complexity of the process and how long it takes before the regulations are actually published.[45] In doing so, we would like to show whether and to what extent the knowledge and skills required for working in the field of renewable energy sources, energy-efficient construction and refurbishment (for enhancing energy efficiency) are included.

A detailed analysis of the content of VET frameworks for apprenticed occupations in the building sector is to be found in Chapter 7.3.

[44] An overview of all state-recognised apprenticed occupations can be found under http://www.bibb.de/berufe (German) or http://www.bibb.de/en/26171.htm (English).

[45] Generally speaking, the Federal Government and the *Länder* are in agreement that regulatory procedures must not last longer than one year (cf. BIBB 2011, p. 22). Regulatory processes are always deemed to be protracted when the social partners involved cannot reach agreement.

Responsibility for developing apprenticeship frameworks or updating existing ones ensuring uniform training standards throughout Germany lies with the Federal Institute for Vocational Education and Training (*Bundesinstitut für Berufsbildung* or BIBB for short) in Bonn, Germany's VET governing body (cf. §90 BBiG) (cf. Chapter 4.2). Generally speaking, the trigger for compiling or updating an apprenticeship framework is: (1) changes in the working or technological setting of a specific occupational field, whereby these are communicated to the BIBB by trade associations, employer organisations or trade unions, (2) BIBB research into skill needs, or (3) an order of the ministry responsible. Insofar as the ministry itself does not prescribe the compilation / adaptation of an apprenticeship framework, the social partners (employers and employees) ideally jointly define its cornerstones before requesting a meeting with the ministry to go through the proposed contents. In the subsequent meeting in which the application for a new framework is submitted (in which the social partners and the KMK also participate), the cornerstones for the revision / development of a framework are set.[46] The subsequent compilation and coordination stage can basically be divided into the following steps:[47]

1.a The BIBB (represented by its president), in consultation with Federal Government experts nominated by the social partners, compile a draft version of the new apprenticeship framework.
1.b Experts appointed by the KMK draft a proposal for the content of the framework curriculum.
2. The two proposals are discussed, ensuring that they match each other with regard to content and timeframes (joint session).
3. The draft regulation is submitted by the BIBB president to the BIBB Steering Committee (*Hauptausschuss*), in which the social partners are also represented. The Committee's approval is synonymous with a recommendation for the Federal Government to adopt the new apprenticeship framework.
4. KMK approval of the two regulatory documents.
5.a Once the legal compliance of the apprenticeship framework has been checked, it is then adopted by the ministry responsible.
5.b The KMK publishes the framework curriculum in its compendium of resolutions (*Beschlusssammlung*).

These explanations highlight the fact that it is not just the experts designated by the federal government and the KMK who are responsible for developing new apprenticeship frameworks, but also the experts appointed by the social partners. From a legal perspective, the development and coordination phase is governed by the Joint Protocol between the Federal Government and the Ministers (Senators) of Culture of the individual Länder (30.05.1972).

[46] Further information on the cornerstones can be found at the BIBB (2011, p. 25 f.).
[47] A detailed presentation of the procedure can be found in BIBB (2011; 2003b).

Due to this complex procedure it is not possible for apprenticeship frameworks to be permanently updated. Nevertheless BIBB does it best to cater for the demands of industry to have up-to-date apprenticeship frameworks[48]. For this reason, the frameworks are designed as openly as possible, to avoid having to adapt them to every technological development. With regard to the project in general and the aspects of renewable energy and energy efficiency in particular, this open design means that instruction by the apprenticeship company in the relevant knowledge, capabilities and skills can take place at any time during the apprenticeship.

To illustrate how requirements are worded neutrally, the skill termed "recording measurements" is defined by the BIBB (2003) without reference to specific measurement devices or methods for conducting the measurement. The inclusion of technological developments involving the use of new measurement devices and methods is therefore no problem (p.11). A glance at the framework curriculum (cf. Chapter 6.2) for a "builder of stoves and air heating systems" shows that the testing and measuring skill (§4.14) is defined as a skill involving the selection of measurement methods and devices and the installation of measurement facilities (Section d). Here as well, a neutral definition is used, allowing the different techniques available on the market to be used. Moreover, all framework curricula contain a §4 making environmental protection an integral aspect of the vocational training. §4.c in particular makes it clear that energy efficiency and renewable energy have long been integrated in training programmes, stating that "all opportunities to use energy and materials in an economical and environmentally friendly manner are to be seized".

This all goes to show that the development of apprenticeship frameworks for individual apprenticed occupations is a complex process actively involving a range of different VET players. The wording used in the apprenticeship frameworks is such that technological developments can be accommodated without always having to actually amend the framework.

Alongside the great importance of the apprenticeship system (described in Chapter 6.2), further importance is attached to CVET. Despite the neutral wording of the apprenticeship frameworks, today's steadily changing working environment makes it necessary to continually upgrade and extend existing skills. This is especially true where longstanding employees are involved. VET content has in all probability changed considerably since they finished their apprenticeships years or decades ago, not covering the latest techniques and technologies. This is the focus of CVET, defined in §1 BBiG as an instrument for maintaining and upgrading or enhancing an employee's occupational capabilities. The German Educational Council (1970) describes CVET as the "continuation or resumption of organised learning after the completion of an initial education phase of varying length", whereby the completion of this first phase is characterised by "the start of full employment" (p. 197).

[48] In the last 10 years, 2/3 of all apprenticeship frameworks have undergone revision.

Building on this description, in the field of CVET a distinction can be made between skill upgrade programmes enabling older employees to adapt previously acquired skills to technical, technological and economic developments on the one hand, and programmes enabling employees to gain a higher qualification, for example a master craftsman qualification[49] (cf. ZDH 2012b). Moreover, for a better understanding of the structure of CVET in Germany, a further distinction has to be made between regulated and non-regulated CVET programmes (cf. Chapter 4.2). In the area of regulated CVET, there are statutory requirements set down either by the federal government or the responsible (regional) authorities, whereas in the non-regulated area the completion of a course is certified by the institute in question issuing an appropriate certificate (of attendance)[50] (cf. Schanz 2010, p. 91). A wide range of service providers are active in the CVET market, ranging from the VET colleges, the Chambers, trade associations, via training centres belonging to employer or employee associations, to manufacturers (BMBF 2006, p. 297).

The EU's 20-20-20 goals and the national measures defined in Germany's Integrated Energy and Climate Protection Programme (*Integrierten Energie- und Klimaschutzprogramm* or IKEP for short) are leading to an increasing use of renewable energy sources, to new buildings being built to high energy-efficiency standards and to home improvements boosting the energy efficiency of existing buildings. On the basis of the above CVET description, we will now take a preliminary look at CVET offerings in the building sector, with a focus put on renewable energy and energy efficiency in new and existing buildings. We will start by briefly presenting the different service providers active in the CVET market (structural analysis). We will then move on to categorise the existing CVET offerings, describing the (statutory) criteria used: responsibility, existing examination requirements (regulated v. non-regulated CVET) and duration. As in Chapter 6.3, we will end up by assessing a number of CVET programmes with regard to their adaptability, in certain cases describing their content. All following explanations are also to be seen as a basis for the quantitative and qualitative recording and assessment of CVET offerings described in Chapter 7.4).

While on a regional level skilled craft and industrial companies are required to become members of the respective Chamber of Skilled Crafts or Chamber of Industry and Commerce (cf. Chapter 6.2), on the federal level the German Confederation of Chambers of Skilled Crafts (*Deutsche Handwerkskammertag* or DHKT for short) and the German Confederation of Chambers of Industry and Commerce (*Deutsche Industrie- und Handelskammertag* e.V. or DIHK for short) represent the interests of their member chambers. Skilled craft companies also have the opportunity of voluntarily becoming members of the county-level Skilled Craft

[49] In the following, the term "skill upgrading" covers both skill upgrades and skill extensions, as in the field of renewable energy and energy efficiency it is difficult to distinguish between the two. For instance the skills and knowledge acquired during an apprenticeship as a roofer can be upgraded by a CVET course in solar heating, qualifying the person in question to service and install solar heating equipment.

[50] In the context of the QUALRGY 2020 project, the BBiG (Vocational Training Act) is of particular interest for engineering and manufacturing trades and the HwO (Skilled Crafts Code) for skilled crafts. For the other areas named, other legal sources may exist. These are not cited here.

Guilds (*Handwerksinnungen*), themselves also embedded in a similar state and federal hierarchy[51]. The German Confederation of Skilled Crafts (*Zentralverband des Deutschen Handwerks e.V.* or ZDH for short) brings together a total of 53 Chambers of Skilled Crafts, 36 umbrella trade associations as well as skilled craft business and research institutions. The DIHK represents 80 IHKs.

As in the case of IVET and the apprenticeship system (cf. Chapter 6.2) the Chambers are defined in the HwO and BBiG as the bodies responsible for setting up examination panels and for holding CVET examinations. This responsibility is however restricted to regulated CVET programmes (see below). Moreover, we also need to take into account here that the responsibility for (holding) examinations is not to be equated with the responsibility for holding CVET programmes. Preparations for examinations can for instance be made by a training centre belonging to a chamber, while the examination itself is held by an external VET provider. In this respect the national umbrella organisations as federations of associated trades play an important role. Looking at the building sector, the key player here is the Federation of German Building Trades (*Zentralverband Deutsches Baugewerbe* or ZDB for short), in its own words a business association, an employer association and a technical association (Zentralverband Deutsches Baugewerbe (ZDB o.J.). Its affiliated member organisations in the 16 Bundesländer[52] are not only competent points of contact for their members but also VET providers. In addition the ZDB, in collaboration with the respective employer organisation (*Deutschen Bauindustrie e.V.*) and trade union (*IG Bauen-Agrar-Umwelt*) runs 61 training centres[53] throughout Germany, offering a wide range of CVET programmes. Last but not least, the numerous private VET providers and training courses provided by manufacturers need to be mentioned, although these will not be looked into further.

Focusing on the aspects of responsibilities and examinations, CVET offerings can be assigned to the following categories:

51 The explanations provided here are based on a simplified presentation of organisational structures. A full presentation together with further details can be found under http://www.zdh.de/handwerksorganisationen.html (in German).

52 An overview of the ZDB organisation and a list of all affiliated federations can be found under http://www.zdb.de/.

53 An overview of all training centres can be found under http://www.weiterbildung-bauwirtschaft.de/index.php.

1. CVET offerings ending with examinations based on standard regulated CVET frameworks set by the BMBF in consultation with the BMWi (§ 42 HwO; § 53 BBiG). In this case the chambers are responsible for holding the examinations (§ 42c.1 HwO; § 47.1 BBiG).
2. CVET offerings which, in the absence of a standard national regulated framework, are examined under CVET examination regulations set by the responsible chamber and approved by the corresponding Ministry of the *Bundesland* concerned[54] (§ 42a HwO; § 54 BBiG). Here again, the chambers are responsible for holding the examinations (§ 42c.1 HwO and § 71.1 BBiG; §§47.1 and §71.2 BBiG).
3. CVET offerings where examinations are held without a statutory / quasi-statutory basis.
4. CVET offerings, where merely a certificate of attendance is issued.

CVET programmes assignable to the first and second categories are to be considered as regulated CVET programmes. By contrast, offerings whose size, content and duration are not regulated by the HwO or the BBiG belong to the field of non-regulated CVET programmes.

As there are no standardised CVET statistics available for Germany, but instead only different ones focusing on individual aspects of the CVET market, it is not possible to come up with any simple list of available CVET offerings and their reach here.[55] This deficit, together with the major significance attached to CVET, is of great importance for the objective of this project. Chapter 7.4 attempts to bridge this research deficit, with a survey of Chambers of Skilled Crafts, federations affiliated to the ZDB, skilled craft and industry training centres, and the Chambers of Industry and Commerce being included as a work package in the project plan. Alongside gaining a quantitative insight into the market, the survey is also expected to come up with a qualitative content analysis of the CVET market. An initial overview of existing CVET offerings in the skilled crafts field is expected to be gained via a web survey conducted by the ZDH (available on the ZDH website).[56]
A closer look at the wide range of offerings reveals that the latest environmental regulations (for instance energy passes for buildings, the private production of renewable energy) and changed skill requirements for skilled craftsmen have been recognised by the Chambers of Skilled Crafts, leading to appropriate training courses being conceived. The list also shows that the training on offer in the non-regulated area tends to be less time-consuming and the quantity higher. This composition of the training with non-regulated courses dominating is attributable to the fact that fulfilling the requirement set forth in §42a HwO for an examination framework to be officially established takes time. By contrast, upgrading skills via non-regulated training courses reflects a flexible approach to accommodating the changing needs of the labour market.

[54] The approval of the highest federal state (*Bundesland*) authority is only given for examinations held by the Chambers of Industry and Commerce.

[55] An overview of regularly gathered data on the CVET situation in Germany can be found in the reports published by the Federal Education Ministry: BMBF (2006) *Berichtssystem Weiterbildung IX* (Übersicht 1, p. 3-6).

[56] Cf. the list of regional CVET offerings published by the ZDH (ZDH 2012c).

In the field of regulated CVET in the skilled crafts area, the training required to achieve a master craftsman qualification needs to be highlighted. Master craftsmen have extensive all-round expertise - regarding both their practical craft skills and their business and training activities. Standardised CVET frameworks are compiled in collaboration with the social partners and the FBH, and issued by the BMWi in consultation with the BMBF. Industry as well is covered by standard regulated CVET frameworks, issued by the BMBF in consultation with the BMWi and after hearing the BIBB Steering Committee (*Hauptausschuss*) (§ 53.1 BBiG)[57]. The CVET programmes for achieving the master craftsman level can be seen as the most important CVET offering (cf. BMWi 2012). These involve achieving a higher qualification (moving up the craftsman ladder), and require the prior successful completion of an apprenticeship.

In the skilled crafts field, the possession of a master qualification in a licenced trade is also a requirement for anyone wanting to run his own skilled craft company and train apprentices (§ 45 HwO).[58] Looking at the content, master craftsman training consists of four parts: (I) Craft skills in practice, (II) craft skills in theory, (III) business skills (accounting, legal requirements, etc.), and (IV) apprentice-teaching skills. The formal requirements establishing eligibility to take the master craftsman examination as well general examination requirements are regulated at national level via the *MPVerfVO (Verordnung über das Zulassungs- und allgemeine Prüfungsverfahren für die Meisterprüfung im Handwerk und in handwerksähnlichen Gewerben*). The examination requirements for Parts III and IV , identical for master craftsman examinations and taught for all trades, are similarly regulated at national level via the AMVO (*Verordnung über die Meisterprüfung in den Teilen III und IV im Handwerk und in handwerksähnlichen Gewerben*). Individual occupation-related frameworks for course and examination content are only issued by the BMWi (in consultation with the BMBF) for Parts I (practical knowledge) and II (theoretical knowledge) (*Verordnungen über die Meisterprüfung in den Teilen I und II*).

A similar situation is found in the industrial sector, where training to become an industrial foreman (*Industriemeister*) also consists of different parts, listed in the respective regulation *(Verordnung über die Prüfung zum anerkannten Abschluss Geprüfter Industriemeister–Fachrichtung XY*). Here the training generally consists of (1) apprentice-teaching skills, (2) basic skills not specific to the workplace, and (3) workplace skills. In accordance with the regulation establishing the aptitude to teach apprentices (*Ausbilder-Eignungsverordnung*) based on the BBiG), apprentice-teaching skills must be proven.

[57] Alongside the federally-regulated CVET programmes for gaining an industrial foreman (*Industriemeister*) qualification in the fields of metalworking, electronics and insulation, there are further fields subject to regulation by the chambers.

[58] In the skilled craft sector, a distinction is made between licensed (*zulassungspflichtig*) (§1.2 HwO, Annex), non-licensed (*zulassungsfrei*) trades (§18.2 HwO Section 1) and quasi-trades (*handwerksähnliche Gewerbe*) (§18.2 HwO, Section 2).

Whether in the field of the skilled crafts or industry, the development and coordination of the regulations is always a joint effort involving all stakeholders[59] (trade associations, trade unions, chambers, academia).

6.4 The VET market in figures

Following these explanations regarding Germany's VET system, we first provide details on apprenticed occupations within the apprenticeship system. Table 26 and Table 27 only look at the apprenticed occupations relevant to this project (cf. Chapters 1 and 7.1). For each occupation, the tables detail the number of apprentices in each apprenticeship year, as well as the applicable apprenticeship framework and framework curriculum[60]. Table 28 provides further details based on the statistics compiled by the ZDH on successfully completed skilled craft apprenticeships. Details on the responsible institutions, examinations and financing are not listed due to Germany's complex VET structure and organisation explained above.

As already stated, major deficits exists in the field of CVET statistics. The figures compiled by the ZDH only allow us to give details on successfully completed master craftsman examinations (including repeat examinations). These findings are to be found in Table 29. Further details will be forthcoming, once CVET data has been collected as part of the project (cf. Chapter 7.4).

[59] Further information on how CVET regulations are compiled will soon be available in a brochure published by the BIBB.

Table 26: Apprenticed occupations in the skilled craft sector

Occupation	Apprenticeship duration (in years)	Total apprentices	Apprentices per apprenticeship year				Newly concluded apprenticeship contracts
			Year 1	Year 2	Year 3	Year 4	
Plant mechanic for sanitary, heating and air conditioning systems	3.5	31673	7719	8552	8203	7199	10049
Construction finishing worker"	2	894	389	505	- -	- -	508
Building and object coater	2	2573	1050	1523	- -	- -	1171
Concreter	3	1119	334	333	451	- -	467
Concrete block and terrazzo manufacturer	3	35	13	8	14	- -	17
Well builder	3	80	20	30	30	- -	29
Roofer	3	8582	2950	3001	2627	- -	3592
Electronics technician	3.5	32865	8450	8651	7946	7818	10636
Screed layer	3	133	54	37	41	- -	70
Furnace and chimney builder	3	43	15	13	15	- -	21
Tile and mosaic layer	3	2248	655	787	8790	- -	990
Glazier	3	1441	443	496	502	- -	536
Building construction worker	2	1741	822	919	- -	- -	950
Plumber	3.5	1379	365	348	348	318	469
Painter and varnisher	3	20825	6158	6864	7787	- -	8476
Mason	3	8855	2668	3053	3132	- -	3824
Mechatronics engineer for refrigeration technology	3.5	3382	926	812	807	838	1078
Metal worker	3.5	23962	5603	5851	6100	6408	7340
Builder of stoves and air heating systems	3	302	108	108	86	- -	127
Parquet layer	3	752	277	212	260	- -	312
Interior decorator	3	2175	724	732	711	- -	858

Roller shutters and sunshade mechatronic technician	3	519	175	167	175	- -	193
Chimney sweep	3	1721	519	549	651	- -	627
Stonemason and sculptor	3	1091	344	372	375	- -	407
Stuccoist	3	1673	488	582	590	- -	662
Systems electronics technician	3.5	368	90	87	90	101	101
Civil engineering worker	2	760	365	395	- -	- -	377
Joiner	3	18818	4140	7327	7346	- -	8155
Thermal and noise insulation fitter	3	300	90	102	108	- -	112
Carpenter	3	6842	1342	2882	2615	- -	3442

Source: Own presentation based on ZDH statistics (o.J.a).

Table 27: Concluded apprenticeship contracts and examinations by apprenticed occupation in the industrial sector[61]

Occupation	Apprenticeship duration (in years)	Apprenticeship contracts 2010	Newly concluded apprenticeship contracts	Examination participants	
				Total	Examinations passed
Plant mechanic for sanitary, heating and air conditioning systems	3.5	295	90	86	73
Construction finishing worker	2	926	410	674	372
Building materials tester	3	538	191	176	162
Masonry waterproofer	3	46	22	19	18
Building mechanic for demolition and concrete cutting	3	48	15	49	45
Concreter	3	830	317	564	459
Pre-fab concrete element manufacturer	3	370	126	159	118
Floor layer	3	63	19	27	19
Well builder	3				
Electronics technician for devices and systems	3.5	8466	2218	2623	2523
Screed layer	3	1	1	2	2
Facade erector	3	28	8	10	9
Furnace and chimney builder	3	55	14	28	15
Tile and mosaic layer	3	53	18	59	34
Building construction worker	2	812	430	723	452
Wood technician	3				
Mason	3	439	195	357	289
Mechatronics engineer for refrigeration technology	3.5	161	46	11	11
Stone technician		284	90	111	84
Interior decorator	3	1	0	0	0

[61] Due to the lack of data, the apprenticed occupations "Electronics technician for industrial engineering", "Electronics technician for building and infrastructure systems", "Systems informatics technician" and "Technical system planner – specialising in electro technical systems" are not included in the table.

Pipeline fitter	3	531	236	344	264
Specialist civil engineering works builder	3	59	34	28	27
Stuccoist	3	0	0	1	1
Civil engineering worker	2	1638	771	1145	775
Dry construction builder	3	417	175	325	249
Thermal and noise insulation technician	3	3	3	3	3
Carpenter	3	170	65	183	127

Source Own presentation based on DIHK figures (DIHK 2011).

Table 28: End-of-apprenticeship examinations (skilled crafts) 2010

Occupation	Total examinations		Thereof repeat examinations	Total success rate	
	Male	Female		Male	Female
Plant mechanic for sanitary, heating and air conditioning systems	9557	70	1428	7425	60
Construction finishing worker	Level 1 in the building sector's 2-stage training scheme. The two-year training period can be credited onto one of the following occupations: Screed layer, tile and mosaic layer, stuccoist, thermal and noise insulation technician, carpenter.				
Building and object coater	1343	156	337	822	102
Concreter	461	5	39	390	5
Concrete block and terrazzo manufacturer	21	0	4	21	
Well builder	41	0	0	38	0
Roofer	3091	31	566	2177	28
Electronics technician specialised in energy and building management systems					
Screed layer	31	0	1	27	0
Furnace and chimney builder	19	0	4	10	0
Tile and mosaic layer	920	8	154	5	653
Glazier	510	16	74	398	14
Building construction worker	Level 1 in the building sector's 2-stage training scheme. The two-year training period can be credited onto one of the following occupations: mason, concreter, furnace and chimney builder.				
Plumber	468	8	76	363	5
Painter and varnisher	7756	1009	1104	5821	843
Mason	3846	24	493	3033	21
Mechatronics engineer for refrigeration technology	80	3	1	73	3
Metal worker	6865	49	323	6189	44
Builder of stoves and air heating systems	115	2	13	95	2
Parquet layer	320	9	34	259	6
Interior decorator	473	421	89	350	383
Roller shutters and sunshade mechatronic technician	212	6	15	175	5

Chimney sweep	388	60	76	312	54
Stonemason and sculptor	369	47	41	282	40
Stuccoist	586	13	51	455	12
Systems electronics technician	111	11	1	106	11
"Civil engineering worker	Level 1 in the building sector's 2-stage training scheme. The two-year training period can be credited onto one of the following occupations: road builder, pipeline fitter, sewer builder, well builder, special civil engineering works builder, railway builder.				
Joiner	8204	751	986	6749	684
Thermal and noise insulation technician	107	0	10	89	0
Carpenter	3020	41	352	2482	35

Source: Own presentation based on ZDH statistics (ZDH o.J.b).

Table 29: Master craftsman examinations (skilled crafts) 2010

Occupation	Total examinations		Thereof Repeat examinations	Total success rate	
	Male	Female		Male	Female
Master concrete block manufacturer	10	0	0	10	0
Master well builder	11	0	0	11	0
Master roofer	492	12	66	473	11
Master electrical machinery technician	31	1	0	21	1
Master electrical engineering technician	2256	16	279	2178	15
Master screed layer	7	0	0	7	0
Master tiler	85	2	9	83	1
Master glazier	74	7	18	72	7
Master heating and plumbing technician	1371	9	166	1330	8
Master refrigeration technician	214	1	53	198	1
Master plumber	122	3	8	122	3
Master painter	1117	126	129	1089	118
Master mason / concrete mason	637	1	67	619	1
Master metal builder	1101	12	129	993	13
Master stove builder	41	1	4	40	1
Master parquet layer	30	0	6	30	0
Master interior decorator	40	35	4	40	35
Master sun-shading technician	14	0	1	14	0
Master chimney sweep	207	18	99	207	18
Master stone mason	97	15	10	94	14
Master stuccoist	95	2	11	88	2
Master joiner	1144	47	144	1120	47
Master thermal and noise insulation technician	28	2	8	28	2
Master carpenter	682	6	66	679	6

Source: Own presentation based on ZDH statistics (o.J. c).

7 Status quo analysis

7.1 Systematic choice of occupations

Katrin Rasch, Rolf R. Rehbold, Susanne Rotthege

A large number of occupations in Germany are involved in the application of currently available technologies for saving / generating energy in the construction / refurbishment of buildings. In the context of the status quo analysis, a survey is to be made into which occupations are involved here and to what extent the required skills, knowledge and capabilities are taught during an apprenticeship. To do this, a structured approach is needed for systematically gathering the necessary information. The methodology used covers two dimensions:

1. The part of the house to which the energy saving / generating technologies apply.
2. The process, i.e. the activity carried out in connection with the technology or its use. Table 27 presents this approach schematically.

The consortium's expert group used FBH analyses to discuss and determine the occupations relevant to energy-related building refurbishment and the use of renewable energy sources.

7.1.1 Development of a classification for the choice and analysis of occupations

The analysis of the technologies involved in the construction / refurbishment of a house involved first drawing a distinguishing line between three categories: "a building's envelope", "a building's infrastructure" and its "energy supply". Thus the building's envelope is first looked at, before moving on to the infrastructure[62] within the envelope and finally looking at opportunities for efficiently supplying energy. Looking at the first two categories, our focus is not only on technologies associated with renewable energy. The technologies included here also have the potential to improve a building’s energy efficiency. The third category however concentrates exclusively on technologies for the efficient use of energy, putting the focus on energy-efficient construction and renewable energy sources.

The "building envelope" category

Alongside a building’s shell and roof, the “building envelope” also includes the windows and doors, as well as the facade. The shell of a building is defined as the load-bearing outside walls.[63] The roof consists of the roof-beams, roof-tiles and insulation. Turning to a building's windows and doors, the focus here is on the glazing, the frames and shutters. With regard to doors, only the outside doors are meant. Finally, alongside various forms of cladding, a building's facade also involves the application of insulation.

[62] The term "infrastructure" is defined later in the chapter.

[63] Though the shell can include load-bearing interior walls, these are not however taken into account, due to the focus on energy-efficient construction. See also Chapter 4.3.2

The "infrastructure" category

For the purpose of analysing the occupations, a building's infrastructure is sub-divided into the areas "interior walls and flooring", "electrics", "heating" and "cooling". While the interior walls and flooring reflect the interior finishing focus relevant for this project, the electrics include not just the normal electrical wiring of a building but also building management and automation systems. Heating includes not just heating systems but also the supply of hot water. Last but not least, cooling covers air conditioning and cooling systems.

The "energy supply" category

The technologies bundled together in the "energy supply" category can be subdivided into "electricity" and "heat". Whereas photovoltaic systems, combined heat and power (CHP) systems and wind turbines are used to generate electricity, solar and geothermal plants, biomass plants and again cogeneration systems are used to produce heat.

Having now been through the categories relevant to our status quo analysis, we will now briefly go through the various phases belonging to any construction / refurbishment project. As already done with regard to the categories, we will start by structuring the processes involved. In a heuristic process developed in the course of our evaluation, we will be further subdividing these processes in line with our findings. A further subdivision will be made in the course of evaluating the master craftsman VET frameworks. In this context, process steps not found at journeyman level but only at master level will need to be added.
Moreover we would like to stress from the start that the process chain explained here does not necessarily run in such a linear manner as presented. On the contrary, dependent on the circumstances certain processes or individual steps can be left out while others may be repeated. Moreover certain steps occurring at a later stage of the process chain, such as the "inspection" or "maintenance" of existing systems can also be the starting point for a refurbishment project.

The "provision of advice" process

Any construction process begins with a discussion with the customer regarding his requirements. Before construction actually starts, a review of customer requirements needs to be done, checking to what extent these can actually be offered by the contracting company. This is normally done by the journeyman, with the result being passed on within the company. It is then the master's turn to discuss the resulting offer with the customer.[64]
A further main component of the advisory phase involves maintaining contact with the customer during or after execution of the work. This can include explaining technical matters, how equipment is to be operated, or indicating when maintenance work is needed.
This phase plays a crucial role in achieving energy efficiency goals, as the advisor's expertise acts as a trigger for a customer decision to start work on energy-saving measures.

[64] See the detailed description of individual process steps in Chapters 7.3 (for journeymen) and 7.4 (for master craftsmen).

The "planning" process

The starting point for any planning of a building project involves drafting a concept and compiling an offer for the customer. These process steps are carried out by the master, whereby he may be assisted by a journeyman in certain planning steps. Planning involves first of all the selection and definition of the process steps involved and includes taking account of the relevant regulations, guidelines and/or standards. It further involves calculating the cost of the materials needed and assessing the feasibility of the projected measures. In this phase, agreements need to be reached with all parties involved in the project to ensure that the whole process runs smoothly. This requires a project plan detailing interfaces and dependencies and estimating the time required for each step.

The "execution" process

After all this has been done, project execution begins. This is obviously the main phase and the focus of our analysis. In contrast to the previous "planning" phase, execution involves activities performed on the building site itself. This starts with supplying all the necessary materials and setting up the building site. It may also require making on-site sketches, assessing the properties of the materials to be used before use and considering the possible use of alternative materials.

Moreover the execution phase also requires preparatory measures. Examples include preparing surfaces for further processing or preparing materials for use (punching, marking, etc.). Such preparatory work needs to be done before the material can be used or before components can be installed or connected. The application of insulation is also included in this phase.

Last but not least, execution also involves protecting materials, for example applying an anti-corrosion layer or sealing / sheathing vulnerable parts.

Before the execution phase is finished, all parties involved need to document what they have done. They also need to continually check for any mistakes. At the end of this phase, all scaffolding and machines are to be removed and the site cleared up.

The "quality assurance and acceptance" process

Execution is followed by the quality assurance and acceptance of the work performed. The key function of this phase is that the completed work is handed over to the customer for further use. This involves writing acceptance protocols and commissioning the installed systems. This may require measurements to be taken or certain functional aspects to be checked.

This phase also includes certain activities being performed by someone not belonging to the company which carried out the work. This can be the case for example when a chimney sweep's measurements indicate a need for refurbishment.

The "maintenance and repair" process

In our process chain, the next process is maintenance and repair. Alongside detecting the potential need for such, the maintenance and repair process also includes their actual execution. Here as well the work includes documenting what has been done.

Such maintenance and repair work, especially where existing systems, facades, roofs, etc. are involved, generally represents the starting point for the previously mentioned processes where older buildings in need of refurbishment are concerned.

The "disposal" process

The final process in our process chain involves the disposal of old or defective systems and equipment. Here we need to distinguish between parts which can no longer be used and ones which can be "recycled".

Table 27: Evaluation matrix

			Processes					
			Provision of advice	Planning	Execuation	Quality assurance and acceptance	Repairs and maintenance	Disposal
Building work categories	Building envelope	Shell						
		Roof						
		Facade						
		Windows and doors						
	Energy supply	Interior walls and flooring						
		Electrics						
		Heating						
		Ventilation and air-conditioning						
	Energieversorgung	Geothermal systems						
		Biomass systems						
		Solar heating						
		Photovoltaic systems						
		CHP						
		Wind turbines						

7.1.2 Reasons for choosing the analysed occupations

Before actually analysing existing skills in certain building sector occupations, the reasons for selecting the latter need to be presented. We will start by presenting a few basic considerations.

The goal of the project is to highlight the sector's requirements for "blue-collar workers", i.e. skilled and semi-skilled workers, in all fields associated with renewable energy and energy efficiency. In Germany blue-collar workers in this sector gain their skills via some form of initial vocational training (i.e. an apprenticeship). In the analysis of already existing skills, those occupations are looked into - as the starting point for the analysis - which can be assigned to the skilled craft sector (governed by the Skilled Crafts Code or *Handwerksordnung*) and/or the building industry in general (governed by the Vocational Training Act or *Berufsbildungsgesetz*).[65] Some of the occupations to be analysed can be assigned to both the skilled craft sector and the building industry, meaning that they are regulated both in the Skilled Crafts Code and the Vocational Training Act.[66]

The selection of the occupations is based on the building work categories defined above in the area of home construction and refurbishment. The next step involved mapping the apprenticeship frameworks to these building work categories, i.e. defining which occupations were relevant for the "building envelope" category, which for the "building infrastructure" category and which for the "energy supply" category.[67]

Generally speaking, occupations belonging to the fields of construction ("*Hochbau*" and "*Ausbau*") and finishing can be assigned to the "building envelope" category. These are primarily occupations governed by the "Building industry IVET regulation" (cf. Verordnung über die Berufsausbildung in der Bauwirtschaft, 1999). Relevant for both the skilled craft sector and the building industry are, among others, apprenticeship programmes for bricklayers (Maurer), interior plasterers (Stuckateur) and carpenters (Zimmerer).[68]

In the skilled craft sector, further apprenticeship programmes are of importance: This applies, among other programmes, to the programme for painters (Maler und Lackierer), glaziers and plumbers. While it is possible to assign some trades, as for example the glazier to different sub-categories within the "building envelope" category, other occupations, such as joiner relate mainly to the sub-category "windows and doors".

In addition to the apprenticeship frameworks common to both the skilled craft and industrial sectors, there are further occupations belonging to the industrial sector that can be assigned to the "building envelope" category. These include occupations associated mainly with insulating buildings.

Moreover occupations belonging to the concrete stone industry, such as manufacturers of prefabricated elements or concrete blocks, are also looked at. Stone technicians and dry

[65] In addition the professional field of architects is also looked at.

[66] No full-time IVET (i.e. non-apprenticeship) occupations are included in the evaluation.

[67] It should at this stage be pointed out that certain occupations can be mapped to all categories.

[68] These apprenticeship programmes are two-level programmes, containing the contents of the 2-year IVET programmes aimed at training skilled building workers in different areas.

liners can also be assigned to the "building envelope" category, along with building materials QA specialists and demolition and stone-cutting technicians.

Further building occupations are selected as being associated with the two categories, “building infrastructure” and “energy supply”. As already seen in the "building envelope" category, the relevant occupations in these categories can be assigned either to the skilled craft sector (governed by the Skilled Crafts Code or *Handwerksordnung*) and/or the building industry in general (governed by the Vocational Training Act or *Berufsbildungsgesetz*). Some occupations can be assigned to both sectors.
When looking at "true" skilled craft occupations, we find a number of occupations involving work on the interior of a building, as for example the parquet layer or the screed floorer. Turning to the whole field of "electrics", this is obviously primarily the domain of electricians. A number of occupations have an explicit association with the "energy supply" category, and are therefore relevant for further analysis. These include, among others, the occupations of roofer, electrician and glazier.
Turning to the industrial sector, here we find a number of occupations involving work on the interior of a building as well as electrical occupations.
Table 2 summarises the occupations discussed above, assigning them to their relevant building work categories and sub-categories.

Table 30: Choice of occupations analysed

		Responsibility			Responsibility			Categories		
Journeyman title	Master title	HW	IN	Adoption of AO	HW	IN	Adaption of MstrPrV	GH	GI	EV
Plant mechanic for sanitary, heating and air conditioning systems	Master heating and plumbing technician	✓	✓	24. 06. 2003, dated on 08.07.2003	✓		17.7.2002		✓	✓
	Certified metalworking foreman					✓	12.12.1997, dated on 23.07.2010			
Construction finishing woker		✓	✓	2.6.1999, dated on 20.2.2009				✓	✓	
Building materials tester			✓	24.03.05				✓		
Building and object coater		✓		03.07.2003, zuletzt geändert am 25.07.2003				✓	✓	✓
Masonry waterproofer	Certified industrial foreman in insulation		✓	24.04.97		✓	29.06.1993, datend on 25.08.2009	✓		
Building mechanic for demolition and concrete cutting			✓	2.6.1999, dated on 20.2.2009				✓		
Concreter	Master bricklayer/concrete mason	✓	✓	2.6.1999, dated on 20.2.2009	✓		30.8.2004	✓		
Producer of pre-fabricated concrete elements	Certified industrial foreman in the manufacture of concrete elements		✓	9.9.1985		✓		✓		
Concrete bloc and terrazzo manufacturer	Master concrete block manufacturer	✓		09.09.85	✓		21.1.1993	✓		
Floor layer			✓	17.06.02					✓	
Well builder	Master well builder	✓	✓	2.6.1999, dated on 20.2.2009	✓		14.10.2005			✓
Roofer, specialised in roof, wall and waterproofing technology; specialised in reed-thatch roofing techniques	Master roofer	✓		13.5.1998	✓		23.6.2006	✓		✓

Electronics technician for building and infrastructure systems	State certified technician specialised in electro technology		✓	24.7.2007		✓	30.11.2004		✓	
Electronics technician, specialised in energy and building management systems	Master electrical engineering technician, specialised in energy and building management systems	✓		25.7.2008	✓		17.06.2002, dated on 6.3.2003		✓	✓
Screed layer	Master screed layer	✓	✓	2.6.1999, dated on 20.2.2009	✓		16.2.1995		✓	
Facade erector	Certified industrial foreman in insulation		✓	19.5.1999		✓	29.6.1993	✓		
	Certified industrial foreman in such areas as acoustics or dry wall construction					✓				
Furnace and chimney builder	Master bricklayer/concrete mason	✓	✓	2.6.1999, dated on 20.2.2009		✓	30.8.2004	✓	✓	
Tile and mosaic layer	Master tiler	✓	✓	2.6.1999, zuletzt geändert am 20.2.2009	✓		10.3.2008		✓	
Glazier, specialised in glazing; specialised in windows and glass curtain walling	Master glazier	✓		5.7.2001	✓		9.12.1975	✓		✓
Building construction worker		✓	✓	2.6.1999, dated on20.2.2009				✓		
Plumber	Master plumber	✓		10.3.1989	✓		23.05.2006, dated on 05.11.2008	✓	✓	
Painter and vanisher, specialised in design and maintenance; specialised in building and anti-corrosion protection	Master painter	✓		03.07.2003, dated on 25.07.2003	✓		13.6.2005	✓	✓	✓
Mason	Master bricklayer/concrete mason	✓	✓	2.6.1999, dated on 20.2.2009	✓		30.8.2004	✓		
Mechatronics engineer for refrigeration technology	Master refrigeration technician	✓	✓	20.7.2007	✓		27.8.1979		✓	✓
Metal worker, specialised in construction technology	Master metal builder	✓		25.7.2008	✓		22.3.2002, dated on 17.12.2002	✓	✓	✓
Stone technician	Certified industrial foreman in stoneworking		✓	9.5.2003		✓		✓	✓	
Builder of stoves and heating systems	Master stove builder	✓		6.4.2006	✓		5.3.2009		✓	✓
Parquet layer	Master parquet layer	✓		17.6.2002	✓		28.8.1974		✓	
Interior decorateur	Master interior decorator	✓		18.05.2004, dated on 09.5.2005	✓		18.6.2008		✓	
Roller shutters and sunshade mechatronic technician	Master sun-shading technician	✓		23.6.2004	✓		22.1.2007	✓		
Chimney sweep	Master chimnney sweep	✓		20.6.2012	✓		25.6.1984	✓	✓	✓
Special civil engineering works builder			✓	2.6.1999, dated on 20.2.2009						✓
Stone mason, specialised in stonemasonry	Master stone man	✓		9.5.2003	✓		11.7.2008		✓	
Stuccoist	Master plasterer	✓		2.6.1999, dated on 20.2.2009	✓		30.8.2004	✓		
Systems informatics technician	State certified technician specialised in electro technology		✓	24.7.2007		✓	30.00.2004, dated on 23.7.2010		✓	
Technical systems planner, specialised in electro technical systems; specialised in supply and equipment technology			✓	21.6.2011					✓	
Civil engineering worker		✓	✓	2.6.1999, dated on 20.2.2009						✓
Joiner	Master joiner	✓		25.1.2006	✓		13.5.2008	✓	✓	
Dry construction builder	Certified industrial foreman in such areas as acoustics or dry wall construction		✓	2.6.1999, dated on 20.2.2009		✓		✓	✓	
Thermal and noise insulation fitter	Master insulation technician	✓	✓	2.6.1999, dated on 20.2.2009	✓		3.6.1982	✓	✓	
	Certified industrial foreman in insulation					✓	29.06.1993, dated on 25.08.2009			
	Certified industrial foreman in such areas as acoustics or dry wall construction					✓				
Carpenter	Master carpenter	✓	✓	2.6.1999, dated on20.2.2009	✓		16.4.2008	✓	✓	
	Certified industrial foreman in such areas as acoustics or dry wall construction					✓				
	Certified industrial foreman in woodworking					✓				

AO - Training Regulation, MstrPrV - Master Regulation, GH - Building Shell, GI - Building Envelope, EV - Energy Supply

7.2 Assessment of the labour potential and reference scenario projections to 2020

Robert Helmrich, Tobias Maier

Chapter 7.1 identified the occupations of major significance for the energy-related refurbishment of Germany's building stock. This chapter now looks at (skilled) labour supply aspects with regard to these occupations (referred to below as "building occupations"), quantitatively measuring the supply and projecting it to 2020. Overall developments in the labour market show that, since the beginning of the 21st century, the labour market participation rate of older workers has been steadily increasing (see Figure 28). At the same time, education patterns show a strong trend towards academic qualifications (see Statistische Ämter des Bundes und der Länder/Statistical Agencies of the Federal Government and the Länder, 2012). These developments are of great importance for projecting future (skilled) labour shortages. Whereas the spring 2010 projections for qualifications and occupational fields (QuBe project) of the Federal Institute for Vocational Education and Training (BIBB) and the Institute for Employment Research (IAB) were forecasting labour shortages throughout the economy from the mid-2020s onwards (Helmrich / Zika 2010), later calculations (Helmrich et al. 2012) show that widespread shortages are not be expected until around 2030, due to changes in employment and education patterns. Looking however at the middle skill level, shortages of labour in specific skill areas are expected much earlier. As qualifications in the building finishing sector are for the most part gained via an apprenticeship, the projected developments also have consequences for labour supply in the selected building occupations. Nevertheless our reference scenario shows that there will be sufficient labour supply for these occupations at least until 2020. Further labour supply potential could also become available through changed labour mobility patterns. For example on average only half of the skilled labour force in the selected building occupations actually work in the occupation they originally trained for, although they represent about two-thirds of those employed in these occupations. The remaining one-third consists mainly of workers without formal vocational qualifications. Even so, the labour market situation for building occupations is by no means healthy, given the fact that at the end of the projection period labour supply is set to sink faster than projected demand.

Using the BIBB/IAB Qualification and Major Occupational Field Projections as a basis, this chapter starts by describing the overall labour market development (Section 7.2.1), then goes on to explain the methodology used in the QuBe project (Section 7.2.2). The findings are then presented, classified by skill level (Section 7.2.3) and major occupational fields (Section 7.2.4). On the basis of the occupational fields relevant for the selected building occupations, the labour supply potential for these occupations is ascertained (Section 7.2.5.1) and projected to 2020. In doing so, not only the supply of trained blue collar workers is taken into account (Section 7.2.5.2) but also occupational migration patterns (Section

7.2.5.3). Finally, the labour supply projection taking this occupational flexibility into account is mapped to labour demand in the selected building occupations to 2020 (Section 7.2.5.4).

7.2.1 Overall labour market developments

The future development of the German economy and thereby of the German labour market is one of the key issues currently being discussed by politicians, businessmen and society in general. It is intimately linked to demographic developments, with the focus here on Germany's declining birth rate, rising life expectancy and migration. Over the coming years Germany's population is set to decline and get older (Statistisches Bundesamt / Federal Statistical Office 2009). Even now, the number of people over 65 is higher than that of those under 15. With the baby-boom generation now moving closer to retirement age, the average age of the employable population is going up. A medium variant of the current population projections (W1 variant of the 12th coordinated population projection) sees German immigration outstripping emigration by around 100 000 from 2014 onwards. After years of an often negative migration balance, this previous level is now being achieved again and even over-achieved.[69]

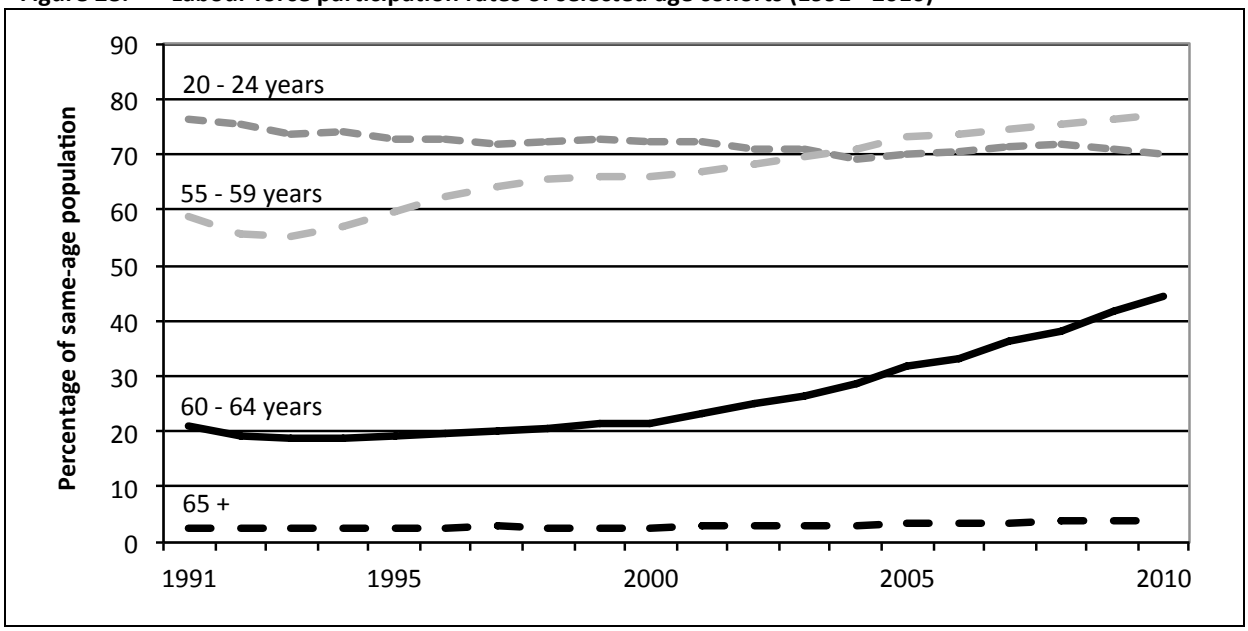
Alongside the demographic development, a trend towards higher-level educational qualifications can be seen, as witnessed by the rising share of academic qualifications (Statistische Ämter des Bundes und der Länder / Statistical Agencies of the Federal Government and the Länder, 2012). Looked at from a purely quantitative perspective, the drop in the number of younger workers as a result of the demographic development, coupled with the changing educational patterns, has the potential to lead to a shortage of skilled blue collar workers with middle-level skills in certain fields. Companies will therefore in the future increasingly have to face up to the fact that they will not always be able to cover their demand for skilled blue collar workers with people with exactly the right qualifications.

This led to the BIBB and the IAB, in cooperation with the Fraunhofer Institut für Angewandte Informationstechnik (Fraunhofer-FIT) and the Gesellschaft für wirtschaftliche Strukturforschung (GWS) coming up with the first model calculations in early 2010 in the context of the BIBB-IAB Qualification and Major Occupational Field Projections (QuBe project) (Helmrich / Zika 2010). One of the findings here was that skilled labour shortages were to be expected not just for people with academic qualifications but also - and in particular - on the middle skill level (successfully completed apprenticeships and VET college qualifications). The shortages were expected to become evident at the end of the projection period used, i.e. around 2025. Looking at the major occupational fields (MOFs) affected, shortages of (skilled) labour were expected mainly in the healthcare and social sector as well as in the hotel/restaurant and cleaning sector. These findings were based on the model calculations done on the basis of the BIBB-DEMOS model, the IAB-INFORGE model and the BIBB-FIT model, all of which used 2005 / 2006 as their base years.

[69] See Statistisches Bundesamt/Federal Statistical Office: https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Bevoelkerung/Wanderungen/Tablen/WanderungenAlle.html (accessed on 06.04.2012).

For a quantitative assessment of labour supply potential and projections for the selected building occupations (Table 31), the QuBe project's data basis is used, as this takes into account developments up to 2010 (Helmrich et al. 2012). This has the advantage of including the demand side effects of the 2009 economic and financial crisis with its surprisingly positive labour market reactions in Germany. With regard to the supply projections, two decisive developments are also taken into account, both of which have gained impetus over the last few years. On the one hand, Germany has experienced a continuous increase in the labour force participation rate of older workers (cf. Figure 28), at least partially compensating the decline in labour supply due to demographic developments. On the other hand, in 2010 the numbers of those eligible to enter higher education – in the context of achieving the Bologna targets – reached a peak at 45% of an age cohort (Statistisches Bundesamt / Federal Statistical Office, 2010), meaning that educational patterns have shifted towards academic qualifications. With regard to the future development, the projection assumes that this increase will not continue, though the figure will remain at a high level.

Figure 28: Labour force participation rates of selected age cohorts (1991 - 2010)



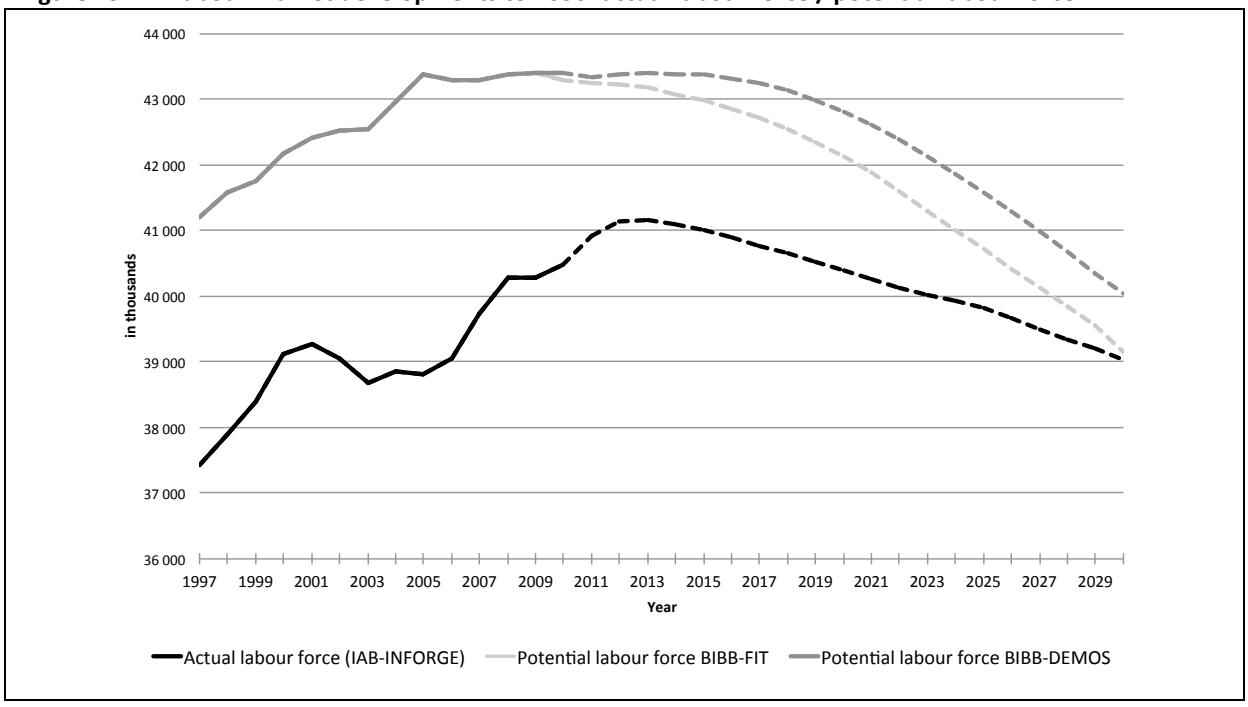
Source: Helmrich et al. (2012, p. 2).

When comparing overall labour supply and demand, it can be seen that, due to demographic developments, labour supply is set to increasingly decline faster than labour demand (cf. Figure 29). Due however to the increases in labour force participation rates over the last few years (cf. Figure 28), it can also be seen that the decline in labour supply will take place later than previously forecast (cf. Helmrich / Zika 2010). Dependent on which model is used for the supply projections[70] this will take place at different speeds. Nevertheless, an identical

[70] Different models are used for taking account of developments in the labour force participation rate, and in particular with regard to the effects of the step-by-step increase in the retirement age to 67 by 2029. For the assumptions, see Kalinowski & Quinke, 2010 as well as Drosdowski & Wolter, 2010.

trend is reflected in both labour supply model calculations. According to the supply projections of the BIBB-FIT model, labour supply and the projected demand of industry will be balanced in 2030. This will not however represent an ideal situation, as many geographical areas can expect to experience massive labour shortages. Figure 29 also shows that the BIBB-DEMOS projections assume higher labour force participation rates for the future, meaning that the point in time when the supply and demand curves intersect is postponed for several years. Both model calculations do not foresee any labour shortages in 2020, as the baby boom generation will still be working. It is only after 2020 that a sharper drop in labour supply is expected.

Figure 29: Labour market developments to 2030: actual labour force / potential labour force



Source: Microcensus of the German Federal Statistics Agency, QuBe calculations and Figures, 2nd wave.

7.2.2 Methodology used in the BIBB-IAB Qualification and Major Occupational Field Projections (QuBe project)

The BIBB-IAB Qualification and Major Occupational Field Projections (Helmrich & Zika, 2010) are coordinated supply and demand projections based on agreed occupational fields and compiled data. The data base used is the microcensus, an official statistic of the Statistisches Bundesamt / Federal Statistical Office on the population and labour market based on an annual representative survey of 1% of German households and adjusted to the reference values of the National Accounts (cf. Bott, Helmrich, Schade, & Weller, 2010). As a way of differentiating occupations, BIBB developed standardised occupational fields (the "BIBB occupational fields" or “OF”), consolidating occupations on the level of the 3-digit occupational categories used in the 1992 Occupational Classification (KldB 1992) in accordance with the homogeneity of the work performed. Occupations within the “BIBB occupational fields" are characterised by greater intra-homogeneity and, at the same time,

greater inter-heterogeneity vis-à-vis occupations in other occupational fields (cf. Tiemann / Schade / Helmrich / Hall / Braun / Bott 2008). To distinguish overall trends, the 54 occupational fields were grouped together to form 12 major occupational fields (MOFs), with the latter similarly being grouped into 3 top-level occupational domains (ODs). The breakdown by skill level corresponds to the highest certified qualification attained by the worker in question using the "International Standard Classification of Education" (ISCED).

7.2.2.1 Projection of labour demand

The IAB INFORGE model used here generates a projection of actual labour demand (i.e. not taking vacancies into account) in 59 business sectors. Using the BIBB occupational fields and the correspondingly compiled BIBB data taken from the microcensus, these sectors are mapped to four skill levels and 54 occupational fields. The INFORGE model is an in-depth disaggregated macro-econometric input / output model for the Federal Republic of Germany. In line with the "bottom-up" construction principle, it differentiates between 59 business sectors, 59 product groups and 43 types of use. The hypotheses used for the demand projection in both the reference scenario and an alternative scenario are presented in Chapter 8.1. Detailed descriptions of the models used are to be found in: Schnur / Zika (2009); Meyer / Lutz / Schnur / Zika (2007); Hummel / Thein / Zika (2010).

7.2.2.2 Projection of labour supply

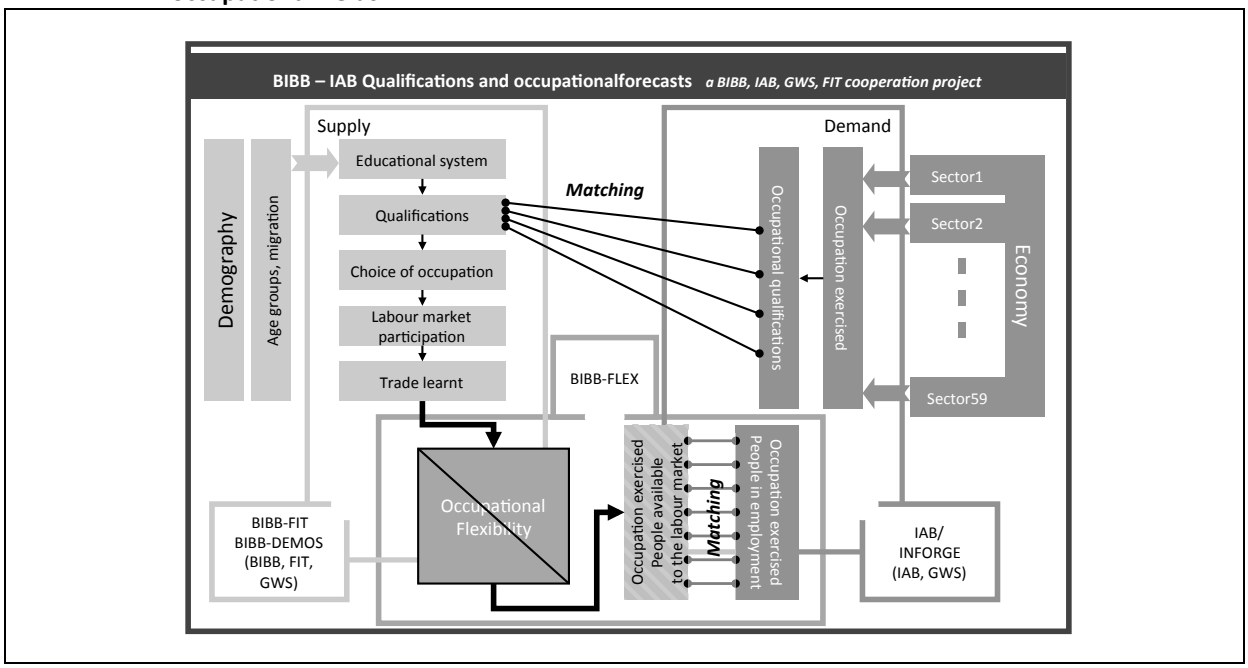
Turning to the supply side, two different projection systems are used to demonstrate how models can react to changes in influencing factors. Preferring to use different models, projections are made using the BIBB-FIT transition model (Übergangsmodell) on the one hand, and the BIBB-DEMOS cohort model on the other. By doing so, methodological uncertainties can be highlighted, while at the same time offering ways of validating the results.

The BIBB-FIT model developed by the Fraunhofer Institut für Angewandte Informationstechnik (FIT) (Kalinowski / Quinke 2010) had already been used for the published forecasts of the Bund-Länder Commission for Educational Planning and Research Promotion (Bonin / Schneider / Quinke / Arens 2007; BLK 2001). By contrast, the BIBB-DEMOS model (cf. Drosdowski / Wolter 2010) of the Gesellschaft für wirtschaftliche Strukturforschung (GWS) shows links to the INFORGE model. Both supply projections map the development of the potential labour force using four skill levels in line with the ISCED categories and a worker's originally learnt occupation (the highest certified qualification). Information on the original occupation was taken from the 2008 microcensus. To ascertain the original occupation for the projection period, a worker's age, gender, skill level and labour market participation play a role in both models. Differences in the results are mainly due to different base hypotheses with regard to the development of labour force participation rates, and especially with respect to the effects of the step-by-step raising of the retirement age in Germany to 67 by 2029 (Kalinowski / Quinke 2010; Drosdowski / Wolter 2010).

7.2.2.3 Balancing supply and demand

To compare supply and demand, those available to the labour market in their originally trained-for occupations (the potential labour force) are merged with the demand for labour in the occupations exercised, using a flexibility matrix. This flexibility matrix is based on the 2008 microcensus. As the unemployed do not exercise an occupation, the assumption is made that they, in line with their original occupation,[71] will show the same flexibility as those with a job. i.e. the share of "electronics technicians" currently working in IT-related occupations is mapped to all "electronics technicians" (including unemployed ones). A schematic diagram showing the methodology used in the BIBB IAB Projections for Qualifications and Occupational Fields is to be found in Figure 30.

Figure 30: Schematic diagram showing the methodology of the BIBB IAB projections for qualifications and occupational fields



Source: QuBe project; Helmrich et al. (2012, p. 13).

7.2.3 Developments from a skill level perspective

Leaving aside the overall development of the labour market (cf. Figure 29) and looking specifically at labour supply and demand developments from a skill level perspective, shortages are theoretically possible in as soon as 10 years (Figure 31).

The supply of workers with a full IVET qualification is set to decline, mainly for demographic reasons, meaning that - assuming an unchanged labour demand situation - in ca. 20 years demand will outstrip supply. It can however be expected that this will actually happen a lot sooner, probably at the end of the 2010's, when Germany will see itself confronted with a

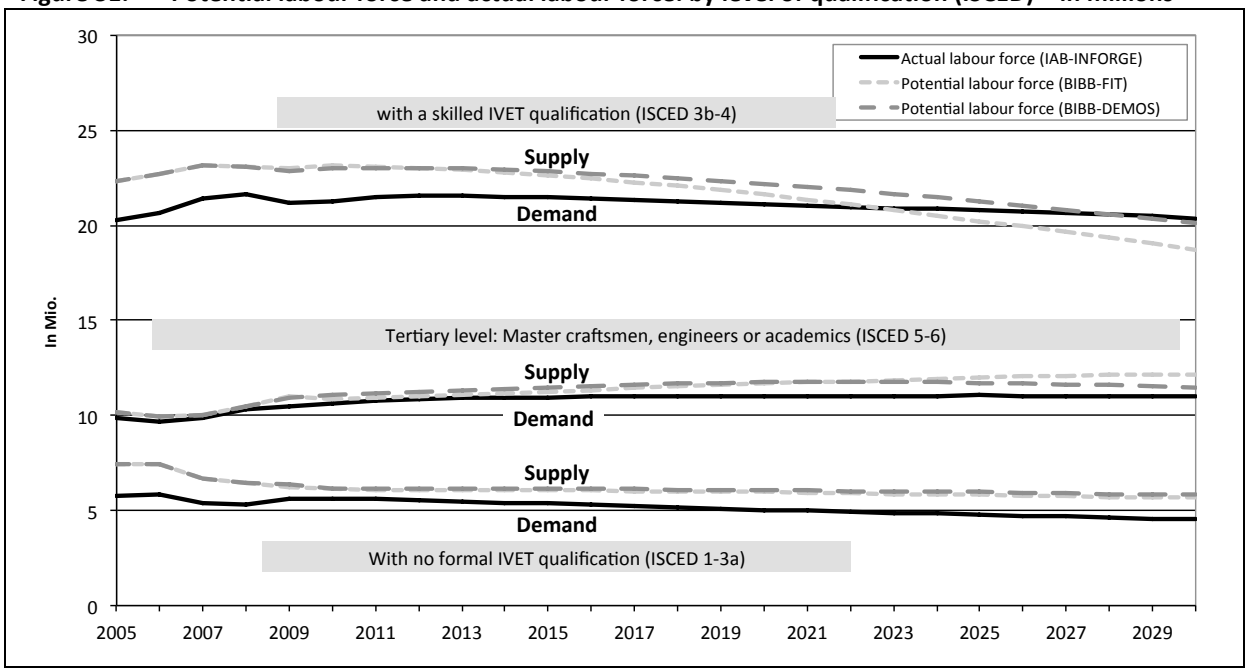
[71] In a comparison of 12 major occupational fields, flexibility rates are calculated on the basis of age, gender and skill level (see Helmrich, et al. 2012; Maier / Schandock / Zopf 2010).

rapidly increasing shortage of skilled blue collar workers, with changing occupational orientations in particular the reason for the supply and demand mismatch. The demand for skilled blue collar workers with IVET qualifications is expected only to decline slightly, mainly due to the wage rises which will become possible on account of the labour shortages (cf. Figure 31). As occupations in the building finishing sector are mainly in the hands of people with a skilled IVET qualification (ISCED levels 3b and 4), a drop in the supply of workers of this skill level will have an effect on these occupations as well.

At the ISCED 5-6 level, both supply and demand are set to increase further - both are currently well-matched. Looking at people with academic qualifications, expected demand is divided equally between replacement demand and new demand caused by structural changes in business. Replacement demand is expected to soar from 2020 onwards, as the baby-boom generation reaches retirement age. The slight academic over-supply is attributable to the current tendency for more academic qualifications. This development has increased in pace over the last few years, whereas the growth in company demand for non-academic highly skilled workers (ISCED 5b) is also on the rise, but not to the same extent.
What can be expected here are adjustments and balancing in favour of the middle skill level, with bachelor qualifications being affected most of all. However there is not as yet sufficient empirical information on their chances in the labour market.

Demand for unskilled labour is expected to drop slightly. The corresponding supply is also expected to decline, though to a lesser extent, meaning that the current over-supply could grow slightly. Employment opportunities for this cohort cannot therefore be expected to improve in the future. What is possible however is for measures to be taken - targeting in particular first-time entrants to the labour market and the younger potential labour force - to increase the supply potential for the middle skill level, for instance through second-chance vocational training.

Figure 31: Potential labour force and actual labour force: by level of qualification (ISCED) – in millions



Source: Microcensus of the German Federal Statistics Agency, QuBe calculations and Figures, 2nd wave.

7.2.4 Developments from a major occupational field (MOF) perspective

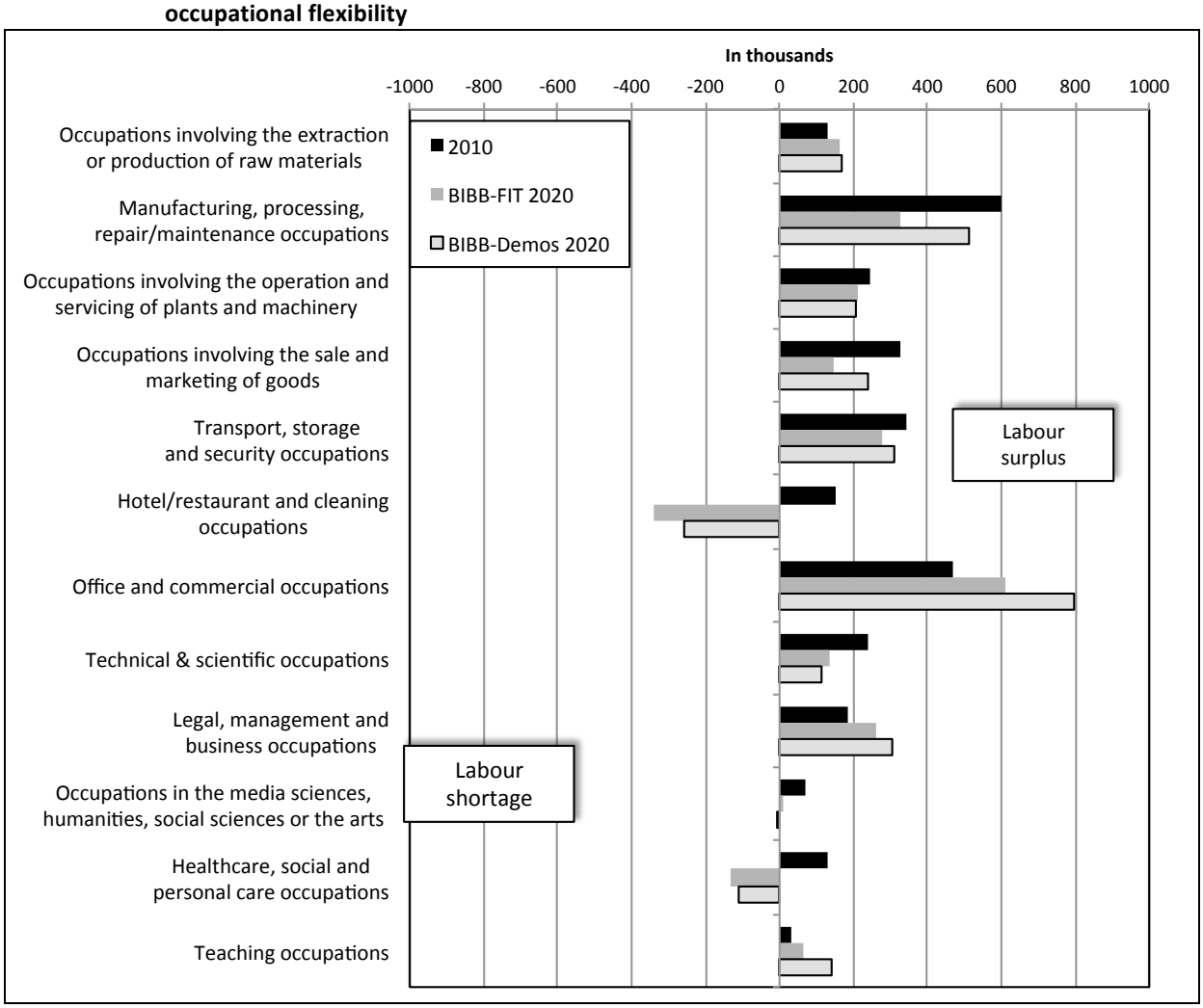
The problems companies experience in recruiting staff are generally less a problem of applicants' skill levels, instead more a problem of the concrete qualifications and skills needed for the job. The BIBB-IAB Qualification and Major Occupational Field Projections therefore compare the matching of supply and demand on the level of the 12 BIBB-defined major occupational fields (MOFs). These MOFs represent clusters of occupational fields with specific activity focuses, whereby the occupations are characterised by greater intra-homogeneity and, at the same time, greater inter-heterogeneity vis-à-vis occupations in other occupational fields.

There are different ways of comparing supply and demand on an occupational level. One can start by comparing the demand for skilled blue collar workers in a specific MOF with the supply of workers with a skilled IVET qualification in this MOF. However many workers do not exercise their originally trained-for occupations, switching to another one in the course of their working life. There are many reasons for this. Incentives to change jobs include better employment or salary prospects, better working conditions, better career opportunities, but also a better balance between family and working life (see Hall, 2010). One labour market indicator for occupational flexibility is the proportion of "stayers" (people who stay in their original occupation) vs. the proportion of "externals" (people working in an occupation other than the one they were originally trained in) in any one MOF. The extent of occupational flexibility is described in the BIBB's so-called flexibility matrix (Maier / Schandock / Zopf 2010; Helmrich et al. 2012), which shows, for all 12 BIBB-defined MOFs, who is working in which occupation with which original IVET qualification. The intention here is not to look at the reasons for switching occupations, but instead to

illustrate the chances and possible competition situations between occupational fields linked to a specific occupation.

When taking the flexibility matrix into account in projecting labour supply developments, it becomes evident that these occupational switches help, at least to a certain extent, to balance supply and demand, showing in particular to which occupation people without a formal VET qualification are switching - i.e. which occupational fields benefit most from this cohort. Figure 32 presents a "profit & loss statement" for each MOF for 2010 and 2020. It shows that, given unchanged educational patterns and stable career mobility patterns, a labour shortage will arise in 2020 in the fields of "hotel/restaurant and cleaning occupations" and "healthcare, social and personal care occupations". Moreover, the "manufacturing, processing, repair/maintenance occupations", which include most of the occupations in the building finishing sector, will also see a decline in labour supply between 2010 and 2020. This decline is more pronounced in the BIBB FIT model than in the BIBB-DEMOS model.

Figure 32: Labour "profit and loss statement" in the MOFs in 2010 and 2020, taking into account occupational flexibility



Source: Microcensus of the German Federal Statistics Agency; QuBe calculations and Figures, 2nd wave.

7.2.5 Labour supply potential in the selected building occupations

7.2.5.1 The selected building occupations in the BIBB-defined occupational fields

The selected building occupations are to be found in eight occupational fields (cf. Table 31) defined by BIBB in the context of the QuBe project. Taking the numbers involved, the three occupational fields "metal construction, plant construction, sheet metal construction, installation, fitters“, "electrical occupations" and “construction, woodworking, plastics manufacture and processing occupations“ are the largest (cf. Table 34). Looking closer at the eight occupational fields, a differentiation needs to be made between whether a field is looked at from an "originally trained-for occupation" or a "currently exercised occupation" perspective.

Table 31: Occupational fields and occupational categories (*Berufsordnungen*) of the selected building occupations

BIBB occupational fields covering building occupations	Occupational categories (Berufsordnungen) associated with building occupations
Stoneworking, construction materials production, ceramics, glass related occupations	101 Stone preparers
	112 Shaped brick, concrete block makers
Metal construction, plant construction, sheet metal construction, installation, fitters	254 Construction mechanics (plant equipment) and associated metal
	259 Other metalworking and related occupations
	261 Plumbers
	264 Plant mechanics (energy systems)
	266 Refrigeration system builders and fitters
	267 Gas and water fitters
	268 Central heating and air-conditioning builders
Electrical occupations	310 Electricians
	311 Energy system electricians
	316 Electro-mechanical technicians, industrial electronic technicians
	317 ICT electronic technicians
Construction, woodworking, plastics manufacture and processing occupations	440 Other construction occupations
	441 Masons, furnace and chimney builders
	442 (Reinforced) concrete masons
	443 Scaffolders
	460 Civil engineering occupations, demolition and blasting experts (not mining)
	466 Other civil engineering occupations
	480 Finishing occupations
	481 Stuccoists
	482 Insulation and sealing specialists
	483 Tilers
	484 Tiled stove and air heating builders
	485 Glaziers
	486 Screed and terrazzo layers
	487 Carpenters
	488 Roofers
	491 Interior decorators, parquet layers
	501 Joiners
	505 Wood mechanics
	511 Painters and varnishers (finishing sector)
Technicians	651 Industry and plant foremen
Specialist skilled technicians	633 Chemical lab technicians
Engineering draughtsmen, related occupations	641 Draughtsmen
Cleaning and waste disposal occupations	804 Chimney sweeps

Looking first at the occupation originally trained in (Table 32), a distinction has to be made as to whether or not a person who is available to the labour market and has the highest possible (certified) IVET qualification in one of the eight relevant occupational fields gained this qualification in an occupational category counted as an apprenticed occupation. Table 32 shows that the percentage of selected building occupations is highest in the occupational field "electrical occupations" (82.2%), followed by the "metal construction, plant construction, sheet metal construction, installation, fitters" (77.3%) The lowest percentages are to be found in the "technicians" field (12%) and the "cleaning and waste disposal" field (14.8%). The only building occupations found here are the "industry and plant foremen" and the "chimney sweep" (see Table 31).

Table 32: Percentage of the potential labour force with a formal IVET qualification in the selected building occupations within the BIBB occupational fields

Occupational field	Occupational category counted as belonging to the selected building occupations?		Total
	No	Yes	
related occupations	54,4	45,6	100
Metal construction, plant construction, sheet metal construction, installation, fitters	22,7	77,3	100
Electrical occupations	17,8	82,2	100
Construction, woodworking, plastics manufacture and processing occupations	24,8	75,2	100
Technicians	88,0	12,0	100
Specialist skilled technicians	34,5	65,5	100
Engineering draughtsmen, related occupations	39,9	60,1	100
Cleaning and waste disposal occupations	85,2	14,8	100
Total	35,5	64,5	100

Source: 2008 microcensus of the Federal Statistical Office; BIBB calculations.

Looking instead at the percentages of people actually working in the selected building occupations within the occupational fields (Table 33), a slightly different picture emerges. We now see that 88.8% of those working in the "electrical occupations" field are actually working in building occupations, compared to just 50.4% of those in the "metal construction, plant construction, sheet metal construction, installation, fitters" field. Due to a high influx of unskilled workers into the "cleaning and waste disposal" field, "chimney sweeps“ – counted as a building occupation - represent just 1.1% of those working in this field.

Table 33: Percentage of those working in the selected building occupations within the BIBB occupational fields

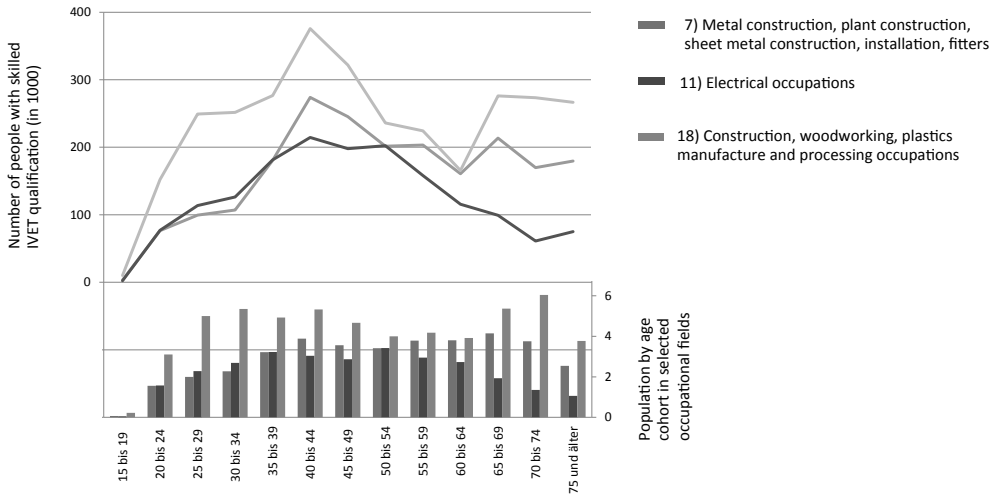
Occupational field	belonging to the selected building occupations? No	Yes	Total
occupations	61,5	38,5	100
Metal construction, plant construction, sheet metal construction, installation, fitters	49,6	50,4	100
Electrical occupations	11,2	88,8	100
Construction, woodworking, plastics manufacture and processing occupations	27,7	72,3	100
Technicians	87,0	13,0	100
Specialist skilled technicians	38,4	61,6	100
Engineering draughtsmen, related occupations	38,8	61,2	100
Cleaning and waste disposal occupations	98,9	1,1	100
Total	56,2	43,8	100

Source: 2008 microcensus of the Federal Statistical Office; BIBB calculations.

Among the building occupations within the occupational fields, this different distribution of the potential labour force with respect to the occupation originally trained in and actual labour force with the occupation currently exercised is the result of the occupational flexibility already discussed in section 7.2.2.3 and 7.2.4. However, for generating a labour supply projection for the selected building occupations, it is not just the occupation originally trained in and the associated occupational flexibility that are of importance, but also the distribution of these occupations by age cohort and gender. Figure 28 shows that the labour market participation rate of older workers has risen sharply in the last few years. Looking however at the age pyramid of people who have a skilled IVET qualification in one of three occupational fields most relevant for the building sector (“metal construction, plant construction, sheet metal construction, installation, fitters”, "electrical occupations" and “construction, woodworking, plastics manufacture and processing occupations“), we see that the cohorts of those entering the labour market are much smaller than those leaving it. Given unchanged employment patterns, population ageing will therefore lead to a decrease in the supply of labour. In addition, as can be seen in the bottom part of Figure 33, a relative decrease is taking place in the younger age cohorts, which is set to have an over-proportional effect on the building occupations. The population of the three occupational fields is highest in the 40-44 age bracket. In the older age cohorts, both the absolute number of people who have trained in one of the selected building occupations and their share of the population decline. Moreover, the building occupations cannot benefit from the increase in the employment rate of women, as only 5.6% of those working in the selected building occupations are women.[72]

[72] Source: 2008 microcensus of the Federal Statistical Office BIBB calculations.

Figure 33: Population cohorts in selected occupational fields relevant for the building occupations (situation in 2008)



Source: 2008 microcensus of the Federal Statistical Office and their National Accounts; BIBB calculations.

The following section first provides a projection of the selected building occupations from a perspective of the occupation originally trained for. This is followed by a presentation of occupational flexibility patterns and the effect they have on the labour supply projection for the building occupations to 2020. Finally the future supply potential is shown, mapping this to the occupational requirements in the building sector determined in the status quo scenario (cf. Chapter 8.1).

7.2.5.2 Projection of the potential labour force with a skilled IVET qualification in the selected building occupations to 2020

For the projection of the potential labour force, the BIBB-DEMOS and BIBB-FIT models are used. The most recent structural information for both models is taken from the 2008 microcensus of the Federal Statistical Office. With regard to the qualifications structure of the population, both models were however adjusted to take account of 2010 figures[73]. Due to the different ways of modelling (cohort model vs. transition model), in certain cases different adjustment methods needed to be applied. This means that the 2010 starting positions of the two models differ slightly. Both models are used to generate a labour supply projection for the selected building occupations, as they differ in their conclusions, especially with regard to the projected development in the middle skill level (see Figure 31). This is very important for the building occupations looked at. The differences in the projected development between the BIBB-DEMOS and the BIBB-FIT model are due on the one hand to the different assumptions with regard to future VET participation and on the other hand to differences in the assumed labour market participation rate. Whereas both models provide similar projections with regard to male labour market participation, the BIBB-DEMOS model

[73] Volkswirtschaftliche Gesamtrechnung / National Accounts - Special analyses of the 2010 microcensus.

assumes slightly higher labour force participation rates for women and a sharper rise of 60+ labour force participation rates.

Table 34 shows the development of the potential labour force in the occupational fields relevant to the building finishing sector by occupation originally trained for (cf. Table 31). The upper section of the table shows the development in the respective occupational fields as a whole. The middle section approximates the potential labour force in the selected building occupations within the occupational fields through adjusting the respective occupational fields for the share of people who according to the 1992 KldB occupational categories are not counted as belonging to the selected building occupations. The information on the proportionate downsizing of the occupational fields is taken from the 2008 microcensus and corresponds to the percentages of the potential labour force with an IVET qualification in the building occupations within the occupational fields, as seen in Table 32. As the percentages are kept constant throughout the projection period, the change in the potential labour force with an IVET qualification in comparison to 2010 (the base year) is the same as in the superordinate occupational fields. This change compared to the base year is reflected in the bottom section of Table 34.

Looking at the size of the potential labour force with a skilled IVET qualification in the selected building occupations, it is highest in the "construction, woodworking, plastics manufacture and processing occupations" field (1.7 million), followed by "electrical occupations (1.2 million) and "metal construction, plant construction, sheet metal construction, installation, fitters" (1.1 million). By contrast, the 20,000 chimney sweeps contained in the "cleaning and waste disposal" field seem relatively insignificant, as do the 35,000 "stone preparers" and "shaped brick, concrete block makers" belonging to the "stoneworking, construction materials production, ceramics, glass related occupations" field. All in all, some 4.5 million people gained a skilled IVET qualification in 2010 in an occupation belonging to the occupational categories of the selected building occupations. According to the BIBB-DEMOS model, this figure is set to drop by 5.4% to 4.2 million by 2020. The BIBB-FIT model goes even further, projecting an 11.4% drop to 4.0 million. The total potential labour force in the occupational fields conducting similar activities is set to drop in the same period from around 7.0 million to 6.6 million (BIBB-DEMOS) or to 6.2 million (BIBB-FIT). In both models, the sharpest drop is expected in the building occupations belonging to the "metal construction, plant construction, sheet metal construction, installation, fitters" field (BIBB-DEMOS: -136 000 or -12.3%; BIBB-FIT: -199 000 or -17.8%).

Looking at the results in Table 34, we see that an overall decline in the supply of people with a skilled IVET qualification in the selected building occupations is to be expected. Moreover this will not be compensated by higher labour force participation rates (cf. BIBB-DEMOS model in Drosdowski & Wolter, 2010). No conclusions can however be drawn from this finding without looking at the corresponding development of demand (cf. Chapter 8.1). Moreover, the share of those remaining in the occupation they originally trained for

("stayers") needs to ascertained, as does the size of the influx into the selected building occupations of workers from other occupational fields and non-skilled workers. In order to estimate this supply potential, the next section looks at occupational flexibility in building occupations.

Table 34: Potential labour force by occupation originally trained for in the occupational fields of the building occupations to 2020

	Potential labour force by occupation originally trained for (in 1000)					
	2010		2015		2020	
Occupational field	BIBB-DEMOS	BIBB-FIT	BIBB-DEMOS	BIBB-FIT	BIBB-DEMOS	BIBB-FIT
Stoneworking, construction materials production, ceramics, glass related occupations	77,2	78,0	72,9	72,9	67,1	67,0
Metal construction, plant construction, sheet metal construction, installation, fitters	1422,3	1441,7	1347,7	1320,5	1246,7	1184,4
Electrical occupations	1410,8	1423,2	1390,6	1372,9	1335,6	1288,3
Construction, woodworking, plastics manufacture and processing occupations	2335,8	2335,1	2362,9	2252,7	2331,3	2137,3
Technicians	1196,1	1172,7	1130,9	1091,2	1043,4	993,1
Specialist skilled technicians	263,4	262,1	258,2	250,0	248,1	229,5
Engineering draughtsmen, related occupations	173,0	173,2	167,3	167,9	158,4	158,8
Cleaning and waste disposal occupations	132,5	133,5	132,3	135,8	129,1	135,0
Total	7011,2	7019,4	6862,8	6663,9	6559,8	6193,5
	Potential labour force by occupation originally trained for in building finishing occupations (based on the 2008 microcensus) (in 1000)					
Stoneworking, construction materials production, ceramics, glass related occupations	35,2	35,6	33,3	33,2	30,6	30,5
Metal construction, plant construction, sheet metal construction, installation, fitters	1099,5	1114,4	1041,8	1020,7	963,7	915,6
Electrical occupations	1159,7	1169,9	1143,1	1128,5	1097,9	1059,0
Construction, woodworking, plastics manufacture and processing occupations	1756,5	1756,0	1776,9	1694,0	1753,2	1607,3
Technicians	143,5	140,7	135,7	130,9	125,2	119,2
Specialist skilled technicians	172,5	171,7	169,1	163,8	162,5	150,3
Engineering draughtsmen, related occupations	104,0	104,1	100,6	100,9	95,2	95,5
Cleaning and waste disposal occupations	19,6	19,8	19,6	20,1	19,1	20,0
Total	4490,5	4512,1	4420,0	4292,2	4247,4	3997,3
	Percentage change of Potential labour force by occupation originally trained for: 2010 - 2020					
Stoneworking, construction materials production, ceramics, glass related occupations	100,0	100,0	94,5	93,4	86,9	85,8
Metal construction, plant construction, sheet metal construction, installation, fitters	100,0	100,0	94,8	91,6	87,7	82,2
Electrical occupations	100,0	100,0	98,6	96,5	94,7	90,5
Construction, woodworking, plastics manufacture and processing occupations	100,0	100,0	101,2	96,5	99,8	91,5
Technicians	100,0	100,0	94,5	93,1	87,2	84,7
Specialist skilled technicians	100,0	100,0	98,0	95,4	94,2	87,6
Engineering draughtsmen, related occupations	100,0	100,0	96,7	97,0	91,6	91,7
Cleaning and waste disposal occupations	100,0	100,0	99,8	101,7	97,5	101,2
Total	100,0	100,0	98,4	95,1	94,6	88,6

Source: BIBB-DEMOS model, BIBB-FIT model, 2nd wave.

7.2.5.3 Occupational flexibility in the selected building occupations

Looking first at the percentage of people staying in the occupation they originally trained for - the so-called 'stayers', one can see that in all occupational fields of the building occupations this percentage within the superordinate major occupational fields is around 50% (upper section of Table 35). The grey-shaded cells in Table 35 show the percentage of 'stayers' in the superordinate MOFs. For instance, only 38.7% of the actual labour force originally trained in the "metal construction, plant construction, sheet metal construction, installation, fitters" occupational field now actually work in this field, while 0.5% now work in "electrical occupations", 4.9% in "construction, woodworking, plastics manufacture and processing occupations" and a further 7.2% in "manufacturing, processing and repair/maintenance occupations". This means that a total of 51.3% or people having trained for an occupation in the field of "metal construction, plant construction, sheet metal construction, installation, fitters" are to be found working in the superordinate MOF of "manufacturing, processing and repair/maintenance occupations". Further MOFs for people originally trained in this occupational field are "occupations involving the operation and servicing of plants and machinery" (16.3%) and "transport, storage and security occupations" (15.4%). People originally trained in the occupational fields of "technicians", "engineering draughtsmen", and "specialist skilled technicians" are to be found working principally in the "technical and scientific occupations" MOF. What meets the eye is that "transport, storage and security occupations" benefit from the occupational fields of the selected building occupations, with an average (based on all those gainfully employed in the building occupational fields) of 12.1% working in this field. A further 7.1% have migrated into "occupations involving the operation and servicing of plants and machinery".

The lower section of Table 35 shows the occupational flexibility rates found in the selected building occupations within the occupational fields. This for the most part matches the occupational flexibility patterns found in the occupational fields (upper section of Table 35) with the exception of "technicians" (in this case referring to the occupational category of "industry and plant foremen") and the "cleaning and waste disposal occupations", to which chimney sweeps belong. The main reason for this is that, apart from the two just mentioned occupational fields, the occupational categories of the selected building occupations dominate the occupational fields listed (cf. Table 32). In the occupational field of "stoneworking, construction materials production, ceramics, glass related occupations", the differences are somewhat larger, as building occupations only represent 45.6% of the potential labour force in this field (cf. Table 32). Generally speaking, the percentage of stayers in the selected building occupations seems to be somewhat higher than the respective percentage of the corresponding occupational field. There would seem to be a tendency for people with a skilled IVET qualification in the building occupations to be "more loyal" to their occupation than their colleagues with similar occupational qualifications.

Table 35: Occupational flexibility: Target occupations of gainfully employed workers with an initial qualification in one of the selected building occupations

Percentage in target MOFs														
	MOF 2: Manufacturing, processing, repair/maintenance													
MOF 1: Raw material extraction	OF 7: Metal construction, plant construction, sheet metal construction, installation, fitters	OF 11: Elecrical occupations	OF 18: Construction, woodworking, plastics manufacture and processing	Other Manufacturing, processing, repair/maintenance occupations	MOF 3: Occupations involving the operation and servicing of plants and machinery	MOF 4: Occupations involving the sale and marketing of goods	MOF 5: Transport, storage and security occupations	MOF 6: Hotel/restaurant and cleaning occupations	MOF 7: Office and commercial occupations	MOF 8: Technical & scientific occupations	MOF 9: Legal, management and business occupations	MOF 10-12: Media, humanities, social sciences, arts; healthcare, social and personal care; teaching	Total	Number of cases in 2008 micro-census
0	0	0	6,1	64,8	2,7	1,7	16,3	4,8	0,8	0,9	0	1,9	100	323
2	38,7	0,5	4,9	7,2	16,7	2,6	15,4	1,8	3	4,7	1,8	0,7	100	9468
0,7	3	39*	1,5	5	4,3	4,3	9,9	1,8	4,5	20,8	3,4	1,8	100	9637
1,7	2,4	0,1	55,3	7,6	4,2	2,8	16,5	2	2	2,1	1,8	1,4	100	14040
0,4	4,3	6,4	0,6	11,8	6,6	5	5,3	1,7	6	42,4	6,7	2,9	100	7800
0	0,4	0	0	1,3	0,7	9,1	6,3	3,7	17,1	54,9	2,4	4	100	1628
3,4	0	0,3	0	0,7	2,6	7,1	5,1	6,6	11,1	56,8	1,9	4,3	100	993
2,3	0,8	0	0	3,2	1,2	3,5	4,8	73,4	2,6	1	3,3	3,9	100	650
1,3	10,4	9,7	19,1	7,6	7,1	3,8	12,1	3,1	4,2	16,8	3	1,8	100	44539
ıpations														
0	0	0	8,8	70,1	3,8	0	17,3	0	0	0	0	0	100	152
2	39	0,6	5,2	7,1	15,8	2,7	15,3	1,8	3,1	4,8	1,9	0,8	100	7740
0,8	3,1	40,7	1,7	5,3	4,9	4	10,2	1,9	3,6	19,2	3	1,7	100	8095
2	2,3	0	56	6,7	4	2,9	16,6	1,8	2	2,3	2,2	1,2	100	10612
0,3	4,1	6,1	0	3,4	11,2	3,1	3,3	0	5,1	54,1	7	2,3	100	927
0	0,4	0	0	1,5	0,9	8,1	5,6	3,8	15,8	55,8	3	5,1	100	998
0	0	0,5	0	0,7	2,9	5,9	4	8	11	59,9	2,6	4,5	100	627
0	0	0	0	0	0	0	4,6	95,4	0	0	0	0	100	133
1,5	12,1	11,7	22,2	6,3	7,4	3,4	13,4	2,4	3,5	12,2	2,5	1,5	100	29284

Source: 2008 Microcensus; BIBB calculations based on extrapolated figures, the number of cases reflects the actual sample size.

*Sample text: 39% of people with an IVET qualification in an "electrical occupation" remain in this field. This represents the percentage of 'stayers'.
The percentage of 'stayers' in the major occupational field is always shaded dark grey.

Table 36: Occupational flexibility: Original occupations of those working in the selected building occupations

Percentages from the original MOFs												
	Occupational domain 1: Production occupations						Occ. Domain 2: Primary services (MOF 4-7)	Occ. domain 3: secondary services		Unskilled (ISCED 1-3a)	Total	Number of cases in 2008 micro-census
		MOF 2: Manufacturing, processing, repair/maintenance				MOF 3: Occupations involving the operation and servicing of plants and machinery						
Occupational field of the occupation currently exercised	MOF 1: Raw material extraction	OF 7: Metal construction, plant construction, sheet metal construction, installation, fitters	OF 11: Elecrical occupations	OF 18: Construction, woodworking, plastics manufacture and processing	Other Manufacturing, processing, repair/maintenance occupations			MOF 8: Technical & scientific occupations	Other secondary services (MOF 9-12)			
Stoneworking, construction materials production, ceramics, glass related occupations	0	3,8	2	7,7	52,3	0,9	0	0	1,2	32	100	369
Metal construction, plant construction, sheet metal construction, installation, fitters	0,7	43,3	3,4	4	6,9	7,3	3,9	4,4	0,9	25,2	100	8347
Electrical occupations	0,1	0,8	65.9*	0,1	1,1	3,5	0,9	9,8	0,3	17,5	100	5676
Construction, woodworking, plastics manufacture and processing occupations	1	3,7	1,1	63,1	3,3	1,4	1,4	0,5	0,2	24,2	100	12086
Technicians	0,5	4,9	19,5	2,8	4,7	7,5	3,5	47	2	7,6	100	7836
Specialist skilled technicians	0	0,4	0,7	0	0	1,7	0,4	82,4	0	14,5	100	823
Engineering draughtsmen, related occupations	1,4	0,7	0,6	0,4	1,2	1,6	1,4	72	2,8	17,9	100	835
Cleaning and waste disposal occupations	1,5	1	0,9	1,9	7,3	1,9	25,2	1,8	8,6	49,9	100	10873
Total	0,9	9,9	12,3	18,1	5,1	3,8	7,7	12,9	2,7	26,6	100	46845
Of these, occupations belonging to the finishing sector												
production, ceramics, glass related occupations	0	4,4	0	9,1	63,7	0	0	0	2,6	20,1	100	168
Metal construction, plant construction, sheet metal construction, installation, fitters	0,3	63,7	1,9	1,4	5,4	6,9	0,6	5,3	0	14,5	100	4340
Electrical occupations	0,1	0,7	65,4	0,1	1,1	3,8	0,8	9,6	0,2	18,2	100	5093
Construction, woodworking, plastics manufacture and processing occupations	0,5	3,1	1	69,7	2,3	0,6	1	0,6	0,3	21	100	9090
Technicians	0,7	7,7	5,9	4	6,2	14,8	3,4	50,5	0,3	6,3	100	1012
Specialist skilled technicians	0	0,6	0,6	0	0	2,7	0,6	80,9	0	14,6	100	511
Engineering draughtsmen, related occupations	0	0,5	0	0,6	1,3	1,8	2,1	74,5	4,2	15	100	548
Cleaning and waste disposal occupations	0	0	0	0	0	0	93,7	0	0	6,3	100	134
Total	0,3	15,1	17	31,2	3,2	3,4	1,6	9,9	0,3	17,9	100	20896

Source: 2008 Microcensus; BIBB calculations based on extrapolated figures, the number of cases reflects the actual sample size.

*Sample text: 65.9% of those working in an "electrical occupation" recieved their original training in this field. This represents the percentage of 'stayers'.
The percentage of 'stayers' in the major occupational field is always shaded dark grey.

Table 35 show the (major) occupational fields into which workers with initial training in a selected building occupational field migrate, Table 36, by contrast, shows from which occupations workers now working in a selected occupational fields have been recruited. As before, Table 36 is also divided into two sections: the upper one shows the original occupations of those currently working in the occupational fields of the selected building occupations, while the lower one shows the corresponding occupational flexibility within the building occupations. Both sections take account of the percentage of unskilled workers (in both sections, the third column from the right in Table 36).

Comparing the 'stayers' (the grey shaded cells) in Table 35 and Table 36, one can see that the percentage of 'stayers' in the (major) occupational field in Table 36 is always above the corresponding percentage in Table 35. Taking "electrical occupations" as an example, this means that though only 39% of people with an IVET qualification in an electrical occupation actually work in "electrical occupations", they represent 65.9% of those working in this field. This similarly applies for the other occupational fields of the selected building occupations. Although only about half of the skilled blue collar workers actually stay in the occupation in which they originally trained, they still account for two-thirds of those working in the corresponding occupational fields. The remaining one third is recruited for the most part from workers without any formal qualifications, and less from skilled workers from other occupations.

Comparing the original occupations of the occupational fields of the selected building occupations (upper section of Table 35) with the recruitment occupations of the apprenticeship frameworks within the occupational fields (lower section of Table 36), we see that the percentage of 'stayers' is on average somewhat higher in the building occupations than in the corresponding occupational field. In addition, the participation rate of unskilled workers is generally lower, on average 8.7%. This means that the percentage of specialised and skilled workers in the building occupations is somewhat higher than in the superordinate occupational fields. As a result of the above mentioned "occupational loyalty" in the selected building occupations, the percentage of specialised and skilled workers in the building occupations is also higher than in the other occupations performing similar work in the same occupational fields.

The differences in occupational flexibility between the occupational fields of the selected building occupations and the occupational categories within the occupational fields are of particular relevance for generating the labour supply projection for the selected building occupations taking occupational flexibility into account, as the projection cannot be done for single occupational categories but only for occupational fields. The occupational flexibility found in 2008 is kept at the same level throughout the projected period. This only makes sense when this flexibility matches that of the building occupations in the occupational fields. From the perspective of the occupation originally trained for, this is not always the case with "technicians", "engineering draughtsmen" and "cleaning and waste disposal

occupations". In these occupational fields, those working in the selected building occupations do not account for more than 50% of all those working in the corresponding occupational field (see Table 32). Similarly, from the perspective of original occupations, great differences in the flexibility rates of the occupational categories and their three superordinate occupational fields exist. To gain a projection of the potential labour supply for the building occupations, it therefore makes sense to only project those occupational fields where more than 50% of those working in them actually work in the selected building occupations (see Table 33). Similarly, a comparison between labour supply and demand can only be done for the selected building occupations in the following occupational categories: "metal construction, plant construction, sheet metal construction, installation, fitters", "electrical occupations", "construction, woodworking, plastics manufacture and processing occupations", "engineering draughtsmen and related occupations", and "specialist skilled technicians". These represent some 94% of the labour force working in the selected building occupations[74]. One also needs to be aware of the fact that the labour supply for the building occupations, assuming the same occupational flexibility rates as 2008, could be slightly lower than projected, due to the fact that the selected building occupations benefit less from the influx of unskilled workers than the superordinate occupational field in general (see Table 36).

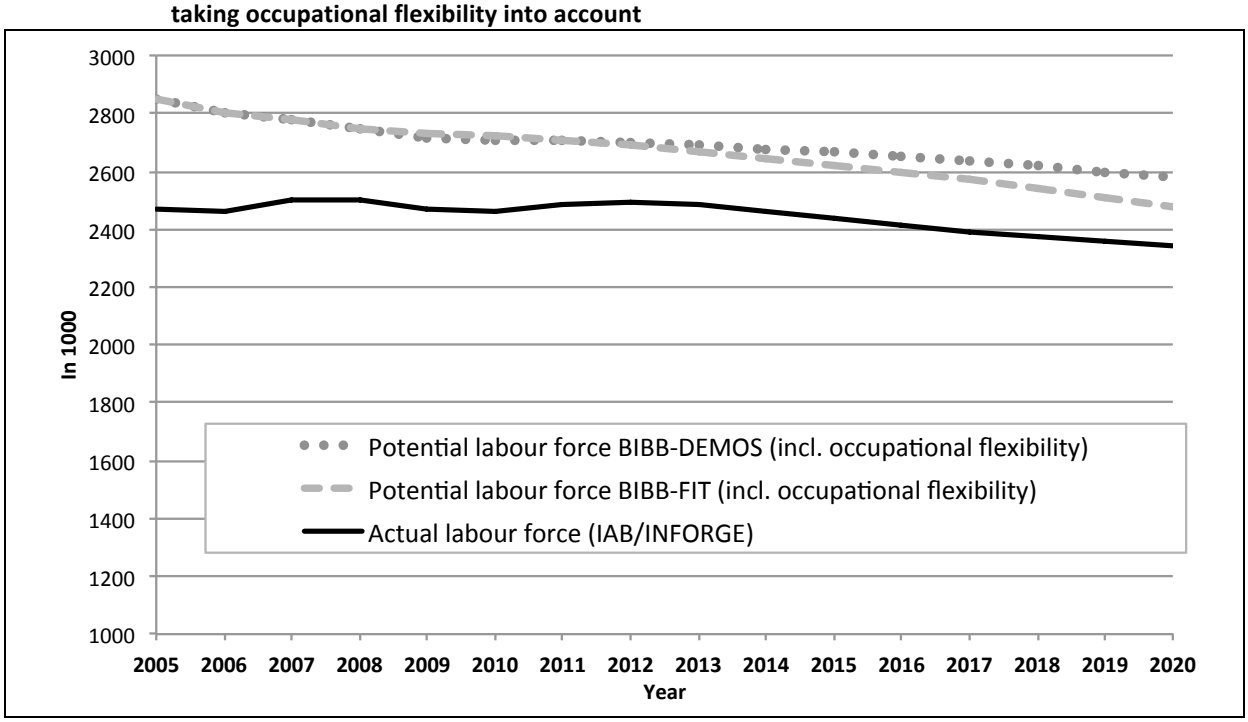
7.2.5.4 Labour supply projection for the selected building occupations, taking occupational flexibility into account

Through taking into account the immigration of unskilled and 'external' (i.e. those from other skilled occupations) workers and the emigration of skilled workers into and out of the five occupational fields relevant for the building occupations, one can compare the development of supply and demand for workers in the building occupations. Figure 34 shows the potential labour supply to 2020, taking this occupational mobility into account. As with the labour supply projection for workers with a skilled IVET qualification (cf. Section 7.2.5.2), the 2008 percentage of the selected building occupations within the occupational fields "metal construction, plant construction, sheet metal construction, installation, fitters", "electrical occupations", "construction, woodworking, plastics manufacture and processing occupations", "engineering draughtsmen and related occupations", and "specialist skilled technicians" was kept constant for the whole projection period, with the calculated stock of workers in all five occupational fields being added together. The starting stock of workers was then projected using the projected development in these occupational fields. To gain a better picture of possible labour shortages, in Figure 34 labour supply was compared with labour demand on the basis of the reference scenario. As with the labour supply projections, this scenario is taken from the QuBe project (BIBB-IAB Qualification and Major Occupational Field Projections) and projects the demand for labour in the selected building occupations (as with the supply model) pro rata for the five selected occupational fields. An in-depth explanation of the methodology used is to be found in the next chapter (cf. Chapter 8.1).

[74] Source: 2008 microcensus of the Federal Statistical Office.

What can be seen is that both supply and demand will be lower compared to 2010. While the BIBB-DEMOS model shows labour supply dropping by about 5% between 2010 and 2020, the BIBB-FIT model shows it dropping by 9%. This means that there would be an excess supply of workers amounting to 240,000 (BIBB DEMOS) or 140,000 (BIBB-FIT) in 2020. In view of a total labour force of 2.34 million, this corresponds to an excess supply of around 10% (BIBB-DEMOS) or 6% (BIBB-FIT).

Figure 34: Labour supply and demand projection to 2020 in the selected building industry occupations, taking occupational flexibility into account



Source: QuBe project, 2nd wave.

Figure 34 shows that, on the basis of the QuBe reference scenario, no mathematical labour shortage in the building occupations is to be expected in the period up to 2020. In the post-2020 period, assuming a continuation of current developments, greater shortages are however possible, due to the step-by-step exit of the baby-boom workers with their mainly middle skill levels from the labour market (see Figure 31 and Figure 33). Regional shortages or shortages due to a rise in demand as a result of greater investment in the building sector (see Chapter 8.1) are also possible, meaning that it could become necessary in such an event to mobilise further supply potential for building occupations.

7.3 Qualitative analyses of qualifications in existing IVET programmes

Katrin Rasch, Rolf R. Rehbold, Susanne Rotthege

The objective of the qualitative analysis is to identify and structure existing qualifications developed by skilled blue collar workers in the building industry via currently available IVET and CVET programmes. In view of Germany's differentiated VET system (described in Chapter 6) with its standardised occupational profiles and its wide range of CVET opportunities, it is seen as a good idea to approach the analysis in two steps.

In a first step, the standardised (throughout Germany) apprenticeship frameworks (*Ausbildungsordnungen*) and their associated national curricula (*Ausbildungsrahmenpläne*) for the selected occupations were evaluated with regard to references to energy-efficiency activities executed in connection with refurbishing an existing house or building a new one.[75] These apprenticeship frameworks provide information on the main focuses of in-company training in the respective apprenticed occupations.[76]

In a second step (cf. Chapter 7.4) the CVET level was looked into, with two complementary analysis methods being used. In connection with the master qualification characterising the German skilled crafts sector (and also the industrial sector), the respective master craftsmen training frameworks were analysed. To gain an overview of the wide range of CVET offerings, the various providers of relevant CVET courses were requested to provide information on their training offerings and the content thereof.

The resultant overview shows which occupations and CVET offerings already contribute to achieving the 2020 goals and in what form this is being done.[77] The evaluation took place using the above steps. In the following the procedure used to evaluate the apprenticeship frameworks is described in detail before we go on to present our findings. Chapter 7.4 widens this perspective by looking at the CVET market. The methodology used in this part of the evaluation is presented at the beginning of the section.

7.3.1 Methodology used in the qualitative analysis apprenticed occupations

To find out which qualifications already exist in the current apprenticed occupations, the evaluation matrix presented in Chapter 7.1 was used. The apprenticeship frameworks for the apprenticed occupations identified as being relevant were analysed with regard to the technologies used and their involvement in the construction processes looked into.

In the first evaluation step the relevant frameworks were studied (desk research), pinpointing with which of the relevant energy-saving and energy supply technologies the

[75] The reasons for selecting certain occupations are explained in Chapter 7.1.

[76] The apprenticeship frameworks include the national curriculum and the respective skill profiles. Moreover the apprenticeship framework provides details on the formal framework of an occupation, such as its official name, IVET duration and examination requirements (cf. Sloane / Twardy / Buschfeld 2004, p. 120).

[77] It should however be pointed out that while certain apprenticeship frameworks are very up-to-date, to a great extens covering renewable energy focus we are concentrating on, other frameworks date back to the 1980's or 1990's and therefore hardly cover the focus at all.

individual occupations worked with and in which processes of the building refurbishment / construction value chain (e.g. the advisory process, planning, execution, acceptance) these occupations were involved. First identified were the skills listed in the apprenticeship frameworks. These were then entered in the individual cells of the evaluation matrix (see Chapter 7.1)[78] i.e. an exact mapping of qualifications to the different categories and subcategories of building work and process steps considered was done, to the extent this was possible on the basis of the documents available.

This evaluation step was carried out separately for each occupation, meaning that, once all evaluations had been completed, a database existed containing all occupations and their respective skills, all in relation to the project's objectives.[79]

In the evaluation, we also had to take into account the fact that the qualifications listed in the apprenticeship frameworks were not always formulated in the same depth - certain qualifications were defined in great detail, while others were formulated on a more general level. During the evaluation, we tried as far as possible to standardise the formulation depth of the different apprenticeship frameworks. The reason for the different levels is that the apprenticeship frameworks have been created over the years, and not all at once. The oldest apprenticeship framework looked at dates back to 1985, while the latest ones are from 2012. The result is that, due to developments in the design of the basic curriculum principles over the last 15 years, different understandings of qualifications and different relationships to the categories of building work looked at are to be found.[80] This also has to be taken into account during the evaluation.

Moreover, due to certain technology-neutral formulations (see Chapter 6), it was not always possible to establish a 1-1 relationship with the categories of building work used in the matrix. In an attempt to prevent any misunderstanding arising, in such cases we wherever possible contacted the trade associations (chambers, guilds, etc.) concerned to find out in what form the qualifications listed in the apprenticeship frameworks related to the categories of building work looked into in the context of the project.

Table 37 illustrates this evaluation step, using a joiner as an example.

[78] The relevant paragraphs in the apprenticeship frameworks are cited, allowing the original wording to be traced.

[79] The following evaluations are not to be understood as a complete overview of all qualifications found in a certain apprenticed occupation. The respective apprenticeship frameworks were filtered to find the qualifications relevant to the project.

[80] The apprenticeship framework for the "concrete block and terrazzo manufacturer" dates back to 1985, while the latest version of the one for the chimney sweep was published in 2012.

Table 37: Example of an evaluation in step 1

Apprenticed occupation: joiner			Processes					
			Provision of advice	Planning	Execution	Customer acceptance	Repair and maintenance	Disposal
Building work categories	A building's envelope	Windows and doors		Selecting constructions, especially for frames, carcasses or stand (§ 4 No. 6)	Producing and assembling elements (§4 No. 11)			
	A building's infrastructure	Walls and floors	Discussing specific situations, explaining the points in question (§ 4 No. 7)	Producing and using diagrams, plans and drawing (§ 4 No. 6)		Compiling customer acceptance protocols (§ 4 No. 14)	Determining, assessing and documenting malfunctions and damage, carrying out repair and maintenance work (§ 4 No. 15)	Sort and store waste material and have it disposed of (§ 4 No. 8)
			Accepting and processing complaints (§ 4 No. 16)	Selecting constructions and fittings (§ 4 No. 6)		Handing over completed work to the customer, providing him with care, maintenance, and operating instructions (§ 4 No. 16)	Preparing, executing and documenting maintenance work (§ 4 No. 15)	
			Informing customers of the company's scope and providing design guidance (§ 4 No. 15)	Setting up the workplace, making sure it is safe, keeping it clean and tidy, vacating it (§ 4 No. 8)			Preparing and executing refurbishment work (§ 4 No. 15)	
			Recording and passing on customer requirements (§ 4 No. 15)	Being able to distinguish between different types of wood and wooden materials and select the appropriate ones in line with the job at hand (§ 4 No. 9)			Executing wood preservation measures (§ 4 No. 13)	
			Producing and presenting drafts and samples pursuant to customer requirements (§4 No. 6)		Carrying out measurements, checking materials, veneers, semi-finished products (§ 4 No. 9)			
			Coordinating work with other trades and others involved (§ 4 No. 7)		Assembling parts (§ 4 No. 11)			
			Informing customers of the company's scope and providing design guidance (§ 4 No. 15)	Configuring, operating and maintaining tools, machines and other equipment (§ 4 No. 10)				
			Handing over completed work to the customer, providing him with care, maintenance, and operating instructions (§ 4 No. 16)	Producing models, deciding how to build things, checking technical feasibility (§ 4 No. 6)	Carrying out fitting work, and executing finishing touches (§ 4 No. 11)			
			Accepting and processing complaints (§ 4 No. 16)	Recording, planning and preparing jobs, taking into account technical requirements and the amount of material needed (§ 4 No. 7)	Executing wood preservation measures (§ 4 No. 13)			
			Handing over completed work to the customer, providing him with care, maintenance, and operating instructions (§ 4 No. 16)		Selecting and installing insulation material and sealants (§ 4 No. 14)			
					Checking whether all customer requirements have been complied with and documenting the work done (§ 4 No. 16)			
					Performing intermediate and final controls pursuant to the order specifications, evaluating and documenting the results (§ 4 No. 17)			
		Electrics			Installing and connecting up electrical facilities and appliances pursuant to the manufacturer's instructions (§ 4 No. 14)			
					Complying with safety regulations when working on electrical facilities and appliances (§ 4 No. 14)			

As can already be seen in this example, qualifications are presented in a very comprehensive manner. Although supplying important information, a more compact form is needed for the subsequent presentation.

The result was that, once all apprenticeship frameworks identified as being relevant had been evaluated, a second step was performed. This involved looking at the individual building phases and checking whether it was possible to structure the individual phases in greater detail so that they could be used for all occupations.

In doing so, the findings of evaluation step 1 were again used as a basis. The verbs used in the individual process steps were filtered and the process steps described in greater detail. The verbs thus identified were then generalised and grouped into new sub-processes within the already existing process categories. It was thus possible to build more exact process steps. Table 38 illustrates the mapping of the verbs to the individual process steps.

This in turn enabled us to compile the above table at a more generalised level and in a more compact form, while at the same time structuring the overall construction / refurbishment process in greater detail.

Table 38: Evaluation step 2: Table of verbs

Provision of advice			Planning				Execution (1)				
Recording customer requirements (BEFORE execution)	**Order-related customer advice**	**Providing customers with information (AFTER execution)**	**Planning and order preparation** ("Planning concepts")	**Taking requirements / standards into account (**Iimplementing concepts")	**Choice of measures**	**Coordinating work with other trades working on the same project**	**Preparatory / organisational measures; Choice of materials; Setting up the building site**	**On-site preparatory measures / excavation work**	**Preparing materials**	**Processing materials**	**Assembling and installing components and systems**
Recording customer requirements and passing them on within the company	Advice customers	Advise	Design/Conceptual work	Read	Prepare	Coordinate	Choose	Prepare	Mark	Process	
Check	Negotiate	Point out	Calculate (forecasting of costs)	Plan	Determine	Recognise contexts	Differentiate	Smooth	Punch	Perform	Install
Provide (initial) information	Definition of (contract goals	Clarify	Calculate (post calculations)	Apply standards	Assess	Take into account	Draft	Dig	Prepare	Set up	Stamp
	Offer services	Present	Prepare and submit offers	Read technical documentation	Evaluate		Prepare diagrams	Level	Cut to size	Execute	Assemble
			Conclude contracts		Estimate times		Make available			Cover	Erect
			Bill services				Assess			Clad	Extend
			Design technical work plans (using computers)				Ascertain			Treat	Fit in
			Analyse order handling				Prepare			Shape	Fix
							Set up			Bore / drill	Manually insert
			Tender and award contracts				Structure			Countersink	
										Manufacture	

Execution (2)					Quality assurance and customer acceptance	Repair and maintenance			Disposal
Connecting up systems	**Protection / Sealing / Waterproofing / Insulation**	**Commission-ing**	**Documentation / system tests**	**Clearing up and vacating the site**	**Quality assurance and customer acceptance**	**Determining repair and maintenance needs (diagnosis)**	**Performing repair and maintenance work**	**Documenting repair and maintenance work**	**Disposal**
Installation	Seal / waterproof	Commission	Document	Clear up and vacate	Check	Recognise	Perform	Document	Identify
Production of systems and equipment	Protect		Document final results	Take down	Perform measurements	Estimate	Replace		Dispose of
	Grout		Adjust	Disassemble	Hand over	Check	Add to		Assess
	Cover / clad		Check whether customer requirements have been fulfilled		Compile (acceptance) reports	Analyse	Install		Make available
	Check / test		Perform measurements			Test	Maintain		
	Aftertreat		Check components with regard to quality and size			Optimise	Configure		
	Brace					Ascertain	Replace		
	Cover / coat					Determine	Adjust		
	Insulate					Assess	Fine-tune		
	Coat						Substitute		
							Treat		

A second step enabled us to map the qualifications already identified in evaluation step 1 to the individual sub-processes. This more detailed break-down of the processes ended up with a table in which we only needed to tick the relevant process steps. This greatly shortened the duration of the evaluation, and also enabled us to compare occupations with regard to the building work categories. Moreover this step helped us to greatly improve readability, with all occupations using the same scheme. Joiners are again used as an example for illustrating how the qualifications found in an apprenticeship framework are mapped to more detailed process steps:

Table 39: Evaluation step 2: Inclusion in the table of verbs

Apprenticed occupation: Joiner (§4 No. x)			Processes									
			Provision of advice		Planning			Execution (1)				
			Recording customer requirements (BEFORE execution)	Providing customers with information (AFTER execution)	Taking requirements / standards into account	Choice of measures	Coordinating work with other trades working on the same project	Preparatory / organisational measures; Choice of materials; Setting up the building site	On-site preparatory measures / excavation work	Preparing materials	Processing materials	Assembling and installing components and systems
Building work (sub)category	A building's infrastructure	Interior walls and floors	References in the apprenticeship framework	x (No 6, 15, 16)	x (No 16)	x (No 6,7)	x (No 6,7)	x (No 7)	x (No 6, 8, 9,12, 14)		x (No 11, 12)	x (No 9, 11)	x (No 11, 14)
			Wording in the apprenticeship framework	e.g. draw up and present drafts and sample, taking customer requirements into account	e.g. hand over finished work, provide the customer with maintenance, care and usage instructions	e.g. apply diagrams, plans and drawings; make use of technical documentation	e.g. draw up drafts and samples; check technical feasibility; determine the steps involved	e.g. coordinate work with other trades working on the same project	e.g. set up workplaces; differentiate between the different types and characteristics of materials; check on-site working conditions		e.g. prepare and pretreat parts	e.g. treat and process wood and other materials, either manually or with the help of machine tools	e.g. assemble and finish products using glass, semi-finished parts made of metal or plastic in preparation for final installation

Processes								
Execution (2)					Quality assurance and customer acceptance	Repair and maintenance			Disposal
Connecting up systems	Protection / Sealing / Waterproofing / Insulation	Commission-ing	Documentation / system tests	Clearing up and vacating the site	Quality assurance and customer acceptance	Determining repair and maintenance needs (diagnosis)	Performing repair and maintenance work	Documenting repair and maintenance work	Disposal
	x (No 14)	x (No 11, 12, 13,14)	x (No 8)	x (No 9, 11, 14,16, 17)	x (No 14, 16)	x (No 15)	x (No 15)	x (No 15)	x (No 8)
	e.g. select and apply fixing material in accordance with the building's circumstances	e.g. protect surfaces from damage; perform chemical-based wood preservation measures	e.g. clear up and vacate workplaces	e.g. Perform interim and final checks in accordance with the contract; assess and document results	e.g. compile customer acceptance reports; hand over finished work to the customer	e.g. Prepare, perform and document refurbishment work, taking into account the type and style of building and customer requirements			e.g. sort and store waste and have it disposed

Once the evaluation had been completed for all occupations, the skilled craft trade associations in question were again contacted.[81] Their representatives were requested to

[81] No trade association representatives of purely industrial occupations were available for evaluating the findings.

check the FBH findings and, where necessary, to provide additional information.[82] The results of these meetings / telephone discussions were then integrated into the evaluations.
In addition, the overall construction process developed in the context of analysing the apprenticeship frameworks was discussed with the respective experts (cf. Table 38), going through the individual phases involved. Where deemed necessary, certain process steps were extended, while others, deemed not to be of any great relevance, were deleted. For instance, in the discussions with the representative of the electrician's guild, the step of installing a system was broken down into three separate steps: "installing the system", "connecting up the system" and "commissioning the system". Once this had been done, the overall construction process was described in greater detail, with all process steps being fully defined.

Once this evaluation had been completed, we were able to see which occupations were involved in which processes in which building work category. What quickly became apparent was that a whole range of different occupations were involved in each building work category and subcategory. For example, in the electrics sub-category, not only "electronics technicians" were listed as being involved but also "plant mechanics for sanitary, heating and air conditioning systems" and joiners. What also became clear was that the individual trades, in relation to the individual sub-category, were involved in very different ways, with an "electronics technician" doing for example other electrical work than a joiner. Whereas the joiner is listed as being qualified to install and connect up electrical equipment and appliances, an "electronics technician" has much more advanced electrical qualifications enabling him also to install and configure building management and remote management systems.
For this reason, in analogy to a more differentiated presentation of the construction process, a categorisation of building work was made in the course of the evaluation, identifying individual work areas.[83] To do this, various points of reference were established for all occupations listed as being relevant for a certain area of building work. These points of reference are then used to show which activities the individual occupations perform in any one sub-category and how the occupations, through the execution of these activities, differ from other occupations also involved in the same sub-category. This led for instance to the “electrics" sub-category being given a point of reference "simple electrical connections". Joiners were then linked with this. By doing this, it quickly becomes clear that though joiners install equipment and appliances, their connection to the mains (within the "electrical

[82] No reply was received from the following trade associations: the Federal Glaziers' Craft Association (Bundesinnungsverband des Glaserhandwerks), the Federal Refrigeration Engineering Association (Bundesinnungsverband des deutschen Kälteanlagenbauerhandwerks), the Federal Interior Decorating Association (Zentralverband Raum und Ausstattung) and the Federal Stonemason Craft Federation (Bundesinnungsverband des Deutschen Steinmetz- und Steinbildhauerhandwerks)

[83] A differentiation was made in the following subcategories: "electrics“, "heating“, "air-conditioning and refrigeration", "photovoltaic systems", "solar heating systems", "geothermal systems", "biomass systems", "CHP systems" and "wind turbines". The decision to make such a differentiation was made on the basis of the occupations involved.

systems from the mains to the handover interface" point of reference) is the sole responsibility of an "electronics technician". Through this differentiation via points of reference, the attempt was made to illustrate the relationship level of individual occupations to specific building work subcategories. The decision to carry out this additional differentiation was prompted by the need to identify gaps and the resultant need for action. Against this background, this step helps to subject individual occupations to a differentiated perspective.

The presentation of the results in the subsequent chapters is limited to the more compact matrix achieved at the end of evaluation step 2. Where necessary, additional explanations are provided, linking this step with the previous one.

Results are structured primarily according to the sub-categories, with occupations being mapped to these. The ensuing analysis of the overall construction/refurbishment process is done focused on the individual building work sub-categories, mapping the qualifications existing in the different occupations to the corresponding processes. It should be noted here that in Chapters 7.3.3, 7.3.4 and 7.3.5 the focus is solely on the qualifications needed in the apprenticed occupations at journeyman level. Master-level CVET, with the specific qualifications needed in the field of advisory services and planning, are not dealt with. These are the subject of Chapter 7.4.[84]

IMPORTANT: The order in which the occupations are specified in the respective fields of building work does not in any way reflect their importance with regard to the field considered. Occupations are listed in the order they were evaluated.

7.3.2 Evaluation results independent of a specific field of building work

Before presenting the results of the analysis of the apprenticeship frameworks, a few skills common to all frameworks are presented. These qualifications are supposed to be taught throughout the apprenticeship, and to be used in other learning areas.
Alongside the two fields "Vocational training, labour and collective agreement legislation" and "Structure and organisation of the company providing the apprenticeship", these are "Workplace health and safety" and "Environmental protection". The latter two are looked at here in greater detail.
For the building occupations in question, safety and prevention play a major role, resulting in their inclusion in all process steps. Also included here are preventive fire protection measures.
The avoidance of work-related negative environmental effects is also a topic common to the whole construction process, and involves making use of all opportunities to use energy and

[84] An overview of qualifications found in the relevant apprenticeship frameworks can be found in Appendix C. This contains both journeyman and master qualifications.

resources in a manner friendly to the environment. A further focus is on avoiding waste and the environmentally friendly disposal of no longer needed materials and equipment.
In the evaluation of the apprenticeship frameworks and their relation to certain technologies, these topics are not explicitly covered. They should nevertheless be taken into account, as they are necessary for gaining an overall understanding of the frameworks.

7.3.3 Evaluation results in the "building envelope" building work category

Shell

The analysis of the occupations and the fields worked in showed that, of the occupations involved in a building's shell, some two-thirds were governed by the "Building industry IVET regulation" (*Verordnung über die Berufsausbildung in der Bauwirtschaft*). In addition, a few further occupations are assigned to this sub-category. These are also discussed below. To achieve a comprehensive analysis, the process steps detailed in Table 39 are looked at separately. Table 40 presents an overview of all occupations belonging to this sub-category, as well as mapping which processes the occupations identified here are involved in it.

Of all occupations concerned, very few are involved in the process of providing advice. One of the few exceptions here is the "metal worker". He advises customers / explains to them the further steps both before and during the execution of the contracted work. The latter work is also performed by the "building materials tester" and the "painter and varnisher".[85] The chimney sweep apprenticeship framework also lists advising customers as a qualification. Within the "building shell" sub-category, this includes providing advice on combustion and ventilation systems. All other identified occupations do not cover the "provision of advice" process - as defined in Chapter 7.1 - in their respective apprenticeship frameworks.

Planning tasks in association with a building's shell are by contrast executed by many more different occupations. These include the 2-year apprenticed occupations of the "construction finishing worker" and the "building construction worker" with their various specialisations.[86] These all refer to qualifications and rules and regulations needing to be complied while working, and correspond to the planning step "Taking requirements into account". The choice of measures is also the responsibility of this occupational group, with the necessary time and manpower needing to be estimated and the necessary steps determined. Last but not least, workers belonging to this occupational group are responsible for visibly checking preparatory work done by other trades. This work corresponds to the planning skill "coordinating execution with those involved".

[85] It should be pointed out here that a "painter and varnisher" apprenticeship in the context of a 2-step course is based on the 2-year "building and object coater" apprenticeship, whereby the "building and object coater" examination after two years is to be seen as an intermediate examination.

[86] Apprenticeships in the building sector are similarly organised as 2-step courses: where a 3-year apprenticeship is involved (for example for carpenters), the 2-year "construction finishing worker" apprenticeship represents the first step.

The 3-year apprenticeships based on these occupations[87] and their involvement in constructing a building's shell go further, adding depth to the planning activities already taught in the first (2-year) stage. This includes the explicitly mentioned skill of taking measures to improve processes and to coordinate work with other trades involved in the building project. Other occupations very much involved in the planning of a building project are the "building materials tester" (with a focus on geo-technology and cement and concrete technology, the "metal worker" and the roofer. All three occupations cover the planning process in all three sub-aspects. Both occupations therefore explicitly cover the qualifications of recording what needs to be done and checking the requirements with regard to their feasibility. In a similar vein, the need to take technical documentation into account and to coordinate work with other trades is explicitly mentioned.
With regard to the planning process, the chimney sweep covers the application of fire and other cross-trade regulations, as well as compiling and evaluating technical documents. The choice of suitable measures, together with the coordination of other trades performing work beforehand or afterwards, is also listed in the apprenticeship framework.
Occupations not included in the planning process are the "concrete block and terrazzo manufacturer" and the "pre-fab concrete element manufacturer"[88], while the "masonry waterproofer" only covers certain parts of this step. The "painter and varnisher" is also involved in parts of the planning process, though is not involved in coordinating work on a building's shell with other trades.

Turning to the execution of work on a building's shell, there are occupations covering nearly all execution steps, while other "support occupations" are responsible for specific execution aspects. This is the reason why certain occupations are a lot more involved in the planning of the work on a building's shell, as seen in Table 40.
All trades involved in execution have training in setting up a building site or their workplace. In addition, a majority of the occupations also have the qualifications to select the materials needed on the building site, to carry out measuring work and to select appropriate tools. [89]
A number of the occupations found working on a building's shell are also involved in the preparatory work. These include the "building construction worker" with his various specialisations, who is involved in the initial excavation work. Responsible for taking and testing building site samples, the "building materials tester" is also involved in this process step, as are the "masonry waterproofer" and the "metal worker", checking that the surfaces to be sealed / covered are suitable for such. In addition the "metal worker" supplies both fixed and movable support constructions, used for example for the walls of the shell or for

[87] These include the carpenter, the "concreter", the "building mechanic for demolition and concrete cutting", the "furnace and chimney builder" and the "mason".

[88] These two occupations are covered by an apprenticeship framework dating back to 1985.

[89] These include the "construction finishing worker", the "building materials tester", the "masonry waterproofer", the "pre-fab concrete element manufacturer", the "concrete block and terrazzo manufacturer", the roofer, the "building construction worker", the "metal worker" and the "civil engineering worker".

applying insulation. The preparatory work done by the roofer involves sealing surfaces against ground moisture and non-pressing water.

The next execution steps in constructing a building's shell are done sequentially, with the material needed for the next steps often being prepared on site. For example a "building construction worker" will build casing, lay rebars for reinforcing concrete, and pour and spread concrete. In the same vein, he will also measure and mark wood, before cutting it into shape for making joints.[90] The "construction finishing worker" specialised in carpentry and the next-stage occupation of a carpenter also have such woodworking qualifications.

The "pre-fab concrete element manufacturer“ and the "concrete block and terrazzo manufacturer" also have these preparatory qualifications, mixing concrete, adding rebars, working with metal to produce, anchor and install concrete elements.

The preparatory work conducted by the “masonry waterproofer" involves preparing the necessary sealing and insulation materials. These need to be measured out and cut to size before being installed. He will also mix concrete, re-point walls and work with wood.

The "metal worker" is very much involved in preparing and processing the materials used in constructing a building's shell. Alongside punching and marking workpieces, his qualifications also include processing them with machine tools and by hand. As the two steps - the preparation of the material and its subsequent processing - are not clearly distinguishable in the work of a "metal worker", they are viewed together in the analysis of the "metal worker" apprenticeship framework. The "metal worker" is also involved in assembling building elements.

The roofer is similarly listed as having qualifications relating to a building's shell, mixing cement and mortar for laying stones and render for coating walls.

The "painter and varnisher" will execute processes for drying (parts of) buildings and apply metal connection techniques. The latter correspond to the "assembly" process step.

This step also illustrates the lack of any concrete delimitation between individual process steps. While the "painter and varnisher" is also involved in installation operations, for instance installing composite insulation and finish systems, the same paragraph in the apprenticeship framework also refers to coating surfaces and applying special coatings - work belonging to the next process step, "protecting / sealing / treating surfaces". The apprenticeship framework also contains references to anti-corrosion processes which play an important role where metal connecting elements are used in a building's shell.

Once again, the building occupations of the "construction finishing worker" and "building construction worker" can be mapped to this step,[91] with the protection and sealing of wooden, concrete and reinforced concrete elements against damp and the application of different forms of coating / cladding to walls all represented in the different specialisations.[92] Anti-corrosion measures also belong to these qualifications.

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[90] This also applies to the "concreter", the "furnace and chimney builder" and the "mason".

[91] Here as well the transition from the last step is not clearly defined.

[92] The "construction finishing worker" specialised in carpentry work for instance will carry out varnishing, impregnating and sealing work on surfaces. Other building occupations do not cover this skill to such an extent.

The "masonry waterproofer" is also listed as having similar qualifications, knowing how to apply wood preservation and how to waterproof buildings. The "pre-fab concrete element manufacturer" and the "concrete block and terrazzo manufacturer" are also involved in treating surfaces, with their apprenticeship frameworks specifying the polishing, sanding, hydrophobisation and re-pointing of surfaces.
Last but not least, the "metal worker" needs to be mentioned in association with this process step, as he is also responsible for carrying out anti-corrosion measures or for protecting surfaces through mechanical or chemical procedures.
Execution always ends with the documentation and quality assurance of the work performed. This process step belongs to the majority of occupations identified as being relevant.[93] A further execution step common to all occupations involves clearing up and vacating the building site.

Only one of the occupations identified as being relevant to the building shell sub-category - the chimney sweep - is listed as performing the quality assurance and customer acceptance step (i.e. handing over the work to the customer). The chimney sweep is qualified to inspect systems and buildings with regard to compliance with fire protection, emission, and health & safety standards and to carry out the necessary measurements.

In the area of a building's shell, maintenance and repair is only covered by a few occupations, though is often to be found in the 3-year apprenticeships offered by the building trade. The apprenticeship frameworks of the following occupations list the skill of identifying buildings (and parts thereof) worthwhile preserving and carrying out the necessary preservation work: the carpenter, the "concreter", the "furnace and chimney builder" and the "mason". These occupations thus contribute to establishing which maintenance measures are needed. Moreover the "concreter's" profile includes the skill of visually inspecting concrete surfaces for possible damage. Similarly the "furnace and chimney builder" and the "mason" also have the necessary skill to establish any possible damage and its cause(s).
A chimney sweep is also qualified to detect any faults in or malfunctioning of heating and ventilation systems and to document such in measurement and inspection protocols.
The "painter and varnisher" is also well placed to establish the need for maintenance work on a building's shell, being qualified to perform a diagnosis of any damage and to select the appropriate protection and remedial measures. He also has the requisite qualifications to actually perform such work on a building's shell, being able to repair damaged concrete surfaces and any cracks in concrete buildings or elements. "Metal workers" as well are involved in the maintenance of metal and steel structures and therefore of importance for work on a building's shell. Last but not least, the already mentioned 3-year building industry apprenticeships also teach skills associated with maintenance work on a building's shell.

[93] This step is not fulfilled by the "concrete block and terrazzo manufacturer" or the "pre-fab concrete element manufacturer".

"Concreters" for instance apply anti-corrosion protection and bonding courses, and remedy surface defects, while the “furnace and chimney builder” and the “mason” install lintels when making an aperture in an existing wall. "Masons" also carry out repairs to walls. The "building mechanic for demolition and concrete cutting" is also responsible for measures protecting buildings. On the other hand, the documentation of the maintenance work performed is not explicitly mentioned in the apprenticeship frameworks of the occupations concerned.

Qualifications in the disposal process step are listed for the "building mechanic for demolition and concrete cutting". These skills do not just involve the separation and storage of demolished materials, but also the disposal of contaminated waste. Further references to the disposal process are found in the roofer's apprenticeship framework, stating that a roofer is responsible for separating waste on the building site and for ensuring that dangerous substances are appropriately disposed of. A similar reference is found in the chimney sweep framework.

Table 40: Evaluation of all work involving a building's shell

				Processes																				
				Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
				Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into acount ("Design implementation")	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
Building work category	Building envelope	Shell [1]	Construction finishing worker, specialised in carpentry (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9,10 11)		x (No 11,12)	x (No10, 12)			x (No10, 11,12)		x (No 5, 19)	x (No 6, 11)					x (No 6)
			Carpenter, in addition to Construction finishing worker specialised in carpentry (38 No x)				x (No 5)	x (No 5)	x (No 6, 7)				x (No 7)					x (No 6)		x (No 5)			
			Building materials tester, specialised in geo-technology and specialised in cement and concrete technology (§ 5 No x)		x (No 15)	x (No 6, 7, 10)	x (No 6)	x (No 6)	x (No 6, 7, 8, 9, 10, 11, 12)	x (No 9, 12, 13)	x (No 8)						x (No14, 16)	x (No 6)					
			Pre-fabricated concrete producer (§5 No x)						x (No 6, 10, 11, 12, 13, 16)		x (No 10, 11, 12, 13, 16)	x (No 10, 13)	x (No 12, 13, 14, 16)		x (No 15)			x (No 16)					
			Concrete bloc and terrazzo manufacturer (§5 No x)						x (No 6, 10, 11, 12, 13, 16)		x (No 10, 11, 12, 13, 16)	x (No 10, 13)	x (No 12, 13, 14, 16)		x (No 15)			x (No 16)					
			Roofer, specialised in roof, wall and waterproofing technology (§ 4 Para. 1 No x)			x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8,9)	x (Abs, 2 No 1 b, e)	x (No 9)	x (No 9)	x (No 9)				x (No § 4 Para. 2 No 1g)	x (No 6)					x (No 6)
			Roofer, specialised in reed-thatch roofing techniques (§ 4 Para. 1 No x)			x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8,9)	x (Abs, 2 No 2 b, e)	x (No 9)	x (No 9)	x (No 9)				x (No § 4 Para. 2 No 2g)	x (No 6)					x (No 6)
			Building construction worker, specialised in (reinforced) concrete work (§ 5 Nox)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9, 10, 11)	x (No18)	x (No 10,11,12)	x (No 10, 11, 12)	x (No 10, 11, 12)		x (No 10,11,12)		x (No 10, 5 11,21)	x (No 6, 11)					
			Concreter (§ 28 No x), in addition to Building construction worker, specialised in (reinforced) concrete work				x (No 5)	x (No 5)	x (No 6)			x (No 7)	x (No 7, 8)				x (No 10)	x (No 6)		x (No 5, 9)	x (No 9)		
			Building mechanic for demolition and concrete cutting (§ 37a No x), in addition to Building construction worker, specialised in (reinforced) concrete work				x (No 5,6,11)	x (No 5)	x (No 7)								x (No 11)	x (No 6)		x (No 8)	x (No 8)		x (No 10)
			Building construction worker, specialised in furnace and chimney building work (§ 5 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9, 10, 11)	x (No18)	x (No 10,11)	x (No 10, 11, 12)	x (No 10, 11, 12)		x (No 10,11,12)		x (No 5,10,11, 21)	x (No 6, 11)					x (No 6)

A building's roof

Compared to the previous discussion on occupations working on a building's shell, there are not many occupations involved in roofing work. Roofing is predominately the domain of carpenters[94], roofers, glaziers, plumbers, "stuccoists", "dry construction builders" and "metal workers", with "masonry waterproofers" also involved in certain sub-processes.

With regard to providing customers with advice on roofing matters, only little information is to be found in the apprenticeship frameworks identified as being relevant. Glazier and "metal worker" frameworks are the only ones where the skill is actually listed. A "metal worker's" profile fully covers the provision of advice process, stating that he is responsible for providing customers with advice on the execution of any measures required. In doing so, he proposes different alternatives, takes note of customer change requests and advises them on upcoming steps. The glazier's profile lists him as having the ability to execute the required work in line with a customer's wishes and to explain to the customer any maintenance requirements. This basically means that the glazier only partially covers the provision of advice process.

All the occupations identified above as being dominant cover the planning process. Nearly all their apprenticeship frameworks contain provisions with regard to taking relevant requirements, standards and plans into account, as well as the selection of appropriate measures. Similarly these occupations all include the coordination of work with other trades involved in the building project. Though the "masonry waterproofer's" profile includes reading plans and drawings as a qualification, no other qualifications associated with planning are listed.

The organisational measures required in preparation of execution are covered in depth by all occupations. In the roofing sub-category, these include the selection of appropriate materials and the setting up of a building site. As however these qualifications are defined without specific reference to any particular process, the explanations provided above in relation to a building's shell are also deemed to apply here and are therefore not gone into.
Preparatory roofing work is only performed by a small number of occupations, with carpenters, "stuccoists" and "dry construction builders" listed as being capable of both inspecting and preparing base surfaces. The "masonry waterproofer" also prepares sealing work on-site, for instance by testing the surfaces to be sealed with regard to their texture and suitability as well as to their temperature and moisture content. In the same vein, the "metal worker" first checks the surfaces he will be treating. He also builds roofing support structures. In doing so, he also has to check the suitability of the base surface for fixing the roof support structure to it. The roofer similarly inspects the surfaces of the support structure, assessing their suitability for bearing the actual roofing materials.

[94] This occupation is based on the 2-year "construction finishing worker" apprenticeship, which is also greatly involved in the roof subcategory.

The materials to be used are prepared beforehand by workers from all occupations looked at. Glaziers for instance have to mark, cut and bore holes in wood, plastic and metal, produce composite elements, or prepare for the installation of building elements and fittings. This work is done in preparation for installing glass and glass products, for insulating and sealing, as well as for fitting the building elements.

Roofers and plumbers similarly use many different methods of preparing their materials before actually processing / installing them. A roofer's preparatory work includes woodwork, cutting and drilling slates and roofing sheets, as well as other preparatory measures for roof tiles and corrugated iron sheets. Once everything has been prepared, the roofer then assembles all elements, building the supporting structure, covering it with tiles, installing prefabricated elements and roof fittings. The plumber carries out similar preparatory work, first checking the evenness and form of workpieces, measuring where they are to be fitted, cutting and shaping them, preparing them for welding and soldering. Again, once all this preparatory work has been done, the materials are processed. Processing includes mating, soldering and gluing elements together, cutting, boring and shaping sheet metal, pipes and profiles and further processing them by hand or with the aid of machine tools.

The carpenter (as well as the “construction finishing worker” specialised in carpentry) concentrates mainly on preparing and working with wood. The "construction finishing worker" for instance measures out wood and cuts it to produce connections. He also builds (roof) supporting structures. Once such preparatory work has been completed, the carpenter will make roof supporting structures including extensions and dormers, as well as installing prefabricated roof elements. He also produces insulation systems.

In this context, "stuccoists" and "dry construction builders" produce drylining constructions. In addition, the "stuccoist" may mix his own plaster on-site, as well as producing his own stucco profiles.

The "building mechanic for demolition and concrete cutting" first cuts sealing and insulation materials to size, then glues the elements together and finally installs the insulation.

The "metal worker" also first prepares the pieces he will be working with, then carries out such processing steps as sanding or boring, and finally fits the finished pieces.

Surface protection is also something done by all identified occupations. While the finishing occupations are mainly involved in impregnating, varnishing and sealing wood surfaces and caulking wooden constructions to protect them from driving rain and wind, the "building mechanic for demolition and concrete cutting" is explicitly listed as having the skill to seal roofs. This includes being able to waterproof roof surfaces and to seal joints between old and new roofs. Roofers specialised in roof, wall and waterproofing technology are listed as having the skill to apply plastic- and bitumen-based waterproofing. This means that they seal surfaces against ground damp, and protect roofs using gravel, pebbles and slabs.

Glaziers and plumbers are also listed as having qualifications for protecting roofs. While the former provide waterproofing and carry out wood preservation and anti-corrosion measures, the latter are listed as having the qualifications to treat surfaces through the application of suitable anti-corrosion measures, as well as being able to plate surfaces and

seal elastic joints. "Metal workers" also protect surfaces through applying coatings and anti-corrosion protection, as well as sealing joints with filler, insulation and sealants.
Finally, all occupations identified as being relevant are listed as having the skill of checking their own work for possible faults and of documenting the work done. Moreover, all apprenticeship frameworks mention clearing up and vacating the building site as an important skill.

On the other hand, the quality assurance and customer acceptance of work done on the roof is not done at journeyman level by any of the occupations looked at.

Similarly, not all occupations cover repair and maintenance. For example, finishing occupations are listed as having the skill to recognise building work worthy of preservation, though they are not listed as actually carrying out maintenance work. Roofers on the other hand are involved, having the skills to assess any damage, determine the causes and perform the necessary repair work. They are also listed as documenting the work performed. The complete 3-step repair process is also performed by glaziers, plumbers and "metal workers". They also assess the damage, perform the work necessary to remedy such and finally document what they have done. They are also able to identify building work worth preserving, carry out the necessary preservation work and document what they have done.

The "disposal" process step related to roof work is specifically listed for roofers and glaziers, with the former ensuring that anti-corrosion substances and glass construction parts are properly disposed of, while the latter is responsible for sorting the waste and properly disposing of any hazardous substances.

Table 41: Evaluation of all work involving a building's roof

				Processes																				
				Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
Building work category	Building envelope			Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account ("Design implementation")	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commisioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
		Roof [1]	Construction finishing worker , specialised in carpentry (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9, 10)	x (No 13)	x (No 10)	x (No 10)	x (No 10)		x (No 10)		x (No 5, 19)	x (No 6)					x (No 6)
			Carpenter, in addition to Construction finishing worker, specialised in carpentry (§ 38 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6, 7, 8)			x (No 7)	x (No 7,8)		x (No 9)			x (No 6)		x (No 5)			
			Construction finishing worker, specialised in plastering (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9)	x (No 13)			x (No 14)				x (No 5, 19)	x (No 6)					x (No 6, 15)
			Stuccoist, in addition to Construction finishing worker, specialised in plastering (§ 43 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6)	x (No 8)		x (No 10)	x (No 8, 10)							x (No 5)			
			Construction finishing worker, specialised in drylining (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9)	x (No 13, 14)			x (No 14)				x (No 5, 19)	x (No 6)					x (No 6)
			Dry construction builder (§ 63 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6)		x (No 8)	x (No 8)	x (No 8)				x (No 5, 10)	x (No 6)		x (No 5, 9)	x (No 5, 9)		
			Masonry waterproofer (§ 5 No x)			x (No 7)			x (No 5, 6, 7, 8, 9, 13)	x (No 13)	x (No 12)		x (No 12)				x (No 15)	x (No 5, 17)	x (No 5, 6)				
			Roofer, specialised in roof, wall and waterproofing technology (§ 4 Para. 1 No x) (also includes roof windows)			x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8,10,11,12, 13,15, 16)	x (No 11)	x (No 10,13,14,15, 19)	x (No 10, 11,12, 13,14, 15, 19; Para. 2 No 1a, 1c)	x (No 10, 11, 12, 16, 18,19, 20, Para. 2 No 1a, 1c)		x (No 10, 15, Para. 2 No 1b)		x (No § 4 Para. 2 No 1g)	x (No 6)		x (§ 4 Para. 2 No 1 f)	x (§ 4 Para. 2 No 1f)	x (§ 4 Para. 2 No 1g)	x (No 6)
			Roofer, specialised in reed-thatch roofing techniques (§ 4 Para. 1 No x) (also includes roof windows)			x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8,10,11,12, 13,15, 16, Para. 2 No 2a)	x (No 11)	x (No 10,13,14,15, 19)	x (No 10, 11,12, 13,14, 15, 19; Para. 2 No 2b, 2c)	x (No 10, 11, 12, 16, 18,19, 20, Para. 2 No 2b, 2d)		x (No 10, 15)		x (No § 4 Para. 2 No 2g)	x (No 6)		x (§ 4 Para. 2 No 2f)	x (§ 4 Para. 2 No 2f)	x (§ 4 Para. 2 No 2g)	x (No 6)
			Glazier, all specialisations (§ 3 Para. 1 No x)		x (No 6, 17)	x (No 7)	x (No 6)	x (No 6)	x (No 7, 8, 9, 10, 11, 12, 14)		x (No 10, 11, 12, 14)	x (No 10, 11, 20)	x (No 10, 12, 14, 20)		x (No 11, 12)		x (No 14, 17, 20)	x (No 8)		x (No 15, 16)	x (No 14, 15, 16)	x (No 15, 16)	x (No 11)
			Glazier, specialised in glazing (§ 3 Para. 2 No x Point x), in addition to § 3 Para. 1						x (Point a)		x (Point a)		x (Point a)				x (Point a)						x (Point a)
			Plumber (§ 4 No x)			x (No 6)	x (No 5)	x (No 5)	x (No 5, 6, 7, 8, 9, 10, 14, 15, 18, 15)		x (No 7, 8, 9, 13, 15)	x (No 8, 9, 10, 12, 13, 18, 19)	x (No 8, 13, 17, 19, 21, 24)		x (No 11, 16, 19)		x (No 5, 6, 11, 14, 16, 22)	x (No 25)		x (No 11, 22)	x (No 11)	x (No 11)	
			Metal worker, specialised in construction technology (§ 4 Para. 2 Abschnitt A No x)	x (A No 5)	x (A No 5)	x (A No 5)	x (A No 6)	x (A No 6)	x (A No 5, 6, 8, 10, 11, 18; B No 2, 3)	x (A No 8, B No 4)	x (A No 8, 9, 10, 11, 13, 14, 15, 16, 18, B No 3, 4)		x (A No 9, 18, B No 5)		x (A No 16, B No 5)		x (No 5, 6, 7, 13)	x (B No 2)		x (Abschnitt B No 7)	x (Abschnitt B No 7)	x (Abschnitt B No 7)	

[1] The trades looked at here work with different degrees of intensity and with different materials on a building's roof. Nevertheless they are all relevant for implementing the 20-20-20 targets.

Facade

As with the other work subcategories relating to a building's envelope, facade work is for the most part carried out by occupations belonging to the construction and finishing trades. As can be seen in Table 42, there are however further occupations involved in facade work, with the focus now on the "building and object coater" and the "painter and varnisher", as well as on the "masonry waterproofer" and roofer.[95]

Advice in this field is provided by the "building and object coater" and the "painter and varnisher", with their apprenticeship frameworks listing the recording of customer requirements as a qualification. They are also able to explain maintenance intervals. Similar qualifications are also assigned to "metal workers", who record customer requirements on-site and forward them for further order processing. "Metal workers" also provide customers with instructions on how to use products. The latter is something also done by the glazier and the "building materials tester", whereby they are also listed as having the skill to accept complaints and discuss specific situations with customers.

The majority of occupations identified as being relevant to facade work cover the whole planning process: these include the "building construction worker", the "construction finishing worker", the "building materials tester", as well as roofers, glaziers and plumbers. Coordinating work with other trades involved in the building work is not defined as a qualification for the "façade erector" and the "building and object coater". Though taking technical standards into account, the apprenticeship framework for the “masonry waterproofer" does not however list any further planning qualifications.

Looking at the individual execution phases, what quickly becomes clear is that most of the occupations involved in facade work are very much involved in on-site preparatory measures. Both the choice of materials and the weighing up of the pros and cons of different procedures belong to this step. The two occupations hardly involved in this preparatory work are the "pre-fab concrete element manufacturer" and the "concrete block and terrazzo manufacturer".
Compared with the building work subcategories discussed so far, the process step "preparatory building measures / excavation work" is very much present where facade work is involved. For instance, "construction finishing workers" performing either rendering or outside insulation work have to prepare the surfaces beforehand, checking whether these are suitable for the application of the rendering or insulation, and whether they are damaged or contaminated. Moreover the "construction finishing worker", whatever work he is specialised in, and the "building construction worker" specialised in brickwork check whether the facade is suitable for applying insulation or rendering. The "thermal and noise

[95] It should be pointed out here that a "painter and varnisher" apprenticeship in the context of a 2-step course is based on the 2-year "building and object coater" apprenticeship, whereby the "building and object coater" examination after two years is to be seen as an intermediate examination.

insulation fitter" is also involved in installing the necessary support constructions, something also done by a roofer. The latter will also check surfaces before they are sealed.
The "building and object coater", the "painter and varnisher", the "masonry waterproofer" and the "façade erector" also carry out similar preparatory work, checking surfaces to see whether they are suitable and possibly cleaning them before fitting the new facade (or elements thereof). The "façade erector" in addition cuts out the holes needed for installing connections once the new facade has been fitted. "Metal workers" also check the surface before carrying out any facade work.
Glaziers, whether specialised in windows and glass curtain walling or in glazing, also perform preparatory work, for example building the support constructions needed later for installing pre-fabricated elements.
The "building materials tester" also carries out preparatory work, preparing to take samples of building materials before the building work actually begins.
The subsequent steps of preparing and using/applying the building materials are - as already done with the shell and roof - looked at together. The "construction finishing worker" covers all work associated with the facade, with his apprenticeship framework specifying that he has the skills to cut insulation to shape and install it, and to mix and apply render. "Stuccoists" not only do this, but also apply special and thermal insulation render and make composite insulation and finish systems. A carpenter may also install external cladding and provide protection against driving rain and wind for facade joints and corners. By contrast, the work of a "thermal and noise insulation fitter" involves installing insulation and cladding it in some form.
The skill set of a "façade erector" provides for wide-ranging qualifications in the execution phase, with him being able to work with wood, make and manually apply and finish different sorts of concrete, He also mixes cement and render, applying these to the facade, works with pre-fabricated facade components, installs anchoring, connecting and fixing elements and produces adhesive bonds. Last but not least, he installs (pre-fabricated) facade elements and applies insulation and protective layers to the facade.
Plumbers also play a role in executing work on a façade. To start with, they are listed as carrying out preparatory and processing work, including such manual operations as mating, cutting and bending, and such machine-tool assisted operations as soldering and welding pipes, plates and profiles. Plumbers are also able to plate surfaces, produce facade cladding made of metal sheeting and elastic seals, and to clad openings in the facade. Similar to plumbers, a "metal worker" specialised in construction technology will prepare the material to be used, mating, torch-cutting and otherwise processing it manually or with machine tools. In addition he works with different kinds of cladding materials, fixing them to facades using various fixing techniques. He also installs facades, where necessary sealing any joints.
"Building construction workers" work with wood and apply thermal, sound and fire insulation, after cutting the respective material to size. They also mix and apply single-layer render. On top of this construction work, "masons" may also be responsible for applying thermal insulation render, making composite insulation and finish systems, applying coats of synthetic resin and using different methods of finishing render.

In this process step, the "painter and varnisher" prepares various coating materials which are then applied to the facade.. In addition he works with different insulation materials and applies, renews and repairs coatings on outside surfaces and installs composite insulation and finish systems. "Painters and varnishers" specialised in design and maintenance produce plaster / render surfaces to design plans, as well as installing (pre-fabricated) building components. They use coating and application techniques to reduce heat losses and produce composite insulation and finish systems. They are also responsible for waterproofing buildings, using special coating techniques.

In this step, "masonry waterproofers" mix mortar and concrete, using it to repair damaged brickwork and plaster. They similarly work with sealants and insulation material and apply coatings.

Similar work is also done by the "concrete block and terrazzo manufacturer" and the "pre-fab concrete element manufacturer". They carry out simple rendering and insulation work, and install pre-fabricated concrete elements.

Roofers are also to a great extent involved in this process step. They construct and mount substructures and clad outside walls with (corrugated) metal sheets and other materials. Glaziers specialised in windows and glass curtain walling are listed as being qualified to assemble and install facade structures, at the end checking that they work properly. Glaziers specialised in glazing also install glass facade elements.

Last but not least, also stonemasons will be found processing and installing facade components. Moreover stonemasons are listed as having the skills to install insulation and seal joints.

Protecting and waterproofing outside surfaces is an essential part of the building work carried out on facades. For this reason, this process step is covered by the majority of apprenticed occupations identified as being relevant, with a large number of them listed as having skills in applying surface protection, timber preservation and various coatings. These include the "construction finishing worker" in all relevant specialisations, the "building and object coater", the "masonry waterproofer", the "façade erector", the glazier specialised in windows and glass curtain walling, the "building construction worker", and the "painter and varnisher".

The "concrete block and terrazzo manufacturer" and the "pre-fab concrete element manufacturer" both grind and polish the surfaces they produce, while a roofer will apply elastic seals and perform anti-corrosion work, in this way protecting the outside surfaces of facades. In addition, the "façade erector", the plumber and the "metal worker" also apply anti-corrosion protection and seal joints. Glaziers also perform anti-corrosion work, as well as applying adhesives and sealants. The "painter and varnisher" specialised in design and maintenance will also apply special coatings and sealants, as well as carrying out protection and maintenance work on metal surfaces. By contrast the focus of the "painter and varnisher" specialised in building and anti-corrosion protection is on applying different forms of anti-corrosion coatings and on producing metal-based cladding.

As can be seen in Table 42, nearly all apprenticed occupations are listed as being responsible for documenting and checking the work done. Where necessary, any faults discovered here

are to be remedied. Finally, all occupations identified as being relevant are responsible for clearing up and vacating sites after work has been finished.

Customer acceptance and commissioning are not undertaken by any of these occupations.

Qualifications related to repair and maintenance are listed in a number of the occupations. The "construction finishing worker" specialised in plastering / rendering identifies damage to plaster / render and will carry out the necessary repairs. Moreover, the "stuccoist" apprenticeship framework lists a "stuccoist" - as is also the case with a carpenter - as being able identify buildings or parts thereof that are worthwhile preserving and to perform measures aimed at protecting them. Looking at carpenters, they will establish any damage through visual checks, take the measures necessary to contain the damage, and carry out preservation and maintenance measures, especially on wooden structures.
Similarly a "building and object coater" will carry out repair and maintenance work on outside surfaces. Roofers as well establish damage to outside walls, take measures to stop the damage spreading and carry out the necessary repair work. In addition, a "painter and varnisher" specialised in design and maintenance will carry out decoration and restoration work on facades, repairing cracked render and possibly inserting new glass elements. A "painter and varnisher" specialised in building and anti-corrosion protection will also fill cracks in concrete buildings and elements.
A "façade erector" by contrast is responsible for the whole repair and maintenance process, including documenting what they have done. He will first assess what repair work needs to be done to the facade, identifying which bits are worthwhile preserving. He will inspect reinforced concrete, checking whether it needs to be protected: He will repair any faults, check seals and where necessary repair them, and apply insulation to existing facades. He also carries out and documents maintenance work.
Glaziers are also responsible for this whole process step, preparing and executing any repairs to building elements and glass constructions needed.[96] Moreover they can identify buildings or parts thereof worthwhile preserving and document all work carried out.
The identification of buildings or parts thereof worthwhile preserving is also to found in the apprenticeship frameworks of the "mason" and the "concreter". Both occupations also perform maintenance and repair work.
Plumbers similarly carry out maintenance and repair work, with their apprenticeship framework listing removing and installing components, and remedying any faults. The "metal worker" also performs inspections in accordance with plans, finding and remedying possible damage. He also carries out preventive maintenance.

[96] In the specialisations "glazing" and "windows and glass curtain walling" , this step is explicitly mentioned for glass curtain wall elements.

The final process step, disposal, is carried out by the following occupations involved in facade work: the "construction finishing worker" specialised in plastering, as well as glaziers, roofers and stone technicians.

Table 42: Evaluation of all work involving a building's facade

				Processes																					
				Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
				Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account ("Design implementation")	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
Building work category	Building envelope	Facade [1]	Construction finishing worker, specialised in plastering (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9,13,14, 15, 16)	x (No 13, 14, 15)	x (No 14, 15)	x (No 15)	x (No 14,15)		x (No 14)		x (No 5, 19)	x (No 6)		x (No 15)	x (No 15)		x (No 6, 15)
			Stuccoist, in addition to Construction finishing worker, specialised in plastering (§ 43 Nr. x)			x (No 5)	x (No 5)	x (No 5)	x (No 6)				x (No 7)							x (No 5)			
			Construction finishing worker, specialised in carpentry (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9,15, 16)	x (No 15)	x (No 14, 15)	x (No 15)	x (No 14,15)		x (No 14)		x (No 5, 19)	x (No 6)					x (No 6)
			Carpenter, in addition to Construction finishing worker, specialised in carpentry (§ 38 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6)				x (No 9)		x (No 9)		x (No 13)	x (No 6)		x (No 5, 12)	x (No 12)	x (No 12)	
			Construction finishing worker, specialised in thermal and noise insulation (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9,13,14)	x (No 13)	x (No 14,15)	x (No 15)	x (No 14,15)		x (No 14)			x (No 6)					x (No 6)
			Thermal and noise insulation fitter, in addition to Construction finishing worker, specialised in thermal and noise insulation (§ 58 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6)	x (No 8)	x (No 9)		x (No 10)				x (No 10)	x (No 6)					
			Building materials tester, specialised in geo-technology and specialised in cement and concrete technology (§ 5 No x)		x (No 15)	x (No 6, 7, 10)	x (No 6)	x (No 6)	x (No 6, 7, 8, 9, 10, 11, 12)	x (No 9, 11, 12, 13)	x (No 8)						x (No14, 16)						
			Building and object coater (§ 5 No x)	x (No 5)	x (No 5)	x (No 7)	x (No 7)		x (No 7, 8,9,10, 11, 12)	x (No 11)	x (No10)	x (No 10, 11, 12)	x (No 12)		x (No 11, 12)		x (No 13)	x (No 8)			x (No 12)	x (No 13)	x (No 8)
			Painter and varnisher, specialised in design and maintenance (§ 6 No 1 Point x), in addition to Building and object coater	x (Point e)	x (Point e)		x (Point g)		x (Point g)			x (Point g)	x (Point g, k)		x (Point i, k)		x (Point l)				x (Point g, i, k)	x (Point l)	
			Painter and varnisher, specialised in building and anti-corrosion protection (§ 6 No 3 Point x), in addition to Building and object coater		x (Point e)				x (Point g, i)				x (Point h, i)		x (Point i)		x (Point m)			x (Point k)	x (Point k)	x (Point m)	
			Masonry waterproofer (§ 5 No x)			x (No 7)			x (No 5, 6, 7, 8, 9, 11, 13)	x (No 13)	x (No 11, 12)	x (No 10, 11)	x (No 10, 12)		x (No 10, 14)		x (No 5, 11, 17)	x (No 5, 6)					
			Pre-fabricated concrete producer (§ 5 No x)						x (No 7, 16)		x (No 7, 16)		x (No 7, 14, 16)		x (No 7, 15)			x (No 16)					
			Concrete bloc and terrazzo manufacturer (§ 5 No x)						x (No 7, 16)		x (No 7, 16)		x (No 7, 14, 16)		x (No 7, 15)			x (No 16)					

A building's windows and doors

In contrast to the subcategories discussed above, the "Windows and Doors" building work subcategory of the "Building Envelope" category is not dominated by finishing and construction occupations. In this subcategory, the glazier, the "roller shutters and sunshade mechatronic technician", the "metal worker" and the joiner are predominant. Installation work is also undertaken by certain finishing occupations, as well as by carpenters and "stuccoists".

Starting with the step involving the provision of advice, what is conspicuous is that both joiners and "metal workers" fully cover this step, recording customer requirements before carrying out work and respecting these during execution. Moreover they explain subsequent steps to customers, as well as any inspection and maintenance work needing to be done by customers. The latter is also true for the glazier and the "roller shutters and sunshade mechatronic technician".

Turning to the planning steps, these are also performed by the occupations mentioned above. As can be seen in Table 43, joiners, glaziers, "roller shutters and sunshade mechatronic technicians" and "metal workers" are all responsible for planning subsequent steps. This includes taking into account technical and statutory requirements, and scheduling and coordinating work with other trades also working on the building site.

As the next step, execution work is also done by the above-mentioned occupations. The preparatory organisational measures, including ensuring supplies of building materials and deciding on the best methods and materials, are all performed by most of the occupations identified as being relevant here. In addition, setting up the building site is also part of the process step. In the glazier's apprenticeship framework, the choice of the right material, i.e. the right type of glass and glass products, is listed as a skill. Other materials selected include wood, plastics and metal. Glaziers specialised in glazing also select the appropriate glass constructions, window fittings and jambs. For glaziers specialised in windows and glass curtain walling, selection work also includes the choice of appropriate installation and fixing systems.

Preparatory work on the building site is by contrast not performed by many of the occupations. Glaziers specialised in windows and glass curtain walling may install substructures to be used later for installing doors and windows. The work done by the "metal workers" in this step involves checking surfaces with regard to their quality, wear and tear and possible damage, and assessing whether they are suitable as a base for further work.

Preparing materials is a further step performed by all above-mentioned occupations. Joiners can be seen cutting wood and other materials to size, and making components ready for assembly, while glaziers will prepare the necessary glass elements. In addition the latter will prepare composite adhesives, and, when specialised in windows and glass curtain walling, will prepare and treat window and door structures. “Metal workers” also cut their materials

to size and do additional preparatory work such as assembling metal structures. "Roller shutters and sunshade mechatronic technicians" prepare pre-fabricated elements for installation.
The treatment of these materials is done in a further step preceding their actual installation. Joiners work on the wood and other components either manually or with the help of machine tools before fitting the required fittings. Once this has been done, parts are assembled and window and door frames made. They similarly assemble products, including preparing and fitting glass and other semi-finished products for installation. Moreover, joiners apply insulation and sealants, and adjust and install products.
By contrast, a glazier will cut and break glass and glass products, possibly sawing, sanding and polishing them. Once ready, he will then install and seal them. He also produces adhesives and sealants and installs further components and fittings. When specialised in glazing, he will also install glass constructions, fixing and bonding them. When specialised in windows and glass curtain walling, he will produce and assemble components for windows and doors, select and install appropriate fittings and make sure that everything is in good working order. Such constructions are then installed, making sure that they fit properly.
The "roller shutters and sunshade mechatronic technician" works with different materials and accessories, processing them into profiles and rods which are then assembled into security roller shutters, Venetian blinds and window shutters. In addition he makes and installs roller shutter boxes, as well as installing (garage) doors. Moreover he manufactures and assembles parts for roller shutters and window combinations.
A "metal worker" prepares his materials through mating and welding, as well as otherwise processing metal plates and profiles manually or with machine tools. Once this has been done, he builds and installs profiles made of different materials.
The installation step is carried out by the four occupations: carpenter, "stuccoist", "thermal and noise insulation fitter" and "dry construction builder". The apprenticeship frameworks of these occupations all list the installation of windows and doors, without being involved in any other way in the "windows and doors" subcategory.
The protection, waterproofing and treatment of surfaces is also covered by most of the occupations identified as being relevant. For instance, joiners will clean, sand, stain and paint surfaces before giving them a final finish. Glaziers, similar to joiners, carry out wood preservation and anti-corrosion measures, do sealing work and, where specialised in windows and glass curtain walling, also coat surfaces. Similarly, the "roller shutters and sunshade mechatronic technician" is listed in his apprenticeship framework as having the following qualifications: treating surfaces, reducing wind-induced flexibility and applying anti-corrosion protection. The latter is also done by the "metal worker".
All occupations identified as being relevant in this connection are listed as having the qualifications to perform measures protecting their work, to document their work, to clear up and vacate the site and to remove any scaffolding they might have needed.

Two of the occupations identified here are also involved in customer acceptance and quality assurance: joiners and "roller shutters and sunshade mechatronic technicians" are explicitly listed as having the skill to hand over the finished work to the customer.

Repair and maintenance work is also carried out by the majority of occupations in this subcategory. To start with, joiners prepare, perform and document maintenance work. They also check whether windows and doors are working properly or are damaged and will restore windows and doors seen as worth preserving. The latter is also done by glaziers, who will check whether glass structures and building elements are worth preserving, then documenting their findings. Glaziers also document damage to glass structures, check the causes and perform appropriate repair work. Where they are specialised in windows and glass curtain walling, this also involves window structures.
The "roller shutters and sunshade mechatronic technician" also performs maintenance work, checking for and remedying any damage. This work is then documented.
Last but not least, "metal workers" carry out inspection work according to plans, as well as performing preventive maintenance.

The disposal of no longer needed elements and materials is also listed in many of the occupations belonging to the "windows and doors" subcategory, with joiners, glaziers and "roller shutters and sunshade mechatronic technicians" all having such qualifications.

Table 43: Evaluation of the "Windows and doors" sub-category

			Processes																				
			Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
			Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account ("Design implementation")	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
Building work category	Building envelope	Windows and doors																					
		Glazier, all specialisations (§ 3 Para. 1 No x)		x (No 6, 17)	x (No 7)	x (No 6)	x (No 6)	x (No 7, 8, 9, 10, 11, 12, 14)		x (No 10, 11, 12, 14)	x (No 10, 11)	x (No 10, 12, 14)		x (No 11, 12)		x (No 14, 17)	x (No 8)		x (No 15, 16)	x (No 14, 15, 16)	x (No 15, 16)	x (No 11)
		Glazier, specialised in windows and glass curtain walling (§ 3 Para. 2 No21 Point x), in addition to § 3 Para. 1						x (Point a, b)	x (Point a, c)	x (Point b)	x (Point a)	x (Point a, c)		x (Point b)		x (Point a, c)				x (Point c)		x (Point c)
		Glazier, specialised in glazing (§ 3 Para. 2 No 1 Point x), in addition to § 3 Para. 1						x (Point a)				x (Point a)				x (Point a)						x (Point a)
		Metal worker (§ 4 Para. 2 Section A No x)	x (A No 5)	x (A No 5)	x (A No 5)	x (A No 6)	x (A No 6)	x (A No 5, 6, 8, 10, 11, 18; B No 2, 3)	x (A No 8, B No 4)	x (A No 8, 9, 10, 11, 13, 14, 15, 16, 18, B No 3, 4)		x (A No 9, 18, B No 5)		x (A No 16, B No 5)		x (No 5, 6, 7, 13, Section B No 6)	x (B No 2)		x (Section B No 7)	x (Section B No 7)	x (Section B No 7)	
		Roller shutters and sunshade mechatronic technician (§ 4 No x)	x (No 17)	x (No 17)	x (No 6)	x (No 6)	x (No 6)	x (No 6, 7, 8, 9, 10, 11, 12, 13, 14, 15)		x (No 8, 14)	x (No 8, 10, 11)	x (No 10, 11, 12, 13,14)		x (No 10, 11)		x (No 15)	x (No7)	x (No 17)	x (No 16)	x (No 16)	x (No 16)	x (No 7)
		Stuccoist (§ 43 No x)										x (No 10)										
		Joiner (§ 4 No x)	x (No 6, 15, 16)	x (No 16)	x (No 6,7)	x (No 6,7)	x (No 7)	x (No 6, 8, 9)		x (No 11)	x (No 9, 11)	x (No 11, 14)		x (No 12, 13, 14)		x (No 9, 11, 14,16, 17)	x (No 8)	x (No 16)	x (No 15)	x (No 15)	x (No 8)	x (No 8)
		Dry construction builder (§ 63 Nr. x)										x (No 8)										
		Thermal and noise insulation fitter (§ 58 No x)										x (No 10)										
		Carpenter (38 No x)										x (No10)										

[1] The trades looked at here work with different degrees of intensity and with different materials on a building's windows and doors. Nevertheless they are all relevant for implementing the 20-20-20 targets.

7.3.4 Evaluation results in the "building infrastructure" category

Electrics

Looking at the processes involved in the "electrics" building work subcategory, the apprenticeship frameworks of the electrical occupations in industry and the skilled craft sector are relevant.[97] These cover for the most part the whole execution process, including the individual sub-processes. In addition the apprenticeship frameworks of the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems" are also looked at, as these are also characterised by a high involvement in the "electrics" category. Moreover, the "construction finishing worker" specialised in tiling, the plumber, the "metal worker", and the joiner are also involved in some of the sub-processes.

As the individual occupations are involved in different ways in the electrics of a building, this subcategory was divided up into different “points of reference”. Alongside the "simple electrical connections" point of reference, which basically involves connecting domestic appliances, three further points of reference were established, all involving much higher qualifications: "measurement and control systems from the handover interface", "electrical systems from the mains to the handover interface", and "intelligent systems", whereby the different trades need to agree on the so-called "handover interface", i.e. the point at which the work of one trade stops and that of the next trade starts. The electrical cabling from the mains to this handover interface may only be done by certain trades, whereas the electrics on the other side of the interface are done by a generally larger number of trades.
Occupations related to measurement and control systems may perform such work on the systems in question as from a pre-defined interface. Such work is different to the electrical work on the other side of the handover interface. Occupations needing to take such a differentiation into account may in addition be responsible for the building's internal cabling up to a predefined interface. Finally "intelligent systems" is also defined as a point of reference, and refers to the coordination of different systems within a building.

All four points of reference are covered by the "electronics technician" specialised in energy and building management systems and the "electronics technician for building and infrastructure systems". These occupations are also the only ones with a reference to a building's electrics from the mains to a defined handover interface. Measurement and control systems behind this interface as well as simple electrical connections are performed by the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems". The "construction finishing worker" specialised in tiling

[97] Industrial electrical engineering occupations include the "electronics technician for industrial engineering", the "electronics technician for building and infrastructure systems", the "electronics technician for devices and systems" and the "systems informatics technician". However, the only one relevant to our evaluation is the "electronics technician for building and infrastructure systems". The "electronics technician specialised in energy and building management systems” is classified as being a skilled craftsman.

and the "metal worker" are also listed as performing certain electrical measurement and control steps as well as simple electrical connections. Plumbers and joiners are similarly listed as being able to perform simple electrical connection work.

Looking first at the provision of advice process, we see that this is covered by all electrical occupations with an industrial background. These occupations will find out what a customer requires and which services need to be offered. In addition they inform and advise customers on specific offerings. Finally they instruct customers in the use of the systems and inform them of their guarantee rights and of any necessary maintenance work. The apprenticeship framework of the "electronics technician" specialised in energy and building management systems also lists these process steps. This includes advising customers about products and materials and making various proposals when something goes wrong to a system.

Nearly all the above occupations are also involved in the planning process. In addition to the occupations mentioned above, the "plant mechanic for sanitary, heating and air conditioning systems" also needs to be mentioned, who, just as with the electrician occupations, also has to take technical regulations and standards into account, as well having to plan his work, for instance defining which steps are to be done in which order. Also included in the planning process is the coordination of work with the trades performing work beforehand and afterwards.

As can be seen in Table 44, the majority of occupations listed as being relevant in the field of "electrics" perform preparatory work. Again we look first at the "electronics technicians", whether they have an industrial or skilled crafts background. Preparatory work for the “electricians technician for building and infrastructure systems” includes the choice of the right measurement process and equipment, suitable hardware and software.
The "electronics technician" in the skilled craft sector starts by selecting the materials, components and fittings required for the work. He also chooses the necessary technical facilities, tools, measuring equipment and machine tools. In addition he has to take into account the safety rules for electrical equipment. Moreover he looks for information on the energy and building management systems and their technical interfaces and standards, and evaluates such with regard to their functionality. The "plant mechanic for sanitary, heating and air conditioning systems" also performs preparatory work. Apart form setting up the building site and making drawings, the work mainly involves complying with safety rules and VDE regulations. The latter also applies to the "builder of stoves and air heating systems". In this process step, joiners are listed as having the skill to select the right fixing aids and insulation material.
On-site preparatory work is listed in several of the apprenticeship frameworks identified as being relevant. For instance the "construction finishing worker" specialised in tiling will make holes for electrical and plumbing installations. The "electronics technician" specialised in energy and building management systems is also listed as having the skill to check the

suitability of a surface for installing systems or components, and to prepare and install support constructions and mounting brackets. He will also assess rooms with regard to their environmental conditions.
Finally, the installation of the material and the assembly of the individual components are carried out by the majority of the occupations, though in different forms. For instance, the "plant mechanic for sanitary, heating and air conditioning systems" will mount measurement, control and safety systems for energy supply devices and systems. Similarly, "electronics technicians" governed by the apprenticeship framework for industrial electronics will install electrical equipment.
The installation of electronic devices is performed by various other occupations. For instance, the "metal worker" installs and tests electronic components, checks the functionality of interfaces of electronic building groups and makes them operational. The "builder of stoves and air heating systems" installs and connects up the components of stoves and air heating systems. He will also install the appropriate measurement, control and safety equipment. Also involved in this process step is the joiner, who will install and connect up electrical appliances following the manufacturer's instructions.

Connecting up equipment is also done by the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems". The “electricians technician for building and infrastructure systems” similarly connects up equipment and install and configure systems. Additionally, he is also listed as having the skill to install, extend or modify building management systems, and to configure measurement and control systems. The "plant mechanic for sanitary, heating and air conditioning systems" moreover builds electrical interfaces, and installs electrical components in power supply devices and systems.
The "electronics technician" specialised in energy and building management systems similarly assembles and installs devices and electrical equipment. In addition he installs wiring and cables, assembles special wiring systems and installs system components and networks. He also installs control, measurement and monitoring equipment, wiring them and labelling the wires, all in accordance with customer specifications. The installation of energy conversion systems and their control systems belongs to the qualifications of an "electronics technician", as do the installation and commissioning of household appliances, and the installation of building management and remote control devices.
Compared with the already described work on a building's shell, only the electronics technician specialised in energy and building management systems in the "electrics" category covers the "protection" process. He installs protective equipment, panels and electrical insulation.
Finally, the commissioning of electronic systems is done by "electronics technicians" from both industry and the skilled craft sector. The commissioning of electrical controls and circuits is also done by the "plant mechanic for sanitary, heating and air conditioning systems".

Documenting and checking the work done is listed as a task carried out by the majority of the occupations analysed here (cf. Table 44). In particular testing and finding the cause of and rectifying any malfunctions are skills listed for the electrician occupations, whether in industry or the skilled craft sector, and for the "plant mechanic for sanitary, heating and air conditioning systems".
By contrast clearing up and vacating a building site is only listed for the "plant mechanic for sanitary, heating and air conditioning systems" as well as the "electronics technician" specialised in energy and building management systems.

Comparably seen, a lot of the occupations looked at in this area cover the process step of quality assurance and customer acceptance – the electricians technician for building and infrastructure systems and the electronics technician specialised in energy and building management systems Both the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems" are similarly listed as having such qualifications.

The occupations just mentioned are also involved in repair and maintenance work. In this process step, the "electronics technician" specialised in energy and building management systems performs such services as the planning, execution and documentation of maintenance work on electrical devices and systems. Checking and performing maintenance on building management systems is also listed as an "electronics technician" qualification. Finally, the "plant mechanic for sanitary, heating and air conditioning systems" is listed as carrying out maintenance work, visually checking electrical connections for any mechanical damage and wiring for any damage to its insulation. The "builder of stoves and air heating systems" also checks for faults and malfunctions of electrical components, locates where they are, looks for the causes and remedies them.

The "disposal" process step in the sub-category "electrics" is performed by the "plant mechanic for sanitary, heating and air conditioning systems", the "electronics technician" and by all industrial "electronics technician" occupations.

Table 44: Evaluation of all work involving a building's "electrics"

				Point of reference		Processes																						
						Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
						Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account (*Design implementation*[1])	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulation	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
Building work category	Building infrastructure	Electrics	Plant mechanic for sanitary, heating and air conditioning systems (§ 4 Para. 1 Nox)	EAT	x																					
				MSRT from ÜS	x			x (No 5,19)	x (No 5)	x (No 6,22.2)	x (No 5, 6, 14, 22.3)			x (No 15)	x (No14, 15, 16)	x (No 14,15, 16)		x (No 14)	x (No 5,6, 7,8, 14, 15)	x (22.3)		x (No 8, 13, 22.4)	x (No 13,22.4)	x (No 13)	x (No 19)
				ET to ÜS																						
				IS																						
			Construction finishing worker, specialised in tiling (§ 4 Para. 1 No x)	EAT	x																					
				MSRT from ÜS	x							x (No 18)													x (No 6)
				ET to ÜS																						
				IS																						
			Electronics technician, specialised in energy and building management systems (§ 4 Para. 2 A No x)	EAT	x																					
				MSRT from ÜS	x	x (No 7, B No 1)	x (No 5,6, 7, 14, B No 1)	x (No 5, 6)	x (No 6)	x (No 6)	x (No 6, 8, 9, 10, 11, 12, B No 1)	x (No 9, 11, 12)	x (No 9)	x (No 9)	x (No 9,13, 14 Abschnit No 2)	x (No 13,14 B No 2)	x (No 9, B No 2)	x (No 10, B No 2)	x (No 6, 9, 13, B No 1g)	x (No 8)	x (No 7)	x (Nr 14, 15, B No 1, 6)	x (Nr 14, 15, B No 6)	x (Nr 14, 15)	x (B No 6)
				ET to ÜS	x																					
				IS	x																					
			Plumber (§ 4 No x)	EAT	x																					
				MSRT from ÜS							x (No 14)	x (No 14)		x (No 14)	x (No 14)				x (No 14)						
				ET to ÜS																						
				IS																						
			Metal Worker (§ 4 Para. 2 A Nox)	EAT	x																					
				MSRT from ÜS	x										x (A No 15; B No 1, 6)				x (A No 15; B No 1, 6)						
				ET to ÜS																						
				IS																						
			Builder of stoves and air heating systems (§ 4 No x)	EAT	x																					
				MSRT from ÜS	x						x (No 11, 12)				x (No 11, 12, 13)	x (No 11, 12,13)			x (No 11, 12, 13)		x (No 11, 12, 13)	x (No 12)	x (No 12)		x (No 6)
				ET to ÜS																						
				IS																						
			Joiner (§ 4 No x)	EAT	x																					
				MSRT from ÜS							x (No 14)				x (No 14)	x (No 14)										
				ET to ÜS																						
				IS																						

[1] The systems involved here are electrical, HVAC and energy supply systems.

EAT	Simple electrical connections
MSRT from ÜS	Measurement and control systems from the handover interface
ET to ÜS	Electrical systems from the mains to the handover interface
IS	Intelligent systems

Heating

The heating subcategory is dominated by the two occupations: "plant mechanic for sanitary, heating and air conditioning systems" and "builder of stoves and air heating systems". Also of relevance are the "electronics technician" specialised in energy and building management systems, as well as the chimney sweep. In a number of processes associated with heating technology the "construction finishing worker" specialised in tiling, the "building construction worker" specialised in either concrete work, bricklaying or chimney building work, the plumber, the "building and object coater" and the "painter and varnisher" are also involved.

As in the "electrics" subcategory, a further subdivision into points of reference was undertaken. Together with "plant mechanics", further points of reference are "measurement and control systems behind the handover interface", "electrics before the handover interface", "intelligent systems" and "plant insulation".

Occupations with a reference to measurement and control systems may perform such work on the facilities in question behind a previously defined handover interface. The decisive factor in this differentiation is that the different trades involved reach prior agreement on the definition of such a handover interface. The electrical cabling from the mains to this handover interface may only be done by certain trades, whereas the electrics on the other side of the interface are done by a generally larger number of trades.

Occupations listed as being related to the "electrics before the handover interface" are also allowed to do the in-house cabling from the mains to a predefined interface. Finally, the "intelligent systems" point of reference refers to work coordinating different systems within a building.

References to "plant mechanics" are to be found for the "plant mechanic for sanitary, heating and air conditioning systems", the "builder of stoves and air heating systems", the plumber and the chimney sweep. In addition, these occupations, as with the "electronics technician" specialised in energy and building management systems, are also listed as skilled in measurement and control systems. Both the "construction finishing worker" and the "building construction worker" with corresponding specialisations are involved in certain parts of the process related to "plant mechanics" and "measurement and control systems". The points of reference "electrics before the handover interface" and "intelligent systems" are by contrast the sole domain of "electronics technicians". The "plant mechanic for sanitary, heating and air conditioning systems", the "painter and varnisher", the "building and object coater" and the "builder of stoves and air heating systems" are all listed as carrying out insulation work on heating systems.

Recording customer requirements before execution for planning purposes is done by the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems"In addition the "plant mechanic for sanitary, heating and air conditioning systems" is listed as having the qualification to advise customers on the sustainability of energy and water supply systems. The "electronics technician" specialised in

energy and building management systems also records customer requirements with regard to energy and building management systems and plans appropriate solutions. The "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems" are responsible for informing customers about further steps, maintenance intervals and other usage possibilities. In addition the apprenticeship framework of the "plant mechanic for sanitary, heating and air conditioning systems" explicitly lists informing customers about possible problems with a heating system. In his apprenticeship framework, the chimney sweep is listed as providing customers with advice on combustion and ventilation systems, as well as on other usage possibilities and on the rational use of energy.

Within the "heating" subcategory, planning is also carried out by the occupations just mentioned, though to different degrees. Whereas the "builder of stoves and air heating systems" is only listed as taking technical regulations and documents into account, the "electronics technician" is also responsible for planning the measures foreseen. The "plant mechanic for sanitary, heating and air conditioning systems" also performs the above two steps, and is in addition responsible for coordinating work with other trades. With regard to the planning process, the chimney sweep makes sure that fire and chimney regulations are complied with, as well as creating and assessing technical documents. The choice of appropriate measures and the coordination with other trades involved in the work are also included in the apprenticeship framework.

Preparatory work, as can be seen in Table 45, is performed by a number of occupations. They can be found selecting the materials and fittings to be used, deciding which is the best way to execute the work, and setting up the building site.
On-site preparatory work is also done by occupations not otherwise involved in the "heating technology" subcategory. These include the "building construction worker", who will be seen making the holes in the foundations, ceilings and walls for the pipes. This means that these occupations perform preparatory work for other occupations. The "builder of stoves and air heating systems" also checks surfaces for their quality, signs of wear and tear and damage, as well as laying the right floor and wall coverings for installing a stove. The "plant mechanic for sanitary, heating and air conditioning systems" checks surfaces for their suitability for fixing pipes to them. The "electronics technician" will similarly check surfaces for their appropriateness for fixing support structures and brackets to them.
The processing of materials and the assembly of components are both preparatory measures belonging to the two occupations dominating this subcategory. The "plant mechanic for sanitary, heating and air conditioning systems" will prepare (groups of) components before installing them. In further steps, he will cut and shape metal sheets, pipes and profiles, thread pipes, process the pieces he will be installing with machine tools, and finally install measurement and control systems for heating and energy systems and equipment. He also installs pipes and ducts.

The "builder of stoves and air heating systems" processes metal, plastics and ceramic components both manually and with machine tools, lays glazed tiles and other ceramic and mineral materials and components. In doing so, he mixes concrete, mortar and plaster. Finally the "builder of stoves and air heating systems" installs measurement, control and safety equipment for the stoves and air heating systems, assembles the ovens and stoves, and also installs panel heating and air conditioning systems as well as oil and gas burners.
The plumber similarly makes ducts for air-conditioning systems, installs panels covering ducts and pipes, as well as exhaust systems, pipes and ducts for air-conditioning systems.
The "electronics technician" specialised in energy and building management systems is also involved in this process step, first preparing his materials through sawing, boring and threading them, and then installing such appliances as hot water boilers - a step basically belonging to the installation of equipment process step.
The chimney sweep is also involved in the component installation process step, installing or renewing for instance secondary air cleaning devices and cleaning valves or mounting chimney terminals.
Connecting up equipment is similarly done by the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems". Both occupations configure and adjust measurement, control and safety equipment for supply facilities, stoves and air heating systems, with the latter also connecting fireplaces to exhaust systems. The "plant mechanic for sanitary, heating and air conditioning systems" goes further, connecting up fuel supply and storage systems.
The skill of sealing and protecting the materials used is also found with the "plant mechanic for sanitary, heating and air conditioning systems", who seals supply and exhaust systems. In this context, the "builder of stoves and air heating systems" is listed as having the skill to execute anti-corrosion measures on pipes and ducts. The "painter and varnisher" and the "building and object coater" are similarly involved in this process step, carrying out anti-corrosion and insulating measures on such objects as containers, pipes and ducts.
The commissioning of the respective equipment is done by the "electronics technician" specialised in energy and building management systems, the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems".
Documentation and testing for malfunctions is performed both by the "plant mechanic for sanitary, heating and air conditioning systems" and the "pipeline fitter". Similarly the "electronics technician" is listed as being qualified to inspect heating, ventilation and air-conditioning systems.
Clearing up and vacating the building site is a skill explicitly listed for the "builder of stoves and air heating systems" and the "plant mechanic for sanitary, heating and air conditioning systems".

Quality assurance and customer acceptance of the work performed are qualifications assigned to the "plant mechanic for sanitary, heating and air conditioning systems", the "builder of stoves and air heating systems" and the chimney sweep in their respective apprenticeship frameworks. Whereas the "plant mechanic for sanitary, heating and air

conditioning systems" hands over systems with a customer acceptance protocol, the "builder of stoves and air heating systems" checks the measurement, control and safety systems, configures and adjusts them and commissions them. The chimney sweep is listed as having the qualification to inspect systems and buildings with regard to their fire, emissions, hygiene and health protection and to carry out measurements. His apprenticeship framework also lists creating customer acceptance and commissioning protocols.

These two occupations are similarly involved in the repair and maintenance of heating systems. The "plant mechanic for sanitary, heating and air conditioning systems" is listed as being specifically qualified in recognising what repair and maintenance work needs doing. He tests and inspects supply systems, checks devices and equipment for any leaks or faults and uses test methods and diagnosis systems. Finally he executes appropriate measures for remedying faults and repairing equipment, ending up by documenting what he has done.
The "electronics technician" also has qualifications in this process step, assessing a customer's energy and building management systems with regard to their functionality and whether they meet up to (future) energy efficiency and energy-saving standards. He also inspects and maintains building management systems.
The "builder of stoves and air heating systems" also carries out repair and maintenance work, for instance on air heating systems, stoves and wood burners. He also repairs and maintains panel heating systems, hot air systems, and central heating oil and gas supply systems. He is not however explicitly listed as carrying out any preparatory work.
The chimney sweep is very much involved in the repair and maintenance process step, for instance measuring the emissions of heating and air-conditioning systems and ensuring their operational safety (also with regard to fire regulations). In addition he checks for faults and malfunctions in heating and air-conditioning systems, documenting these for instance via measurement and inspection protocols. He also executes measures aimed at improving energy efficiency.
The "painter and varnisher" is also involved in this process step, diagnosing damage (including corrosion) and carrying out rust prevention work.

The disposal of old heating systems is carried out by both the "plant mechanic for sanitary, heating and air conditioning systems" and the "electronics technician". The chimney sweep is also listed as being responsible for the storage and disposal of hazardous materials.

Table 45: Evaluation of all work involving a building's heating

Building work category	Building infrastructure	Ventilation and air-conditioning		Point of reference		Processes: Provision of advice – Discussing and recording customer requirements (PRIOR to execution)	Provision of advice – Informing customers (AFTER execution)	Planning – Taking requirements into account ("Design implementation")	Planning – Choice of measures	Planning – Coordination of measures with other trades / firms	Execution – Preparatory / organisational measures / choice of materials / site preparation	Execution – On-site preparatory measures / excavation work	Execution – Preparing building materials	Execution – Processing building materials	Execution – Installation work	Execution – Connection work[1]	Execution – Preservation / sealing / insulatoin	Execution – Commissioning	Execution – Documentation / checks	Execution – Site clearance	Quality assurance and acceptance – Customer acceptance and commissioning	Repairs and maintenance – Preparing repair / maintenance measures	Repairs and maintenance – Executing repair / maintenance measures	Repairs and maintenance – Documentation	Disposal – Disposal / de-commissioning
			Plant mechanic for sanitary, heating and air conditioning systems (§ 4 Para. 1 No x)	AM	x	x (No 5, 20,22.2)	x (No 5, 7, 20)	x (No 5,19)	x (No 5)	x (No 6,22.2)	x (No 5, 6, 8, 9, 18,19,21,22.3)	x (No 18)	x (No 18)	x (No 10, 11)	x (No9, 16, 18,19)	x (No 16, 19)	x (No 21)	x (No 22.1)	x (No 5,6, 7,8, 19)	x (22.3)	x (No 22.2)	x (No 8, 13, 19, 22.4)	x (No 13,22.4)	x (No 13)	x (No 19)
				MSRT from ÜS	x																				
				ETto ÜS																					
				IS																					
				AD	x																				
			Construction finishing worker, specialised in tiling (§ 4 Para. 1 No x)	AM	x							x (No 18)													x (No 6)
				MSRT from ÜS	x																				
				ETto ÜS																					
				IS																					
				AD																					
			Electronics technician, specialised in energy and building management systems (§ 4 Para. 2 A No x)	AM		x (No 7, B No 1)	x (No 7, B No 1)	x (No 5, 6)	x (No 6)	x (No 6)	x (No 6, 8, B No 1)	x (No 9)	x (No 9)	x (No 9)	x (No 13, B No 2)	x (No 13, B No 2)	x (No 9, B No 2)	x (B No 2)	x (No 6, 13, B No 1g)	x (No 8)		x (B No 1, 6)	x (B No 6)		x (B No 6)
				MSRT from ÜS	x																				
				ETto ÜS	x																				
				IS	x																				
				AD																					
			Building construction worker, specialised in (reinforced) concrete work, specialised in brickwork, specialised in furnace and chimney building work (§ 5 No x)	AM	x							x (No 20)													x (No 6)
				MSRT from ÜS																					
				ETto ÜS																					
				IS																					
				AD																					
			Plumber (§ 4 No x)	AM	x							x (No 21)	x (No 21)	x (No 21)	x (No 21)										
				MSRT from ÜS																					
				ETto ÜS																					
				IS																					
				AD																					
			Building and object coater (§ 5 No x)[2]	AM		x (No 5)	x (No 5)	x (No 7)	x (No 7)		x (No 7, 8,9,10, 11, 12)	x (No 11)	x (No10)	x (No 10, 11, 12)	x (No 10, 11, 12)		x (No 11, 12)		x (No 13)	x (No 8)			x (No 12)	x (No 13)	x (No 8)
				MSRT from ÜS																					
				ETto ÜS																					
				IS																					
				AD	x																				
			Painter and varnisher, specialised in design and maintenance (§ 6 No 1 Point x), in addition to Building and object coater[2]	AM		x (Point e)	x (Point e)							x (Point k)	x (Point k)		x (Point k)		x (Point l)				x (Point k)	x (Point l)	
				MSRT from ÜS																					
				ETto ÜS																					
				IS																					
				AD	x																				
			Painter and varnisher, specialised in building and anti-corrosion protection (§ 6 No 3 Point x), in addition to Building and object coater[2]	AM													x (Point i)		x (Point m)			x (Point i)	x (Point i)	x (Point m)	
				MSRT from ÜS																					
				ETto ÜS																					
				IS																					
				AD	x																				
			Builder of stoves and air heating systems (§ 4 No x)	AM	x	x (No 5, 18)	x (No 18)	x (No 5)			x (No 6, 8, 9, 10)	x (No 14, 15)	x (No 9, 10)	x (No 8, 9, 10)	x (No 8, 10, 13, 15, 16, 17)	x (No 13, 15)	x (No 8)	x (No 11, 13)	x (No 5, 7, 13, 14)	x (No 6)			x (No 15, 16, 17)		x (No 6)
				MSRT from ÜS	x																				
				ETto ÜS																					
				IS																					
				AD	x																				
			Chimney sweep (§ 3 Para. 2 Point x No x)	AM	x	x (A No 10, B No 5)	x (A No 10, B No 5)	x (A No 1, 2, 4, 11)	x (A No 11, B No 6)	x (A No 11)	x (A No 4, B No 6,7)				x (A No 12)				x (B No 9)		x (A No 5,8, 9, 11)	x (A No 7 ,8. 9, 12)	x (A No 6)	x (A No 9)	x (B No 8)
				MSRT from ÜS	x																				
				ETto ÜS																					
				IS																					
				AD																					

[1] The systems involved here are electrical, HVAC and energy supply systems.

[2] The results in these building work categories are based on discussions with the respective trade associations.

AM	Plant mechanics
MSRT from ÜS	Measurement and control systems from the handover interface
ET to ÜS	Electrical systems from the mains to the handover interface
IS	Intelligent systems
AD	Plant insulation

Air-conditioning and refrigeration technology

As can be seen in Table 46, the "air-conditioning and refrigeration" subcategory to a large extent overlaps the occupations identified as relevant in the "heating" subcategory.[98] The "plant mechanic for sanitary, heating and air conditioning systems", the "construction finishing worker" specialised in tiling, and the "electronics technician" specialised in energy and building management systems relate to the same references for both subcategories in their respective apprenticeship frameworks.[99] For this reason, it is deemed unnecessary to repeat the explanations and comments already made with regard to the "heating" subcategory. Instead, we will only look at those occupations that differ from "heating" occupations. The two occupations involved here are the "mechatronics engineer for refrigeration technology" and the "builder of stoves and air heating systems" Whereas the latter is only involved in installing and maintaining systems, the "mechatronics engineer for refrigeration technology" is involved in the whole process and is presented in detail below.

To allow a more detailed presentation, air-conditioning and refrigeration technology is also subdivided into “points of reference”. The "refrigerant cycle" is chosen as one point of reference, as this requires specific qualifications for handling refrigerants, which are only found in the apprenticeship framework of the "mechatronics engineer for refrigeration technology".

Together with "plant mechanics", further point of reference are "measurement and control systems behind the handover interface", "electrics before the handover interface", "intelligent systems" and "plant insulation".

Occupations with a reference to measurement and control systems may perform such work on the facilities in question behind a previously defined handover interface. The decisive factor in this differentiation is that the different trades involved reach prior agreement on the definition of such a handover interface. The electrical cabling from the mains to this handover interface may only be done by certain trades, whereas the electrics on the other side of the interface are done by a generally larger number of trades.

Occupations listed as being related to the "electrics before the handover interface" are also allowed to do the in-house cabling from the mains to a predefined interface. Finally, the "intelligent systems" point of reference refers to work coordinating different systems within a building.

In the "air-conditioning and refrigeration" subcategory, the "plant mechanics" point of reference is covered by the "plant mechanic for sanitary, heating and air conditioning systems", the plumber, the "mechatronics engineer for refrigeration technology", the "builder of stoves and air heating systems" and the chimney sweep. The "measurement and control systems" point of reference is covered by the same occupations (apart from the plumber). The "construction finishing worker" specialised in tiling carries out preparatory work within these two points of reference. The "electronics technician" is however the only

[98] Cf. also Table 45.

[99] References generally refer to energy supply systems, whereby air conditioning systems are also included.

occupation covering the points of reference "electrics before the handover interface" and "intelligent systems".
When the "mechatronics engineer for refrigeration technology" provides a customer with advice, this involves recording customer requirements, passing them on to other staff within the company and explaining technical considerations, and instructing customers in the use and maintenance of the equipment.

The apprenticeship framework of the "mechatronics engineer for refrigeration technology" also includes planning processes. These include taking the relevant technical documentation and standards such as overall and explosion diagrams into consideration. Moreover they are expected to plan and determine the required work units and to coordinate their work with other trades.

As the next step, execution begins with setting up the building site and selecting appropriate materials and methods. The "mechatronics engineer for refrigeration technology" is listed here as having the qualification to select components and cables, to determine which tools and machines are necessary, to configure these, to differentiate between various insulation materials and their characteristics and to select appropriate test and measurement methods. This leads to measurement and test data being defined, which can then be used for deciding the next steps.
Finally, preparation also involves preparing the materials to be processed or installed, for instance through soldering or gluing components together, or through processing workpieces, components, pipes, metal sheets, protective equipment and profiles either manually or with machine tools. Switchgear is also wired according to wiring diagrams and cables are laid. This step also involves installing insulation material.
The "builder of stoves and air heating systems" is also involved in this step, installing air-conditioning systems.
Similarly plumbers are also involved in installing air-conditioning and refrigeration systems, building ducts for air-conditioning systems, covering ducts and pipes with panels, and installing pipes and ducts for air-conditioning systems.
Applying anti-corrosion coating is a task mapped to the next step, i.e. protection and sealing.
The "mechatronics engineer for refrigeration technology" similarly documents the work he has performed and carries out testing. Vacating the building site is not explicitly listed in the apprenticeship framework.

By contrast, handing over the systems to the customer and commissioning them is explicitly listed in the apprenticeship framework, as are qualifications related to the repair and maintenance of systems. This includes compliance with maintenance intervals and checking components for wear and tear or damage. The "mechatronics engineer for refrigeration technology" also checks possibilities of using different refrigerants and ways of increasing energy efficiency. Such measures will then be executed by the "mechatronics engineer for refrigeration technology". He is also listed as inspecting the systems, looking for any leaks

and documenting the results. The "builder of stoves and air heating systems" also performs maintenance on air-conditioning systems.

Finally the "mechatronics engineer for refrigeration technology" is listed as disposing of no longer usable components such as refrigerants and oil in an environmentally friendly manner.

Table 46: Evaluation of all work involving "air-conditioning and refrigeration"

Building work category	Building infrastructure	Ventilation and air-conditioning		Point of reference		Processes																						
						Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
						Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account ("Design implementation")	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / clearing materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commisioning
x	x	x	Plant mechanic for sanitary, heating and air conditioning systems (§ 4 Para. 1 Nox)	KMK		x (No 5, 20, 22.2)	x (No 5, 7,16, 20)	x (No 5,19)	x (No 5)	x (No 6,22.2)	x (No 5, 6, 9,15, 18,19,21,22.3)		x (No 8,10,11,18)	x (No 9,10, 11)	x (No 9,16, 18, 19)	x (No 16, 19)	x (No 21)	x (No 22.1)	x (No 5,6, 7,8, 19)	x (22.3)	x (No 22.2)	x (No 8, 13, 14, 19, 22.4)	x (No 13,22.4)	x (No 13)	x (No 19)
				AM	x																				
				MSRT from ÜS	x																				
				ET to ÜS																					
				IS																					
			Construction finishing worker, specialised in tiling (§ 4 Para. 1 No x)	KMK	x							x (No 18)													x (No 6)
				AM	x																				
				MSRT from ÜS	x																				
				ET to ÜS																					
				IS																					
			Electronics technician, specialised in energy and building management systems (§ 4 Para. 2 A No x)	KMK																					
				AM																					
				MSRT from ÜS	x	x (No 7, B No 1)	x (No 7, B No 1)	x (No 5, 6)	x (No 6)	x (No 6)	x (No 6, 8, B No 1)	x (No 9)	x (No 9)	x (No 9)	x (No 13, B No 2)	x (No 13, B No 2)	x (No 9, B No 2)	x (B No 2)	x (No 6, 13, B No 1g)	x (No 8)		x (B No 1, 6)	x (B No 6)		x (B No 6)
				ET to ÜS	x																				
				IS	x																				
			Plumber (§ 4 Nr. x)	KMK																					
				AM	x							x (No 21)	x (No 21)	x (No 21)	x (No 21)										
				MSRT from ÜS																					
				ET to ÜS																					
				IS																					
			Mechatronics engineer for refrigeration technology (§ 3 Para. 2 A No x)	KMK	x																				
				AM	x	x (B No 1)	x (B No 1)	x (B No 1)	x (B No 2)	x (B No 2)	x (No 2, 3, 4, B No 1, 3)	x (No 2, B No 3)	x (No 1)	x (No 3)	x (No 1, 2, 3, 4)	x (No 2, 3)	x (No 4)	x (No 3)	x (No 2, B No 4)		x (No 3, B No 1)	x (No 3, 5, 6, 8)	x (No 3, 5, 6, 8)	x (No 6)	x (No 3, 7)
				MSRT from ÜS	x																				
				ET to ÜS																					
				IS																					
			Builder of stoves and air heating systems (§ 4 No x)	KMK																					
				AM	x										x (No 16)								x (No 16)		x (No 6)
				MSRT from ÜS	x																				
				ET to ÜS																					
				IS																					
			Chimney sweep (§ 3 Para. 2 Point x No x)	KMK																					
				AM	x	x (A No 10, B No 5)	x (A No 10, B No 5)	x (A No 1, 2, 4, 11)	x (A No 11, B No 6)	x (A No 11)	x (A No 4; B No 6,7)				x (A No 12)				x (B No 9)		x (A No 5,8, 9, 11)	x (A No 7 ,8. 9, 12)	x (A No 6)	x (A No 9)	x (B No 8)
				MSRT from ÜS	x																				
				ET to ÜS																					
				IS																					

[1] The systems involved here are electrical, HVAC and energy supply systems.

KMK	Refrigerant circuit
AM	Plant mechanics
MSRT from ÜS	Measurement and control systems from the handover interface
ET to ÜS	Electrical systems from the mains to the handover interface
IS	Intelligent systems

Interior walls and floors

Looking at the "interior walls and floors" subcategory, we first need to look at the different specialisations of the "construction finishing worker", all of which are applicable to this subcategory. Moreover, there are a number of other occupations also offering qualifications in support of the processes involved. These include the "building and object coater", the "painter and varnisher", the "floor layer", the "building construction worker", the "parquet layer", the interior decorator, the "stonemason and sculptor" and the joiner. The "pre-fab concrete element manufacturer" and the "concrete block and terrazzo manufacturer" are also involved in the execution process.

What first meets the eye is that the "construction finishing worker", although involved in most other processes, is not involved in advising customers. Instead, this process is the domain of the "building and object coater", the "painter and varnisher", the interior decorator, the "stonemason and sculptor", the "parquet layer", the "floor layer" and the joiner. These occupations record customer requirements before actual execution, possibly also passing them on to other departments in the company. They may also be seen preparing samples for customers and discussing them with them. Turning to the second advisory step, i.e. providing the customer with information for instance on the next steps or on necessary maintenance of restoration work, several other occupations are also involved, as can be seen in Table 47.

The planning process is carried out not just by the occupations just referred to, but also by the "construction finishing worker" with his various specialisations and by the "building construction worker". As already discussed in detail in the other subcategories, compliance with the relevant standards and technical regulations, the planning of the various steps involved in the work, as well as coordinating the work with other trades on the building site are all features of the planning process. The only occupations whose apprenticeship frameworks do not explicitly list this qualification are the "building and object coater" (and thereby implicitly the "painter and varnisher") and the "stonemason and sculptor". The "concrete block and terrazzo manufacturer" and the "pre-fab concrete element manufacturer" are not involved in this process at all.

Execution of wall and flooring work is accompanied by a wide range of organisational measures, in which all occupations identified as being relevant are involved.[100]
Preparatory work plays an important role in the field of wall and flooring work, as can be seen by the high number of occupations covering this process step. We will start with the "construction finishing worker", who assesses and possibly prepares the surfaces to be worked on, for example for tiling or drylining. The "construction finishing worker" in all specialisations apart from "carpentry work" checks surfaces with regard to any damage or

[100] As these measures have already been discussed in detail with respect to the other subcategories, they are not repeated here.

contamination and whether they are smooth enough or possible damp. In the specialisations "tiling work" and "screed work", this also involves laying bonding courses in preparation of pouring screed. In addition the "construction finishing worker" specialised in tiling or plastering will affix mesh before mixing and applying plaster. The "stuccoist" also builds substructures for cornices, sills and pillars, as does the "thermal and noise insulation fitter".
Checking the surface to be worked on, including checking whether previously applied plaster is dry enough, is done by the "building and object coater", the "stonemason" and the "parquet layer". The interior decorator will also check for any cables or pipes under the surface.
Once this on-site preparatory work has been finished, the next step involves preparing materials.[101] All "construction finishing workers" whatever their specialisation are listed as having the qualification to cut and shape tiles before they are laid.[102] They similarly mix plaster, cut drylining panels to shape for use in covering ceilings and walls. In addition the "construction finishing worker" specialised in tiling and screed flooring will mix mortar and screed before pouring, stamping and levelling it. Where specialised in thermal and noise insulation work, he will be found cutting metal panels to shape before using them to protect surfaces. For making concrete floors, the “screed floorer” will mix concrete. Similarly, the "dry construction builder" cuts the panels to shape and makes any necessary holes before fitting them to ceilings and walls.
The "parquet layer" is also involved in this process step, preparing adhesives and separation layers before actually laying the parquet or other wooden flooring.
Finally the "thermal and noise insulation fitter" cuts insulation material to shape before installing it. This last task is also carried out by the "construction finishing worker" in a range of specialisations,[103] as well as mixing and applying plaster.[104]
A number of further occupations are involved in processing and installation work in the "walls and floors" subcategory. It would not be very meaningful to look at all occupations in any great detail. For this reason, only the occupations identified as being of major interest in the "floors and walls" subcategory are looked at. A detailed overview of all qualifications found in the apprenticeship frameworks can be found in Table 47.
Work with wall and floor coverings, as well as with other components and materials, is performed by a range of occupations, including the "building and object coater", the joiner, the "floor layer", the "parquet layer" and the interior decorator. The "floor layer", the "parquet layer" and the interior decorator similarly design and lay flooring on surfaces that have been prepared beforehand. Laying prefinished flooring and layered materials also belongs to a "floor layer's" qualifications, whereas the "parquet layer" will be found laying parquet and other forms of wooden flooring.

[101] It should be pointed out that there is no clear delimitation between the individual steps.
[102] The explanations regarding the individual specialisations of the 2-year "construction finishing worker" apprenticeship generally apply to the 3-year apprenticeships based on these specialisations. Moreover the latter generally provide more detailed information on the qualifications.
[103] The one exception here is the "carpenter" specialisation.
[104] The mixing and application of plaster is done in all "construction finishing worker" specialisations.

The "pre-fab concrete element manufacturer" and the "concrete block and terrazzo manufacturer" are also involved in flooring, working with plaster and laying tiles. They also lay pre-fabricated concrete elements. The joiner and the "parquet layer" also produce and treat wooden flooring and panelling.
The "painter and varnisher" and the interior decorator are to be found working on walls, for example applying wallpaper. Both the "painter and varnisher" and the joiner install insulation. Where specialised in design and maintenance, the "painter and varnisher" also makes composite insulation and finish systems, and installs protection against the cold and damp.
The design and decorating of rooms and the installation of shutters and screens is done by the interior decorator.
The process step of protecting and sealing surfaces is covered by all specialisations of the "construction finishing worker", with him doing the grouting and, when specialised in "carpentry work" also impregnating, varnishing and sealing wooden surfaces. Where specialised in "screed work", he will also be found protecting (parts of) a building against non-pressing water.
Wood and building preservation measures are executed by a range of further occupations, including the "building and object coater", the "parquet layer", the "floor layer" and the joiner. The "painter and varnisher" specialised in design and maintenance is also listed as being qualified to apply impregnation and fixing substances for this purpose. The sealing of grouts is also listed for the above-mentioned occupations, as well as for the "floor layer", the "parquet layer" and the interior decorator. The maintenance and preservation of surfaces is a further skill listed in the apprenticeship frameworks of the "building and object coater", the joiner, the "pre-fab concrete element manufacturer" and the "concrete block and terrazzo manufacturer". Similarly, the sealing of floors is listed for the "floor layer" and the "parquet layer", while the "painter and varnisher" is responsible for performing sealing work, applying special coatings and sealants. Furthermore, the "painter and varnisher" in the specialisation identified here as being relevant is listed as being qualified to apply coating and assembly techniques aimed at reducing heat losses.
The interior decorator is further listed as being qualified to coat walls and ceilings, while the joiner will also be found connecting up and sealing different building elements.
Documentation of the work performed and checking it for any faults is, as can be seen in Table 47, a qualification found in most of the occupations discussed here, as is clearing up and vacating the building site.

Quality assurance and customer acceptance of the work performed is listed in the apprenticeship framework of the joiner, where it is explicitly stated that he hands over the work performed to the customer. This qualification is similarly to be found for the "parquet layer" and the "floor layer", who are not just responsible for gaining customer acceptance but also document the handing over. The other occupations identified as relevant in this subcategory are not listed as having qualifications in this process step.

Turning to the field of repair and maintenance, what first meets the eye is that the "construction finishing worker", whatever his specialisation, is for the most part not involved in this step. The only specialisation listing the skill of determining and remedying damage is that of "plastering". By contrast all 3-year apprenticeships in the field of finishing work are listed as having the skill to recognise (parts of) a building worth preserving and to undertake measures to protect such. In addition the "tile and mosaic layer" will check surfaces for damage and perform any necessary repair work. The “screed floorer” similarly checks screed floors for any damage, and carries out any necessary repairs. The same applies to the "dry construction builder" and the "thermal and noise insulation fitter", who will ascertain the need to refurbish and repair dry-lined walls and thermal and noise insulation, and carry out all necessary work.
The "building and object coater" also carries out repair and maintenance work on walls and floors, while the "painter and varnisher" specialised in design and maintenance is listed as refurbishing rooms and repairing cracks in the plaster.
The "parquet layer" and the "floor layer" are responsible for the repair and maintenance of parquet, other wooden floors and carpeting as well as restoring parquet and other wooden floors. In this connection, they also cover - together with the interior decorator - the whole maintenance process from the assessment of the refurbishment work needing to be done to documenting the work they have performed.
Last but not least, the joiner assesses facilities worth preserving, carries out any necessary restoration work and documents it.

In the "walls and floors" subcategory, the disposal of waste and no longer usable materials is listed for the "parquet layer" and the joiner.

Table 47: Evaluation of the "interior walls and floors" subcategory

				Processes																				
				Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
				Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account (*Design implementation*)	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organizational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[3]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
Building work category	Building infrastructure	Interior walls and flooring	Construction finishing worker, specialised in tiling (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9,10,13,14, 15, 16, 17, 18)	x (No13,15,16, 17, 18)	x (No16, 17,18)	x (No 15,16, 17,18)	x (No 14, 15,18)		x (No 17,18)		x (No 5,19)	x (No 6)					x (No 6)
			Tile and mosaic layer, in addition to Construction finishing worker, specialised in tiling (§ 48 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6, 7)			x (No 7)	x (No 7)				x (No 5, 10)	x (No 6)		x (No 5, 9)	x (No 5, 9)		
			Construction finishing worker, specialised in plastering (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9,10,13,14,15, 16, 17, 18)	x (No 13, 15,17, 18)	x (No17,18)	x (No 15,17,18)	x (No14, 15,18)		x (No 17, 18)		x (No 5)	x (No 6)		x (No 15)	x (No 15)		x (No 6)
			Stuccoist, in addition to Construction finishing worker, specialised in plastering (§ 63 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6)	x (No 8)		x (No 8)	x (No 7)					x (No 6)		x (No 5)	x (No 5)		
			Construction finishing worker, specialised in carpentry (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9,10,15, 16, 17, 18)	x (No 17, 18)	x (No17,18)	x (No10, 15,17,18)	x (No 10,15,18)		x (No 10, 17,18)		x (No 5,19)	x (No 6)					x (No 6)
			Construction finishing worker, specialised in screed flooring (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9,10,13, 14,15, 16, 17, 18)	x (No13,16, 17, 18)	x (No16, 17,18)	x (No 15,16,17,18)	x (No 14,15,16)		x (No16, 17,18)		x (No 5,19)	x (No 6)					x (No 6)
			Screed layer, erg. zu Construction finishing worker, specialised in screed flooring (§ 53 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6, 10)		x (No 11)	x (No 8, 9, 10, 11)	x (No 7, 8, 11)		x (No 8)		x (No 13)	x (No 6)		x (No 5, 12)	x (No 5, 12)		
			Construction finishing worker, specialised in drylining (§ 11 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6,7,8,9,10, 13, 14, 15, 16, 17, 18)	x (No 13, 17, 18)	x (No17,18)	x (No 15,17,18)	x (No 14, 15, 18)		x (No 17,18)		x (No 5, 19)	x (No 6)					x (No 6)
			Dry construction builder, erg. zu Construction finishing worker, specialised in drylining (§ 63 No x)			x (No 5)	x (No 5)	x (No 5)	x (No 6)		x (No 7,8)	x (No 7,8)	x (No 7,8)				x (No 5, 10)	x (No 6)		x (No 5, 9)	x (No 5, 9)		

7.3.5 Evaluation results in the "energy supply" building work category

Geothermal systems

The "geothermal systems" subcategory is the domain of the "civil engineering worker" (the 2-year apprenticeship) and the "well builder" and the "special civil engineering works builder" (3-year apprenticeships building on the "civil engineering worker" apprenticeship). These occupations are responsible for drilling the holes needed to install a geothermal system. The "electronics technician" specialised in energy and building management systems is subsequently responsible for installing and connecting up the geothermal systems.[105]

To allow a more detailed presentation, the geothermal systems subcategory is also subdivided into “points of reference”. The "refrigerant cycle" is chosen as one point of reference, as this requires specific qualifications for handling refrigerants, which are only found in the apprenticeship framework for the "mechatronics engineer for refrigeration technology". Moreover, as in the "heating" subcategory, the following points of reference are also used here: "plant mechanics", "measurement and control systems behind the handover interface", "electrics before the handover interface" and "intelligent systems".
Occupations with a reference to measurement and control systems may perform such work on the facilities in question behind a previously defined handover interface. The decisive factor in this differentiation is that the different trades involved reach prior agreement on the definition of such a handover interface. The electrical cabling from the mains to this handover interface may only be done by certain trades, whereas the electrics on the other side of the interface are done by a generally larger number of trades.
Occupations listed as being related to the "electrics before the handover interface" are also allowed to do the in-house cabling from the mains to a predefined interface. Finally, the "intelligent systems" point of reference refers to work coordinating different systems within a building. Occupations with a reference to measurement and control systems may perform such work on the facilities in question behind a previously defined handover interface. This point of reference is different to the "electrics before a defined handover interface". Occupations needing to take this differentiation into account may in addition be responsible for the building's internal cabling up to a predefined interface. Finally, the "intelligent systems" point of reference refers to work coordinating different systems within a building.
In the "geothermal systems" subcategory, the "plant mechanics" point of reference is assigned to the "plant mechanic for sanitary, heating and air conditioning systems", to the "mechatronics engineer for refrigeration technology", and - in the sense of preparatory measures - the "civil engineering worker", the "well builder" and the "special civil engineering works builder". The "measurement and control systems" point of reference is similarly assigned to the "plant mechanic for sanitary, heating and air conditioning systems" and the "mechatronics engineer for refrigeration technology". The "electronics technician" is

[105] After consultation with the Federation of the German Electrical and Information Technology Crafts, though the "electronics technician" is involved in work on "geothermal systems", this is not in any depth.

the only occupation assigned to working on the "electrics before the handover interface" and to "intelligent systems".

Looking at the individual process steps, the "provision of advice" step is found in the apprenticeship framework of the "electronics technician". The "civil engineering worker", the "well builder" and the "special civil engineering works builder" are not listed as having this qualification. Nevertheless they are involved in the planning process, planning their work in accordance with technical regulations, inspecting the preliminary work of other trades and determining what steps need to be taken.
Alongside such preparatory / organisational measures, they also do excavation work. The "civil engineering worker" will make the necessary holes in the foundations and walls, while the "well builder" will drill down vertically, and prepare and fill the bore-holes. The "special civil engineering works builder" bores holes, in particular for installing piles, supports and anchors.
The "electronics technician" also carries out preparatory work, testing the suitability of surfaces for mounting equipment and deciding on where the cabling and devices are to be installed. He subsequently installs and commissions the decentral energy supply and conversion systems (including systems using regenerative energy sources).

Documentation of the work performed and clearing up and vacating the building site are tasks carried out by all occupations identified as being relevant.

Quality assurance and customer acceptance measures are not listed in the apprenticeship frameworks of the occupations identified as being relevant. With regard to repair and maintenance, the "well builder" can be mentioned here, as he performs repair and maintenance work on wells and shafts (also preparing the work and documenting what he has done). Moreover the "electronics technician" carries out repair work, mainly through replacing electronic components.

The identification of hazardous waste and devices and their disposal is also listed as an "electronics technician" qualification.

Table 48: Evaluation of all work involving geothermal systems

Building work category	Energy supply	Geothermal systems		Point of reference		Processes: Provision of advice – Discussing and recording customer requirements (PRIOR to execution)	Provision of advice – Informing customers (AFTER execution)	Planning – Taking requirements into account ("Design implementation")	Planning – Choice of measures	Planning – Coordination of measures with other trades / firms	Execution – Preparatory / organisational measures / choice of materials / site preparation	Execution – On-site preparatory measures / excavation work	Execution – Preparing building materials	Execution – Processing building materials	Execution – Installation work	Execution – Connection work[1]	Execution – Preservation / sealing / insulation	Execution – Commissioning	Execution – Documentation / checks	Execution – Site clearance	Quality assurance and acceptance – Customer acceptance and commissioning	Repairs and maintenance – Preparing repair / maintenance measures	Repairs and maintenance – Executing repair / maintenance measures	Repairs and maintenance – Documentation	Disposal – Disposal / de-commissioning
			Civil engineering worker, specialised in well building and other special civil engineering work (§ 17 No x) [2]	AM	x																				
				MRST from ÜS				x (No 5)	x (No 5)	x (No 5)	x (No 6,7, 8, 9, 15)	x (No 15)							x (No 16)	x (No 6)					x (No 6)
				ET to ÜS																					
				IS																					
				KMK																					
			Well builder, in addition to Civil engineering worker, specialised in well building and other special civil engineering work (§ 83 No x) [2]	AM	x																				
				MRST from ÜS					x (No 5)	x (No 5)	x (No 6, 8, 9)	x (No 9, 11)			x (No 7, 12)				x (No 15)	x (No 6)			x (No 14)	x (No 14)	
				ET to ÜS																					
				IS																					
				KMK																					
			Special civil engineering works builder, in addition to Civil engineering worker, specialised in well building and other special civil engineering work [2]	AM	x																				
				MRST from ÜS					x (No 5)	x (No 5)	x (No 6, 7, 8, 10)	x (No 11)			x (No 9)				x (No 17)	x (No 6)					
				ET to ÜS																					
				IS																					
				KMK																					
			Electronics technician, specialised in energy and building management systems (§ 4 Para. 2 No x)	AM																					
				MRST from ÜS	x	x (A No 7; B No 1)	x (A No 7; B No 1)	x (No 5, 6)	x (No 6)	x (No 6)	x (A No 6, 8; B No 1)	x (No 9)	x (No 9)	x (No 9)	x (A No 9, B No 2)	x (B No 2)	x (B No 2)	x (B No 2)	x (No 6, 9, 13, B No 1g)	x (No 8)		x (B No 1, 6)	x (B No 6)		x (B No 6)
				ET to ÜS	x																				
				IS	x																				
				KMK																					
			Plant mechanic for sanitary, heating and air conditioning systems (§ 4 Para. 1 No x)	AM	x																				
				MRST from ÜS	x	x (No 20)	x (No 20, 22.2)	x (No 5,19)	x (No 5)	x (No 6,22.2)	x (No 5, 6, 15, 18,19,21,22.3)		x (No 18)	x (No 10, 11)	x (No 15, 16, 18,19)	x (No 16,19)	x (No 21)	x (No 22.1)	x (No 5,6, 7,19)	x (22.3)	x (No 22.2)	x (No 13,19,22.4)	x (No 13, 21, 18,22.4)	x (No 13)	x (No 19)
				ET to ÜS																					
				IS																					
				KMK																					
			Mechatronics engineer for refrigeration technology (§ 3 Para. 2 No x)	AM	x																				
				MRST from ÜS	x	x (B No 1)	x (B No 1)	x (B No 1)	x (B No 2)	x (B No 2)	x (A No 2, 3, 4, B No 1, 3)	x (A No 2, B No 3)	x (A No 1)	x (A No 3)	x (A No 1, 2, 3, 4)	x (A No 2, 3)	x (A No 4)	x (A No 2, 3)	x (A No 2, B No 4)		x (A No 3, B No 1)	x (A No 3, 5, 6, 8)	x (A No 5, 6, 8)	x (A No 6)	x (A No 3, 7)
				ET to ÜS																					
				IS																					
				KMK	x																				

[1] The systems involved here are electrical, HVAC and energy supply systems.

AM	Plant mechanics
MRST from ÜS	Measurement and control systems from the handover interface
ET to ÜS	Electrical systems from the mains to the handover interface
IS	Intelligent systems

Biomass systems

Qualifications in the "biomass systems" subcategory are to be found with the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems", but also with the "electronics technician" and the chimney sweep.

As in the "heating" subcategory, the following points of reference are also used for biomass systems: "plant mechanics", "measurement and control systems", "electrics before the handover interface" and "intelligent systems".

Occupations with a reference to measurement and control systems may perform such work on the facilities in question behind a previously defined handover interface. The decisive factor in this differentiation is that the different trades involved reach prior agreement on the definition of such a handover interface. The electrical cabling from the mains to this handover interface may only be done by certain trades, whereas the electrics on the other side of the interface are done by a generally larger number of trades.

Occupations listed as being related to the "electrics before the handover interface" are also allowed to do the in-house cabling from the mains to a predefined interface. Finally, the "intelligent systems" point of reference refers to work coordinating different systems within a building.

References to "plant mechanics" are to be found with the "plant mechanic for sanitary, heating and air conditioning systems", the "builder of stoves and air heating systems" and the chimney sweep. All occupations identified as being relevant to "biomass systems" have a reference to measurement and control systems, though only the "electronics technician" is qualified for work on the "electrics before the handover interface" and "intelligent systems".

All occupations involved in biomass systems participate in both advising customers and planning.[106] A special focus here is on the "plant mechanic for sanitary, heating and air conditioning systems", who is explicitly listed as having the skill to advise his customers on possibilities of using renewable energy sources.

Turning to the execution process, the assembly of components is listed as a skill in both occupations, alongside preparatory / organisational measures. The "plant mechanic for sanitary, heating and air conditioning systems" for instance installs electronic components in energy supply systems, as well as measurement, control and safety devices. He also (de-) installs pipes and ducts and energy supply systems.

The chimney sweep is also involved in the component installation process step, installing or renewing for instance secondary air cleaning devices and cleaning valves or mounting chimney terminals.

[106] This has already been discussed elsewhere. For this reason an in-depth discussion of the qualifications in the advisory and planning steps is not repeated here.

The "builder of stoves and air heating systems" is explicitly listed as having the qualification to install pellet transport and storage systems. He is also qualified to connect up and commission biomass systems.
This is also done by the "electronics technician" specialised in energy and building management systems, who is qualified to install and commission decentral energy supply and conversion systems, including the use of regenerative energy sources. The execution of anti-corrosion measures on pipes is done by both the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems".
Documentation, testing systems, and vacating the building site are tasks done by all the occupations identified here as being relevant.

Handing over a system to its operator, including compiling a customer acceptance protocol, is a qualification listed in the apprenticeship framework of both the "plant mechanic for sanitary, heating and air conditioning systems" and the chimney sweep. The latter is qualified to inspect systems and buildings with regard to compliance with fire protection, emission, and health & safety standards and to carry out the necessary measurements, with the compilation of customer acceptance and commissioning protocols being listed in the apprenticeship framework.

Repair and maintenance of the systems is also done by all occupations in this subcategory. The "builder of stoves and air heating systems" is for instance listed as being qualified to repair pellet transport systems. The chimney sweep carries out measurements on combustion and ventilation systems and on other similar systems, ensuring their operational and fire safety. In addition he will detect any malfunctioning of combustion and ventilation systems, documenting such via measurement and test protocols. He also carries out measures aimed at enhancing energy efficiency.

Finally, the disposal of no longer used systems in an environmentally friendly manner is listed as a qualification for all occupations in their respective apprenticeship frameworks.

Table 49: Evaluation of all work involving biomass systems

				Processes																				
				Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
			Point of reference	Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account ("Design implementation")	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
Building work category	Energy supply	Biomass systems																						
			Plant mechanic for sanitary, heating and air conditioning systems (§ 4 Para. 1 No x)	AM x MRST from ÜS x ET to ÜS IS	x (No 20)	x (No 20, 22.2)	x (No 5,19)	x (No 5)	x (No 6,22.2)	x (No 5, 6, 15, 18,19,21,22.3)		x (No 8, 10, 11, 18)	x (No 9, 10, 11)	x (No 15, 16, 18,19)	x (No 14,16,19)	x (No 21)	x (No 22.1)	x (No 5,6, 7,19)	x (22.3)	x (No 22.2)	x (No 13,19,22.4)	x (No 13, 21, 18,22.4)	x (No 13)	x (No 19)
			Electronics technician, specialised in energy and building management systems (§ 4 Para. 2 Para. x No x)	AM MRST from ÜS x ET to ÜS x IS x	x (A No 7; B No 1)	x (A No 7; B No 1)	x (A No 5, 6)	x (A No 6)	x (A No 6)	x (A No 6, 8; B No 1)	x (A No 9)	x (A No 9)	x (A No 9)	x (A No 9, B No 2)	x (B No 2)	x (A B No 2)	x (A B No 2)	x (A No 6, 9, 13, B No 1g)	x (A No 8)		x (B No 1, 6)	x (B No 6)		x (B No 6)
			Builder of stoves and air heating systems (§ 4 No x)	AM x MRST from ÜS x ET to ÜS IS	x (No 18)	x (No 18)	x (No 5)	x (No 5)		x (No 6)	x (No 14, 15)	x (No 9, 10)	x (No 8, 9, 10)	x (Nr 15,17)	x (No 13, 15)	x (No 8)	x (No 11, 13)	x (No 5, 7, 13, 14)	x (No 6)			x (No 15, 16, 17)		x (No 6)
			Chimney sweep (§3 Para. 2 Point x No x)	AM x MRST from ÜS x ET to ÜS IS	x (A No 10, B No 5)	x (A No 10, B No 5)	x (A No 1, 2, 4, 11)	x (A No 11, B No 6)	x (A No 11)	x (A No 4; B No 6,7)				x (A No 12)				x (B No 9)		x (A No 5,8, 9, 11)	x (A No 7 ,8. 9, 12)	x (A No 6)	x (A No 9)	x (B No 8)

[1] The systems involved here are electrical, HVAC and energy supply systems.

AM	Plant mechanics
MRST from ÜS	Measurement and control systems from the handover interface
ET to ÜS	Electrical systems from the mains to the handover interface
IS	Intelligent systems

Solar heating

The greatest number of occupations involved in the "energy supply" category of building work is to be found in the "solar heating" subcategory. Alongside the occupations already mentioned (the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems"), we also find the roofer, the glazier, the "façade erector", the "electronics technician" specialised in energy and building management systems, the "building and object coater" and the "painter and varnisher".[107]

Solar heating is divided up into “points of reference” in the same way as "heating". Together with "plant mechanics", further point of reference are "measurement and control systems behind the handover interface", "electrics before the handover interface", "intelligent systems" and "plant insulation".

Occupations with a reference to measurement and control systems may perform such work on the facilities in question behind a previously defined handover interface. The decisive factor in this differentiation is that the different trades involved reach prior agreement on the definition of such a handover interface. The electrical cabling from the mains to this handover interface may only be done by certain trades, whereas the electrics on the other side of the interface are done by a generally larger number of trades.

Occupations listed as being related to the "electrics before the handover interface" are also allowed to do the in-house cabling from the mains to a predefined interface. Finally, the "intelligent systems" point of reference refers to work coordinating different systems within a building.

The "solar heating" subcategory has two further points of reference: the "roof” and the "facade", whereby the focus here is on attaching the solar heating elements to the roof / facade as parts of the building envelope. The initial cabling of the solar heating systems is also implied.

As in the "heating" subcategory, the "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems" are qualified for working with elements of the plant mechanics. In addition these occupations also have insulating the equipment as a point of reference, as does the "painter and varnisher". The "plant mechanic for sanitary, heating and air conditioning systems", the "builder of stoves and air heating systems" and the "electronics technician" specialised in energy and building management systems all have a reference to measurement and control systems, whereby the latter also works in the areas of "intelligent systems" and "electrics before the handover interface". Attaching the elements to the roof and their initial cabling is only done by the roofer and "metal worker", whereby these two, together with the "façade erector", the "painter and varnisher" and the "building and object coater" also carry out work on the facade.

[107] The mapping to these qualifications is based on discussions with the respective German Federation, the "Bundesverband Farbe Gestaltung Bautenschutz".

As the advisory and planning processes have already been discussed in connection with the other subcategories, this is no longer seen as necessary here. Moreover the references to the respective apprenticeship frameworks can be found in Table 50.

In the following, the execution process is described, whereby all the occupations identified as being relevant carry out organisational measures and select the appropriate materials. On-site preparations are mostly done by the "electronics technician", who checks surfaces with regard to their suitability for attaching the systems.
Preparing brackets and supports for installing the solar panels is assigned to the preparatory work done by the roofer.
The work of installing solar panels is by contrast something done by a number of the occupations identified as being relevant.[108] For instance the roofer and "façade erector" will install the energy collectors and converters and prepare them for connecting up. Similarly the glazier will install glass energy collection systems. The "builder of stoves and air heating systems" also installs water heat exchangers including solar heating components. The "painter and varnisher" also installs system elements and components (including their support structures),[109] as does the "building and object coater". The last two occupations are also qualified to insulate the solar heating systems.
Connecting up the solar systems to a building's heating system is the domain of the "plant mechanic for sanitary, heating and air conditioning systems", the "builder of stoves and air heating systems" and the "electronics technician" specialised in energy and building management systems. While the latter work on installing decentral energy supply and conversion systems including the use of regenerative energy sources, the "plant mechanic for sanitary, heating and air conditioning systems" is qualified to connect up the systems.
Commissioning solar heating systems is done by both occupations. While the "electronics technician" is explicitly listed as being qualified to commission the decentral energy supply and conversion systems he has installed, the "plant mechanic for sanitary, heating and air conditioning systems" also does such work, commissioning energy supply systems. All occupations identified as relevant here also document the work they have done and clear up and vacate the building site after finishing their work.

The glazier is explicitly listed as being qualified to repair and maintain solar heating systems, though all other occupations identified as being relevant are also involved. The roofer will for example replace defective elements on the roof, while the "plant mechanic for sanitary, heating and air conditioning systems" will check for any faults by visually inspecting all interfaces, finding the causes and carrying out any repairs necessary.

As can be seen in Table 50, a number of the occupations identified as being relevant are also listed as being responsible for disposing of no longer needed systems.

[108] We have desisted from repeating the discussion of the qualifications of the "plant mechanic for sanitary, heating and air conditioning systems", as these are the same as those discussed under "biomass systems".
[109] The focus here is on facade-mounted solar heating panels.

Table 50: Evaluation of all work involving solar heating systems

Building work category	Energy supply	Solar heating		Point of reference		Processes																				
						Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
						Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account (*Design implementation)	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
x	x	x	Plant mechanic for sanitary, heating and air conditioning systems (§ 4 Para. 1 No x)	AM	x	x (No 20)	x (No 20, 22.2)	x (No 5,19)	x (No 5)	x (No 6,22.2)	x (No 5, 6, 15, 18,19,21,22.3)		x (No 18)	x (No 10, 11)	x (No 15, 16, 18,19)	x (No 16,19)	x (No 21)	x (No 22.1)	x (No 5,6, 7,19)	x (22.3)	x (No 22.2)	x (No 13,19,22.4)	x (No 13, 21, 18,22.4)	x (No 13)	x (No 19)
				AD	x																				
				MRST from ÜS	x																				
				ET to ÜS																					
				IS																					
				D [3]																					
				F [3]																					
			Roofer, specialised in roof, wall and waterproofing technology (§ 4 Para. 1 No x)	AM				x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8,15, 16)	x (No 11)	x (No 15)	x (No 16, 20)	x (No 20)		x (No 15)		x (Para. 2 No 1g)	x (No 6)			x (No 20)		x (No 6)
				AD																					
				MRST from ÜS																					
				ET to ÜS																					
				IS																					
				D 3	x																				
				F 3	x																				
			Roofer, specialised in reed-thatch roofing techniques (§ 4 Para. 1 No x)	AM				x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8)	x (No 11)	x (No 15)	x (No 16, 20)	x (No 20)		x (No 15)		x (Para. 2 No 2g)	x (No 6)			x (No 20)		x (No 6)
				AD																					
				MRST from ÜS																					
				ET to ÜS																					
				IS																					
				D 3	x																				
				F 3	x																				
x	x	x	Electronics technician, specialised in energy and building management systems (§ 4 Para. 2 Section A No x)	AM		x (No 7, Section B No 1)	x (No 7, Section B No 1)	x (No 5, 6)	x (No 6)	x (No 6)	x (No 6,8, Section B No 1)	x (No 9)	x (No 9)	x (No 9)	x (No 9, Section B No 2)	x (Section B No 2)	x (Section B No 2)	x (Section B No 2)	x (No 6, 9, 13, Section B No 1g)	x (No 8)		x (Section B No 1, 6)	x (Section B No 6)		x (Section B No 6)
				AD																					
				MRST from ÜS	x																				
				ET to ÜS	x																				
				IS	x																				
				D 3																					
				F 3																					

Photovoltaic systems

Many of the occupations discussed in the solar heating subcategory are also qualified for working on photovoltaic systems. One further occupation is that of the "metal worker".[110]

The photovoltaic subcategory is also divided up into different “points or reference”. Alongside the "measurement and control systems behind the handover interface" point of reference, these are the "electrics before the handover interface" and "intelligent systems". Occupations with a reference to measurement and control systems may perform such work on the facilities in question behind a previously defined handover interface. The decisive factor in this differentiation is that the different trades involved reach prior agreement on the definition of such a handover interface. The handover interface for photovoltaic systems is defined as the inverter. The electrical cabling from the mains to this handover interface may only be done by certain trades, whereas the electrics on the other side of the interface are done by a generally larger number of trades.

Occupations listed as being related to the "electrics before the handover interface" are also allowed to do the in-house cabling from the mains to a predefined interface. Finally, the "intelligent systems" point of reference refers to work coordinating different systems within a building. The "photovoltaic (PV)" subcategory has two further points of reference: the "roof” and the "facade", whereby the focus here is on attaching the PV elements to the roof / facade as parts of the building envelope. The initial cabling of the solar heating systems is also implied.

The "electronics technician" specialised in energy and building management systems is the only occupation listed as carrying out work on "measurement and control systems", "electrics before the handover interface" and "intelligent systems". All other occupations in this subcategory have "roof" or "facade" qualifications. While the "building and object coater", the "painter and varnisher" and the "façade erector" are all involved in working on facade elements, the other occupations deal with roof work.

Due to the large amount of overlapping with solar heating subcategory, the following explanations refer solely to qualifications specific to PV systems.

The main focus here is on the "electronics technician" specialised in energy and building management systems, who, alongside connecting up and commissioning the systems, also carries out quality assurance and gains customer acceptance. In doing so, as can be seen in Table 51, he influences all process steps associated with PV systems.

The "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems" are also involved in many ways in PV-related processes, though actually connecting them up to the grid, commissioning them and gaining customer acceptance is not done by them.

[110] One of the focuses here is on facade-mounted PV systems.

As with solar heating systems, the roofer is mainly responsible for installing the PV elements on the roof, whereby this work also includes attaching supports and fixings. Turning to repair and maintenance, his main work involves replacing defective elements. The "metal worker" also carries out such work, though the focus is on attaching the elements to a building's facade. The "painter and varnisher" and the "building and object coater" similarly install system elements and carry out protection work. They are also involved in repair and maintenance work.

Table 51: Evaluation of all work involving photovoltaic systems

Building work category	Energy supply	Photovoltaic systems		Point of reference		Processes																				
						Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
						Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account ("Design implementation")	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organizational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
			Plant mechanic for sanitary, heating and air conditioning systems (§ 4 Para. 1 No x)	MSRT to ÜS		x (No 20)	x (No 20, 22.2)	x (No 5,19)	x (No 5)	x (No 6,22.2)	x (No 5, 6, 15, 18,19,21,22.3)				x (No 15, 16,19)				x (No 5,6, 7,19)						x (No 19)
				ET to ÜS [3]																					
				IS																					
				D [4]	x																				
				F [4]	x																				
			Roofer, specialised in roof, wall and waterproofing technology (§ 4 Para. 1 No x)	MSRT to ÜS				x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8)		x (No 15)	x (No 16, 20)	x (No 20)				x (Para. 2 No 1g)	x (No 6)			x (No 20)		x (No 6)
				ET to ÜS 3																					
				IS																					
				D 4	x																				
				F 4	x																				
			Roofer, specialised in reed-thatch roofing techniques (§ 4 Para. 1 No x)	MSRT to ÜS				x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8)		x (No 15)	x (No 16, 20)	x (No 20)				x (Para. 2 No 2g)	x (No 6)			x (No 20)		x (No 6)
				ET to ÜS 3																					
				IS																					
				D 4	x																				
				F 4	x																				
			Electronics technician, specialised in energy and building management systems (§ 4 Para. 2 Section A No x)	MSRT to ÜS	x	x (No 7, Section B No 1)	x (No 7; Section B No 1)	x (No 5, 6)	x (No 6)	x (No 6)	x (No 6, 8,Section B No 1)	x (No 9,11, 12)	x (No 9)	x (No 9)	x (No 9, Section B No 2)	x (Section B No 2)	x (Section B No 2)	x (Section B No 2)	x (No 6, 9, 13, Section B No 1g)	x (No 8)	x (No 7)	x (Section B No 1, 6)	x (Section B No 6)		x (Section B No 6)
				ET to ÜS 3	x																				
				IS	x																				
				D 4																					
				F 4																					
			Stuccoist (§ 5 No x)	MSRT to ÜS																					
				ET to ÜS 3		x (No 5)	x (No 5)	x (No 7)	x (No 7)		x (No 7, 8,9,10, 11, 12)	x (No 11)	x (No10)	x (No 10, 11, 12)	x (No 10, 11, 12)		x (No 11, 12)		x (No 13)	x (No 8)			x (No 12)	x (No 13)	x (No 8)
				IS																					
				D 4																					
				F 4	x																				

Combined heat and power (CHP) systems

As can be seen in Table 52, the "plant mechanic for sanitary, heating and air conditioning systems", the "builder of stoves and air heating systems", the "electronics technician" and the chimney sweep can be assigned to the "CHP systems" subcategory.

Individual “points of references” were also used in the "CHP systems" subcategory for differentiation purposes. Together with "plant mechanics", further points of reference are "measurement and control systems behind the handover interface", "electrics before the handover interface", "intelligent systems" and "plant insulation". Occupations with a reference to measurement and control systems may perform such work on the facilities in question behind a previously defined handover interface. The decisive factor in this differentiation is that the different trades involved reach prior agreement on the definition of such a handover interface. The electrical cabling from the mains to this handover interface may only be done by certain trades, whereas the electrics on the other side of the interface are done by a generally larger number of trades.
Occupations listed as being related to the "electrics before the handover interface" are also allowed to do the in-house cabling from the mains to a predefined interface. Finally, the "intelligent systems" point of reference refers to work coordinating different systems within a building. While the "plant mechanic for sanitary, heating and air conditioning systems", the "builder of stoves and air heating systems" and the chimney sweep all have references to "plant mechanics", the "electronics technician" has references to "measurement and control systems", "electrics before the handover interface" and "intelligent systems".

Advisory and planning processes are carried out by the "electronics technician" in this subcategory, with him ascertaining customer requirements with regard to energy and building management systems, and developing and evaluating different solutions. In his apprenticeship framework, the chimney sweep is also listed as being qualified to give advice on combustion and ventilation systems and their use, as well as on ways of using energy efficiently. Looking at the planning process, he also covers the field of compliance with fire regulations and other regulations common to various trades, as well as compiling and evaluating technical documents. The "plant mechanic for sanitary, heating and air conditioning systems" and the "builder of stoves and air heating systems" are not involved in these processes at journeyman level.

Preparatory / organisational measures are performed by all occupations. In checking the suitability of surfaces, the "electronics technician" is explicitly listed as carrying out preparatory work.
The installation of the CHP systems is by contrast done by all occupations involved in this subcategory, whereby the "plant mechanic for sanitary, heating and air conditioning

systems" and the "electronics technician" are qualified to connect up CHP systems.[111] Commissioning is the sole responsibility of the "electronics technician" specialised in energy and building management systems.
Documenting the work done and clearing up and vacating the building site are done by all occupations identified as relevant.

Gaining customer acceptance for a CHP system is done by the "electronics technician" and the chimney sweep. The latter is qualified to inspect systems and buildings with regard to compliance with fire protection, emission, and health & safety standards and to carry out the necessary measurements. His apprenticeship framework also lists creating customer acceptance and commissioning protocols.

Repair and maintenance work is performed by all occupations identified as being relevant, though to different degrees. Similarly all occupations listed here are involved in the disposal process.

[111] The Federal Plumbing Association (Fachverband Sanitär Heizung Klima) explicitly pointed out that this skill mainly targets micro CHP systems.

Table 52: Evaluation of all work involving CHP systems

			Point of reference		Processes																				
					Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
					Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account ("Design implementation")	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
Building work category	Energy supply	CHP	**Plant mechanic for sanitary, heating and air conditioning systems (§ 4 Abs. 1 No x)**	AM	x					x (No 5, 6, 15, 18,19,21,22.3)				x (No 15, 16, 18,19)	x (No 15,16,19)			x (No 5,6, 7,19)	x (22.3)		x (No 13,19,22.4)	x (No 13, 21, 18,22.4)	x (No 13)	x (No 19)
				MRST from ÜS	x																			
				ET to ÜS																				
				IS																				
			Electronics technician; specialised in energy and building management systems (§ 4 Abs. 2 Section A No x)	AM																				
				MRST from ÜS	x	x (No 7, Section B No 1)	x (No 7, Section B No 1)	x (No 5, 6)	x (No 6)	x (No 6)	x (No 6, 8; Section B No 1)	x (No 9,11, 12)	x (No 9)	x (No 9)	x (No 9, Section B No 2)	x (Section B No 2)	x (Section B No 2)	x (Section B No 2)	x (No 6, 9, 13, Section B No 1g)	x (No 8)	x (No 7)	x (Section B No 1, 6)	x (Section B No 6)		x (Section B No 6)
				ET to ÜS	x																			
				IS	x																			
			Builder of stoves and air heating systems (§ 4 No x) 2	AM	x																			
				MRST from ÜS	x					x (No 6)	x (No 14)			x (No 15)				x (No 5, 7, 13, 14)	x (No 6)			x (No 17)		x (No 6)
				ET to ÜS																				
				IS																				
			Chimney sweep (§ 3 Abs. 2 Point x No x)	AM	x																			
				MRST from ÜS	x	x (A No 10, B No 5)	x (A No 10, B No 5)	x (A No 1, 2, 4, 11)	x (A No 11, B No 6)	x (A No 11)	x (A No 4; B No 6,7)			x (A No 12)				x (B No 9)		x (A No 5,8, 9, 11)	x (A No 7 ,8. 9, 12)	x (A No 6)	x (A No 9)	x (B No 8)
				ET to ÜS																				
				IS																				

[1] The systems involved here are electrical, HVAC and energy supply systems.
[2] The results in these building work categories are based on discussions with the respective trade associations.

AM	Plant mechanics
AD	Plant insulation
MRST from ÜS	Measurement and control systems from the handover interface
ET to ÜS	Electrical systems from the mains to the handover interface
IS	Intelligent systems

Wind turbines

Our analysis of apprenticeship frameworks with regard to the "wind turbines" subcategory came up with no concrete indications of occupations directly listed as having qualifications in this field. The following remarks are therefore based on interviews conducted with the experts from the respective trade associations. The occupations seen as relevant in this context are the roofer[112], the "metal worker" and the "electronics technician" specialised in energy and building management systems.

As with the subcategories discussed above, the "wind turbines" subcategory is also divided up into different “points of reference”. To start with, we have the electrical points of reference: "measurement and control systems", "electrics before the handover interface" and "intelligent systems". Occupations with a reference to measurement and control systems may perform such work on the facilities in question behind a previously defined handover interface. The decisive factor in this differentiation is that the different trades involved reach prior agreement on the definition of such a handover interface. The electrical cabling from the mains to this handover interface may only be done by certain trades, whereas the electrics on the other side of the interface are done by a generally larger number of trades.
Occupations listed as being related to the "electrics before the handover interface" are also allowed to do the in-house cabling from the mains to a predefined interface. Finally, the "intelligent systems" point of reference refers to work coordinating different systems within a building.
In addition, as already used in the "solar heating" and "photovoltaic" subcategories, the "roof" is chosen as a point of reference, as the installation of a wind turbine involves erecting it on a building's roof. The initial cabling of the wind turbines is also implied. Work on installing a wind turbine and its initial cabling is done by the roofer and the "metal worker", whereas all other points of reference are the domain of the "electronics technician".

Advising customers is done by the "electronics technician". Planning is done not only by the "electronics technician", but also to a certain extent by the roofer. All occupations identified as being relevant are involved in the execution phase. Alongside normal preparatory work, both the "metal worker" and the roofer need to prepare certain materials. These two occupations also do the work of actually installing the turbine. The work of connecting up and commissioning the turbine is done solely by the "electronics technician", who will also carry out all preparatory electrical work.

[112] The roofer is involved in "mini" wind turbines capable of being installed on house roofs.

Quality assurance and customer acceptance are not carried out by any of these occupations. As seen in other subcategories of the energy supply category, both the "electronics technician" and the roofer carry out repair and maintenance work, as well as disposing of no longer needed equipment.

Table 53: Evaluation of all work involving wind turbines

				Point of reference		Processes																				
						Provision of advice		Planning			Execution										Quality assurance and acceptance	Repairs and maintenance			Disposal
						Discussing and recording customer requirements (PRIOR to execution)	Informing customers (AFTER execution)	Taking requirements into account (" design implementation ")	Choice of measures	Coordination of measures with other trades / firms	Preparatory / organisational measures / choice of materials / site preparation	On-site preparatory measures / excavation work	Preparing building materials	Processing building materials	Installation work	Connection work[1]	Preservation / sealing / insulatoin	Commissioning	Documentation / checks	Site clearance	Customer acceptance and commissioning	Preparing repair / maintenance measures	Executing repair / maintenance measures	Documentation	Disposal / de-commissioning
Building work category	Energy supply	Wind turbines	Metal worker (§ 4 Para. 2 Section A No x)[2]	MSRT from ÜS							x (A No 5, 6, 8, 18; B No 2, 3)	x (A No 8, B No 4)	x (A No 8, 9, 10, 11, 13, 14, 15, 16, 18, B No 3, 4)		x (A No 9, 15, 18, B No 1, 6)									
				ET to ÜS																				
				IS																				
				D[3]	x																			
			Electronics technician, specialised in energy and building management systems (§ 4 Para. 2 Section A No x)[2]	MSRT from ÜS	x	x (No 7, Section B No 1)	x (No 7, Section B No 1)	x (No 5, 6)	x (No 6)	x (No 6)	x (No 6, 8; Section B No 1)	x (No 9, 11, 12)	x (No 9)	x (No 9)	x (No 9, Section B No 2)	x (Section B No 2)	x (Section B No 2)	x (Section B No 2)	x (No 6, 9, 13, Section B No 1g)	x (No 8)		x (Section B No 1, 6)	x (Section B No 6)		x (Section B No 6)
				ET to ÜS	x																			
				IS	x																			
				D[3]																				
			Roofer, specialised in roof, wall and waterproofing technology (§ 4 Para. 1 No x)[2]	MSRT from ÜS				x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8,15, 16)	x (No 11)	x (No 15)	x (No 16, 20)	x (No 20)		x (No 15)		x (Para. 2 No 1g)	x (No 6)			x (No 20)		x (No 6)
				ET to ÜS																				
				IS																				
				D[3]	x																			
			Roofer, specialised in reed-thatch roofing techniques (§ 4 Para. 1 No x)[2]	MSRT from ÜS				x (No 5, 8)	x (No 5)	x (No 5)	x (No 6,7,8)	x (No 11)	x (No 15)	x (No 16, 20)	x (No 20)		x (No 15)		x (Para. 2 No 2g)	x (No 6)			x (No 20)		x (No 6)
				ET to ÜS																				
				IS																				
				D[3]	x																			

[1] The systems involved here are electrical, HVAC and energy supply systems.
[2] The results in these building work categories are based on discussions with the respective trade associations.
[3] Alongside mounting these elements, this differentiation also includes the preliminary cabling of the modules.

MRST from ÜS	Measurement and control systems from the handover interface
ET to ÜS	Electrical systems from the mains to the handover interface
IS	Intelligent systems
D	Roof (incl. preliminary cabling)

7.4 Quantitative and qualitative analyses of the CVET market

Katrin Rasch, Rolf R. Rehbold, Susanne Rotthege

Alongside the apprenticeship system, the CVET market plays an important role in upgrading workers' skills. The discussion on the structures and underlying principles of Germany's overall VET system (cf. Chapter 6) clearly shows that the completion of an apprenticeship after leaving school facilitates the comprehensive development of capabilities, skills and know-how in a selected apprenticed occupation. The wording of the apprenticeship frameworks is specifically chosen to avoid any reference to a specific technology, thereby easily allowing the IVET programmes to be adapted to the latest developments. Career development programmes or skill upgrades for older workers covering technological advances are by contrast the exclusive domain of the CVET market. In contrast to the recognised apprenticed occupations with their regulations applying throughout Germany, CVET programmes are not always subject to standardised regulations. As a result of the often less regulated structures found in the CVET market, the CVET offerings available are therefore categorised as to whether they belong to "regulated CVET programmes" (*geregelte Weiterbildungen*) or "non-regulated CVET programmes" (*ungeregelte Weiterbildungen*) (cf. Chapter 4.2 and 6). As regards career development CVET programmes to become a master craftsman, a distinction is made as to whether the programmes belong to the skilled craft sector or the industrial sector. In the former, standard examination regulations exist throughout Germany, whereas in the latter this is only partially the case. This whole area will therefore be looked at separately. Looking next at the "non-regulated CVET programmes" category, a survey of all offerings was first required in order to gain a comprehensive status quo, as there is currently no complete list of all CVET offerings in the fields of energy efficiency and renewables available in Germany.[113] Only after this survey had been completed were we able to carry out both a quantitative and a qualitative analysis. The survey involved recording existing offerings via a standard questionnaire. In a first step, we needed to gain an insight into the structure of the CVET market and identify relevant CVET providers in the construction sector.

In the section below, we will first be showing how the questionnaire was compiled and how the survey was carried out (including the methodology used for the random selection and details of the response rate). We will then look at the quality of the data received, with a focus on its comprehensiveness, and the methodology used in analysing the data. We end by presenting the results of our analysis in Chapters 7.4.2 and 7.4.4.

[113] This statement applies in particular to the skilled craft sector. The industrial sector has its own CVET database containing information on seminars, instructors and examinations throughout Germany (Weiterbildungs-Informations-System).

7.4.1 The questionnaire-based survey

Design of the questionnaire

In the development phase - in line with the previous evaluation steps (cf. Chapters 7.1 and 7.3) and the objective of gaining a quantitative and qualitative overview of the CVET market - relevant aspects to be looked into via the questionnaire were defined.

The survey of the CVET offerings involved determining both which technology fields and processes were to be looked at, and - from a more critical perspective - their uptake and whether there were access requirements making it difficult for potential participants to take up the programme.

As part of the quantitative analysis, participation numbers (for 2009 - 2011) were looked at, as well as access requirements. Moreover the examination frameworks needed to be analysed, as well as the duration (in hours) of the programmes, the ratio of theory to practice, the ratio of classroom to e-learning offerings, as well as whether programmes were offered as full-time or part-time courses.

With regard to participation numbers, duration, the theory/practice ratio, the classroom/ e-learning ratio, survey participants were asked to enter concrete values. For all other questions (examination frameworks, access requirements, full-time/part-time) possible answers were printed on the questionnaire, meaning that participants only had to check the relevant box.

For the qualitative side of the analysis, data on programme content is important. The last section of the questionnaire therefore contained a free-format section where participants could enter information on the content of the relevant CVET offerings. As this free format gave participating institutions the opportunity of providing comprehensive information, while at the same time not setting any criteria for comprehensiveness, the questionnaire also included a quantitative check of programme content. This involved using the evaluation matrix developed in Chapter 7.1 with its pre-defined process steps and building (sub)categories, with participants being asked to position their programme(s) within the matrix.

The questionnaire finally used can be found in Appendix D. Readers should be aware that two different questionnaires were used, due to the differences in the examination frameworks between the skilled craft sector and the industrial sector. This in turn is the result of having two different legal bases, i.e. the Skilled Craft Code (*Handwerksordnung* or HwO) on the one hand, and the VET Act (*Berufsbildungsgesetz* or BBiG) on the other (cf. Chapter 6).

The survey

As already discussed, the skilled craft and industrial sectors play an important role in the field of IVET and CVET in Germany. Following discussions with a number of experts taking part in the first information event for the *BUILD UP Skills – Germany* project on 1 December 2011, it was decided that the random sample should focus on Skilled Crafts Chambers (*Handwerkskammer* or HWK), guilds (*Innungen*), trade associations (*Zentralverbände*) and

Chambers of Industry and Commerce (*Industrie- und Handelskammer* or IHK). This decision was backed by the following arguments:

1. CVET programmes and CVET examinations certified under an official legal basis are generally to be found in the scope of a chamber's responsibility. Moreover a high number of CVET programmes in the non-regulated category are also offered by the chambers or by institutions or companies cooperating with the chambers.
2. The chambers with their regional organisation are in a position to provide detailed information on local developments and requirements.
3. Trade associations and guilds operating at Federal and/or *Länder* level are also very well networked, enabling them to also support the project with their expertise. Moreover they are themselves providers of CVET programmes.
4. Given the structure of the skilled craft and industrial sectors, the chambers can be directly contacted via their umbrella organisations, the ZDH (for the skilled craft sector) and the DIHK (for the industrial sector). In addition, the ZDH can also be used to establish contact with the trade associations. This support function made it a lot easier not just to distribute the questionnaires but was also a factor in improving response rates.

However, at this stage, the limits of the study became clear. Whereas the design of the study allowed CVET programmes offered by the chambers, guilds and trade associations to be comprehensively recorded, the whole area of CVET courses offered by manufacturers was ignored. Given the short duration of the survey, it was therefore not possible to gain any great insight into the CVET structures offered by manufacturers.

Following the definition of the random sample, the questionnaire was e-mailed to all selected Chambers of Skilled Crafts, guilds and trade associations via the ZDH in the skilled craft sector, via the ZDB for all construction sector participants, and via the DIHK for all Chambers of Industry and Commerce.
Responses covered a total of 329 CVET programmes. The responses were then entered into our database in one of five categories, allowing a differentiated insight into the composition of the responses. An overview can be found in Table 54, while a list of all CVET offerings by keyword (cf. Chapter 7.4.3.1) is to be found in Appendix E.

Table 54: Type and number of responses on the CVET market

		Number of responses	
Category		Institutions[114]	CVET programmes
1	Chambers of Skilled Crafts	45	223
2	Chambers of Industry and Commerce	6	7
3	Trade associations and guilds	5	21
4	Construction sector training centres[115]	8	51
5	Others[116]	8	27
	Total	**72**	**329**

Whereas the response total of 329 CVET programmes can be seen as positive, the type of responses shows that no reliable statements will be able to made in the status quo analysis for CVET in the industrial sector. In the HWK and IHK area in particular, there was a response rate of 81.82% for the skilled craft sector (45 or 55 chambers), but only of 8.75% (7 of 80 chambers) for the industrial sector.

Entering the data into a database

Entering the data into a database was combined with a plausibility check of the data in the questionnaires sent back, with any answers that were obviously implausible being corrected or certain answers marked for follow-up. Modifications were undertaken in the following cases:

- Implausible data in the field of examination frameworks:
  In many cases CVET programmes regulated by §42 HwO were listed as being regulated Germany-wide. This easily noticed false distinction between a Germany-wide regulation and a regulation subject to chamber law could be corrected straight away.
- Missing participation numbers:
  With regard to participation numbers for 2009 - 2011, the decision had to be taken in certain cases whether empty fields were to be entered as "missing values" or as 0 when in the year in question there had been no demand for the CVET programme. "Missing values" did not take into account whether the question on how participation was developing had not been answered or whether no CVET offerings were available in that period.

Alongside data entry and plausibility checking, the completeness of the data is important for the ensuing evaluation. Generally speaking, incomplete data was to be found mainly in the fields of access requirements, the theory/practice ratio and the classroom/e-learning ratio,

[114] The following data also includes institutions not at present offering CVET programmes in the fields of energy efficiency or renewable energy.

[115] The construction sector's training centres come under the responsibility of both the skilled craft sector and the industrial sector. A joint responsibility is also possible.

[116] This category groups all responses not belonging to the categories 1 - 4.

as well as in qualitative data on the contents of the CVET offerings. Whereas for the first field the data received was as far as possible included in the evaluation, the questions regarding the theory/practice ratio and the classroom/e-learning ratio were not further evaluated. Regarding the data on course content, the assumption with regard to the comprehensiveness of the data was confirmed. For these reasons, the focus below is on assigning the CVET programmes to the processes and building (sub) categories using the evaluation matrix described in Chapter 7.1. An in-depth analysis of the material received will only be done on request.

Evaluation

Our analysis of the CVET market involved first differentiating between responses regarding master craftsman qualification programmes in the skilled craft sector[117] and other CVET programmes. This differentiation is based on the previous analysis of existing skill sets in apprenticed occupations in selected building occupations (cf. Chapter 7.1). The objective now is to update these skill sets, adding the capabilities, skills and knowledge found in master craftsman examination regulations. In the German CVET landscape, gaining a master craftsman qualification plays a major role (cf. Chapter 7.3). At the same time the standardised regulations governing master craftsman training[118] enables - parallel to the analysis of apprenticeship frameworks - the systematic recording of skills in Parts I and II of the master craftsman training. With regard to completeness, we should finally be aware that no representative statement can be made due to there only being 14 responses on course offerings in the skilled craft sector.

7.4.2 Analysis of master craftsman examinations

When looking at the contents of master craftsman examinations below, a distinction needs to be made between master craftsmen in the skilled craft sector and those in the industrial sector. This differentiation is due on the one hand to the different examination frameworks, on the other to the structure of the respective regulations. In the skilled craft sector, master craftsman examination regulations are basically all issued at Federal level, whereas in the industrial sector they are issued by the respective chambers (with the exception of master craftsmen specialised in electrical engineering, metalworking and insulation). Moreover, with regard to the already mentioned aspect of content, there are differences between the skilled crafts and industrial sectors in the way the regulations are structured. Before we start with our analysis, we will quickly look at these differences.

[117] There were no responses for master craftsman (foreman) qualification programmes in the industrial sector.

[118] Whereas in the skilled craft sector all master craftsman examination regulations are subject to Federal jurisdiction, in the industrial sector we find both Federal and chamber regulations (cf. Chapter6).

Master craftsman examinations in the skilled craft sector

With regard to gaining a master craftsman qualification in the skilled crafts sector, the qualitative evaluation was done by analysing the respective master craftsman examination regulations and the associated framework curricula. Referring back to Chapter 6, we should first note that the focus is on the examination requirements found in Parts I and II (Regulation on the Master Craftsman Job Profile and the Regulation on Examination Requirements in Parts I and II of the master craftsman examination) of the examination regulations, as these cover the required practical and theoretical skills and knowledge. Parts III (business, commercial and legal knowledge) and IV (teaching skills), taught at a level covering all trades, are correspondingly ignored. It is further assumed that this focus on content will not lead to any disadvantages, as only the skills specific to the occupation are of interest for the project.

As Parts I and II of the Regulation on Examination Requirements contain the (respective) examination profile listing the activities, knowledge and skills needed for both parts (theory and practice), they are used as the base for the skill analysis. To gain a deeper understanding, the framework curricula were also looked at.[119] In analogy to the skill analysis of apprenticeship frameworks in Chapter 7.3, all regulations were analysed on the basis of the evaluation matrix developed in Chapter 7.1 and modified in the further course of the study. All analyses, together with the evaluations of the apprenticeship frameworks, are to be found in the Appendix (C).

In contrast to the approach chosen before of assigning the skills found in the respective apprenticeship frameworks to categories / subcategories and processes / subprocesses (including a further differentiation) (cf. Chapter7.3) , it became evident after a first look at the documents that the approach would have to be slightly modified. This decision was based on the following perceptions:

- The matrix developed for the skill analysis (cf. Chapter 7.1) was generally seen as too detailed for the analysis of the master craftsman regulations. This was because, at least in the "more recent" regulations on master craftsman job profiles, "overall skills leading to the master craftsman examination are to be taught". These skills cover for example business, commercial and legal skills, which are difficult to include in the existing matrix. One example here is the wording "Planning, organising, performing and monitoring order processing". This type of skill could not be identified in the analyses conducted up to now. It is however of great importance at master craftsman level, meaning that it needed to be assigned to difference process steps in the matrix. At the same time, it should also be pointed out that gaining such skills involves a meta-level, i.e. a level where a master craftsman is required to carry out work not directly associated with his trade and therefore difficult to include in the matrix. Similarly, the inclusion of these skills, knowledge and capabilities in the existing evaluation matrix illustrates the differences between a journeyman and a master craftsman.

[119] As these are not normally available to the public, the statements refer in some cases only to the regulations.

Turning to skills specific to the occupation, their direct assignment to specific columns or even cells is seldom possible. One example here is the wording "To distinguish between types and characteristics of materials to be processed and to take account of such in planning, execution and maintenance". This further exemplifies the fact that a master craftsman, over and above the knowledge, skills and capabilities gained as an apprentice, is in possession of knowledge not just pertaining to a single process but to a number of processes, and consequently of use within different process steps. This meant that master craftsman skills were often assigned to several processes.

- Looking by contrast at the wording used in a number of "older" regulations, it is often still possible to specifically assign occupational skills to individual cells within the matrix. The wording used in these regulations, which no longer correspond to the current requirement of having an activity-based regulation, is not suited to covering the whole range of skills required. The differentiation made between knowledge and skills for filling in the matrix meant that we needed to consider to what extent individual combined references to knowledge and skills corresponded to the overall skills defined in the "more recent" regulations, or were at least to be on a par with such. In doing so, particular account was taken of the fact that theoretical knowledge is always a requirement for the exercise of certain skills or certain executions steps. Last but not least, we would also like to point out that in the "older" regulations a clear distinction is made between Parts I, II and III, meaning that the analyses took no account of any business, commercial or legal skills. These differences are reflected in the overviews found in the Appendix and need to be taken into appropriate account when interpreting the findings.

Master craftsman examinations in the industrial sector

On the basis of the discussion above, the fact that an analysis of statutory regulations is not appropriate for the industrial sector where master craftsman examinations are based on regulations issued by the respective chambers, and the fact that framework curricula are seldom available, the analysis in this section was limited to master craftsmen in the industrial sector of electrical engineering, metalworking and insulation.[120] In analogy to the skilled craft sector with its Federal regulations for master craftsmen, the analysis of the corresponding regulations and the additional analysis of the DIHK-recommended framework curricula ensure a valid analysis.

[120] Following the completion of all surveys, the analyses for foremen (*Industriemeister*) in the industrial sector were not included in the presentation of the findings. This decision is based on the following aspects: In many cases the number of participants reported very low. At the same time, in the FBH's opinion and backed up by the Federal Employment Agency's publicly available CVET definitions and job profiles, foremen in the industrial sector (*Industriemeister*) are not often to be found working in the construction sector. Although master craftsmen in the skilled craft sector are not always to be found actually working on building sites, their work very often involves advising customers, planning and customer acceptance, thereby justifying the inclusion of this CVET programme.
Last but not least, it should be pointed out that, in contrast to the apprenticed occupations covered by the HwO, no expert validation was carried out for the occupations coming under the BBiG (cf. Chapter 7.1).

Looking at the *Regulation for the examination leading to the recognised title of "Certified Foreman"* (Geprüfter Industriemeister), a distinction again needs to be made between "older" and "more recent" regulations with regard to their contents. Table 55 shows that, despite the different wording used, the 3-part structure is to be found in both categories of regulations. This means that the "older" regulations in the industrial sector differ from those in the skilled craft sector, where the contents and examination of business, commercial and legal skills are regulated in separate regulations.

Table 55: Structure of certified foreman / Industriemeister programmes under Federal regulations

Content of the examination	Content of the examination
▪ **Specialised in electrical engineering (30 November 2004)**	▪ **Specialised in metalworking (12 December 1977)** ▪ **Specialised in insulation (29 June 1993)**
Occupational and vocational teaching skills	Occupational and vocational teaching part
Non-occupational basic skills	Non-occupational part
1. Legal awareness 2. Business awareness 3. Use of ICT and planning methods 4. Cooperation at work 5. Taking account of scientific and technical principles	1. Principles of cost awareness 2. Principles of legal awareness 3. Principles for cooperation at work
Occupational skills	Occupational part

As the regulations further state that gaining the occupational and vocational teaching skills is to be done under the Aptitude of Instructors Regulation (*Ausbilder-Eignungsverordnung* or AEVO), the Part on occupational skills / occupational part (see table above) are the parts needing to be looked at in the context of the skill analysis. Due to the very abstract wording, no analysis of the objectives of the examination set forth in §§1.1 and 1.2 could be conducted.

Extension of the differentiated evaluation matrix developed in Chapter 7.3 (table of verbs)

The structural and content-related differences between the regulations in the skilled craft sector and those of the industrial sector, the different years of publication and the subsequent effects this has on the contents of the regulations, and - last but not least - the further skills to be taught in the context of gaining a master craftsman qualification made it necessary to modify the previously developed evaluation matrix and the table of verbs (Table 38). Looking at the planning process step, two new subprocesses are introduced at master craftsman level: *Order-related customer advice* and *Planning and order preparation*. The extended table with the additional subprocesses and verbs is to be found in Appendix B.

7.4.3 Analysis of the recorded CVET offerings

In this section we look at all responses received regarding CVET programmes offered in Germany in the field of energy efficiency and renewables, excluding the master craftsman qualification programmes. Before looking in detail at the findings, we would like to introduce a system of different keyword categories, used to help readers gain a better understanding of what follows.

7.4.3.1 Navigating via keyword categories

A list of all 329 CVET programmes (315 without the master craftsman qualification programmes) would lead to confusion, as it would be difficult to find the relevant information. To facilitate the compilation of a simple list of the different CVET programmes and to ensure a well-structured and easy-to-read presentation on which to base both the quantitative and the qualitative analysis, each CVET programme is assigned a specific keyword. The development of the different keyword categories is based on a bottom-up approach. Once all responses had been reviewed and mapped to the scheme developed in Chapter 7.1, the keywords were categorised under practical aspects.
The resultant category system is to be understood as an analysis instrument under constant development and laying no claim to scientific acceptance. Despite the assignment to a particular keyword, no information found in the individual responses was to be ignored, nor were the individual categories to be looked at from any specific perspective. In the course of the evaluation with its intense discussions on the whole area of CVET, this objective led to certain shifts in the categories, taking into account commonalities and differences in the contents of CVET programmes. An overview of the current states of the keyword categories as well as the number of CVET programmes in each category is to be found in Table 56. The mapping of individual CVET programmes to the different categories as well as the assigned numbers (cf. Chapter 7.4.1) can be found in Appendix E.

Table 56: Category system used for structuring the CVET offerings

	Keyword categories	Number of relevant CVET programmes
1	Asbestos	2
2	EnEV, EEWärmeG (Energy Efficiency Act), EEWärmeG (Heat Act)	15
3	Energy passports	5
4	DIN V 18599	2
5	Energy advisor (buildings)	60
6	Energy advisory services	7
7	Energy management	4
8	"European building energy worker"	1
9	Photovoltaic systems	20
10	CHP systems	5
11	Wind turbines	4
12	Solar heating	32
13	Heat pumps, geothermal systems	9
14	Heating systems	12
15	Insulation, airtightness	35
16	Mildew	8
17	Energy-related construction and refurbishment	20
18	State aid programmes	5
19	Energy-efficient / passive houses	15
20	Interfaces	5
21	Ventilation and air-conditioning (VAC)	3
22	Renewable energy	11
23	Building diagnostics	3
24	Other	25
25	Building management systems	5
26	Supplementary qualifications (EU)	1

The application of the structure found in Appendix E meant that, through removing duplicates, ca. 250 CVET programmes with different titles were counted. Within each category duplicates were removed or only counted once. Through a clustering of the areas within the categories similar CVET offerings were easily identified. Due to their size, the categories energy advisory services / energy management and solar heating are of particular interest, with the result that they will be looked at separately in the following section.

7.4.3.2 Separate analysis of the categories energy advisory services / energy management and solar heating

With a total of 56 CVET programmes in the *energy advisor (buildings)* category and 32 in *solar heating*, these two categories alone account not just almost 30% of all responses, but also for a large number of multiple entries. Whereas in the first category the *energy advisor (buildings)* and the (non-specialised) *energy advisor* CVET programmes are mainly to be found, the solar heating category covers courses training workers to become solar technology specialists.

Detailed analysis of the energy advisory services / energy management category

The *HWK-certified energy advisor* CVET programme has been offered by Skilled Crafts Chambers in Bavaria and Swabia since 1994. The *HWK-certified energy advisor* examination can be taken by master craftsmen from a trade related to energy efficiency (construction, fitting and finishing, HVAC, chimney sweeps and electronic technicians). In connection with the development of the *CVET examination* to become a HWK-certified energy advisor (buildings), it was not possible to reach agreement at a Federal level, with the result that, though the ZDH issued a recommendation in 1995 to issue a CVET examination framework for a HWK-certified energy advisor, Bavaria opted for its own regulation.

This led to the Bavarian (and other) chambers issuing a CVET examination regulation under §§42a ff. HwO, leading to an official qualification as a *HWK-certified energy advisor*. Though there is no binding framework curriculum for this regulation, the analysis of the questionnaire responses and other documents showed that all providers basically offered a similar curriculum consisting of:

1. Basic knowledge of the material
2. Building technology
3. Plumbing, heating and ventilation technology
4. Electronics and
5. Project work for determining the status quo and compiling energy-efficient solutions (the practical part of the curriculum).

The first regulation leading to a qualification as a *HWK-certified energy advisor* was adopted in January 1995. It is similarly based on §§42a ff. HwO and on a framework curriculum standard throughout Germany. The framework curriculum covers the following areas in depth:

1. Building and construction
2. Building physics
3. Technical systems
4. Requirements and certificates under the Energy Efficiency Regulation (EnEV), and
5. Modernisation planning.

Items 1 - 4 focus on theory, while item 5 constitutes the practical side.

Both CVET programmes entitle successful participants to issue "energy passports" under the Energy Efficiency Act (EnEV).

The CVET programme *Energy advisor in the roofing sector* (3003) constitutes a shortened version of the *HWK-certified energy advisor (buildings)* programme, and is open to master roofers. Total course hours for this supplementary master roofer qualification are 150 hours, as certain programme components featuring in the curriculum of the energy advisor (buildings) (e.g. building physics) are already part of a master roofer's training. Passing the examination leads to a certificate being issued, in turn entitling the roofer to a certain extent to issue a building energy passport under the EnEV. In this connection we would like to point to the 2006 draft version of the EnEV. In its Appendix 11 it recommends that a CVET programme entitling a successful participant to issue energy passports should have a duration of at least 120 hours (cf. §21.2.2b) in order to be able to cover the necessary programme content. A definitive statement on the duration of the CVET programme was not however made, as this was dependent on previous knowledge. The above-mentioned restriction applies to BAFA-subsidised projects. In the minimum requirements set for IVET/CVET measures providing the foundation for on-site advice and in the access requirements of the BAFA subsidy guidelines for master craftsmen, at least 200 instruction units are required.

The qualifications *Building energy advisor for painters and varnishers* (3008) and *Energy advisor for facade planning* (3007) can be described in analogy to the above descriptions. Instruction duration is reduced to the 120 hours required to be entitled to issue energy passports under the EnEV (here as well, there is an exception for BAFA-subsidised buildings). Looking at the content of the CVET programme for the *energy advisor for facade planning*, we see a stronger focus on aspects specific to the trade, with the spotlight on composite insulation systems and the planning of weatherproofing measures and condensation and heating requirement calculations. Moreover the required duration of 20-23 instruction units points to a major distinction to the previously mentioned CVET programmes, with the qualification not entitling holders to issue energy passports.

Detailed analysis of the solar heating category
(subcategory in the field of heat generation using renewables)

Looking at the names used for the CVET programmes and resultant qualifications, we find that the terms

- HWK-certified specialist for solar technology
- Specialist for solar technology
- "Solarteur®" and
- Specialist for solar technology – Solarteur; or Specialist for solar technology/Solarteur

are frequently referred to and offered by chambers and other VET institutions. A first rough analysis of the completed questionnaires and the other available material did not indicate

any other criteria for a further differentiation. Quite the contrary, the programmes seems to be very similar content-wise. To gain a further insight, we are therefore going to take a look at how the programmes initially came into being, before revisiting and discussing the responses to the questionnaires.

The CVET programme and examination to become a *Solarteur®* takes place exclusively in so-called "Solarteur Schools". These have acquired a licence to use this copyrighted title and to award it to qualified specialists. The term *Solarteur®* is derived from the terms "solar technology and the German word for a fitter: "Installateur". The Solarteur® CVET programme was developed by the Austrian engineer Werner Rauscher and first offered in the newly founded "Solarteur School" in Vienna in 1993. The curriculum of the *Solarteur®* CVET programme was developed in the 1990's in the context of a Leonardo da Vinci EU project for the "Development and pilot phase of standardised CVET modules in the field of renewable and eco-friendly energy technologies and their transfer to other EU Member States". According to a telephone interview with Dr. Andreas Müller one of the project's initiators was the HWK Münster.

In the development of the CVET programme for *specialists in solar technology*, the basic principles of the *Solarteur ®* programme with its lack of focus on any specific trade were to a great extent used. In a letter of the ZDH to the Skilled Craft Chambers and the Regional Skilled Craft Councils in April 1999, a recommendation was made for awarding the authorisation to carry out work in the field of solar technology and to qualify specialists for such work in the context of §7a HwO through the creation of a CVET regulation. The working group responsible for drafting the regulation based its work on the following considerations: Firstly, solar technology was seen as a technology playing an increasingly important role both nationally and internationally. Secondly, the experts responsible shared the opinion that customer expectations for being offered an all-in-one solar package covering different trades would continue to grow.
On the basis of these considerations, the ZDH spoke in its letter of a "skilled craft sector policy task", recommending the cross-trade use of §7a HwO in the field of solar technology. Further material included a requirements profile and a CVET plan. The former had the function of providing information on which qualifications and/or preparatory measures CVET programme participants had to fulfil (dependent on their background), while the latter was seen as a way of ensuring the use of standards throughout Germany.

On the basis of these explanations, the third alternative (see above) can be explained, i.e. the combination of the two offerings. A number of Solarteur Schools make it possible for participants not just to gain a *Solarteur®* qualification, but also to take the examination of their respective chamber and thereby to become a *HWK-certified specialist for solar technology*.

7.4.4 Quantitative and qualitative analysis of the CVET programmes

In connection with the scheme introduced above for analysing the apprenticeship frameworks (see above, cf. also Chapter 7.1), an evaluation was now done by building work subcategory and process, using the following steps:

1. Mapping each response to the relevant processes and building work subcategories using the answers found in the questionnaire.
2. Gaining an overview of the distribution of all responses to processes and building work subcategories
3. Looking at the different CVET programmes for the individual building work subcategories
   a. Participation numbers
   b. By examination framework
   c. By duration

Data entry and the subsequent mapping of the CVET programmes to the processes and building work subcategories was done before the evaluation was begun. The relevant findings are presented in the context of the subsequent evaluation.

To gain an overview over the distribution of all responses to the building work subcategories and to the processes within each building work subcategory, the mapping was done after data entry using cross tabulation. An overview can be found in Table 57. Due to the structure of the questionnaire, multiple entries were possible for both building work subcategories and processes. This is reflected in the overview.

Table 57: Mapping of CVET programmes to processes and building work subcategories

All CVET programmes Distribution to processes within the building categories		Provision of advice	Planning	Execution	Customer acceptance / QA	Repair & maintenance	Disposal	Total absolute	Total relative
A building's envelope	Shell	104	112	50	72	40	25	**126**	**40,00%**
	Roof	181	180	91	118	72	47	**207**	**65,71%**
	Facade	151	154	75	109	61	42	**177**	**56,19%**
	Windows and doors	141	143	63	96	46	34	**165**	**52,38%**
A building's infrastructure	Interior walls and floors	92	82	44	70	51	27	**100**	**31,75%**
	Electrics	134	134	71	110	69	41	**142**	**45,08%**
	Heating	183	186	93	126	82	45	**199**	**63,17%**
	VAC	73	78	34	59	30	20	**84**	**26,67%**
A building's energy supply	Geothermal systems	79	84	39	62	36	26	**87**	**27,62%**
	Biomass systems	48	52	22	36	23	16	**54**	**17,14%**
	Solar heating	118	122	64	85	53	34	**128**	**40,63%**
	PV systems	131	132	75	99	67	37	**140**	**44,44%**
	CHP systems	87	90	35	66	36	26	**93**	**29,52%**
	Wind turbines	28	30	18	25	18	11	**32**	**10,16%**
	Total absolute	257	260	163	184	139	64		
	Total relative	81,59%	82,54%	51,75%	58,41%	44,13%	20,32%		

Using the absolute and relative values, the table allows conclusions to be drawn as to the distribution of the CVET programmes to the different building work subcategories and processes. The individual cells show the assignments of individual CVET programmes to relevant processes and/or building work subcategories. The number in each cell thus indicates how many CVET programmes offer the combination of the building work subcategory and the process. As some CVET programmes cover many processes and/or building work subcategories and are correspondingly entered into the matrix, there can be fluctuations within the cells of any one line or column. In the right-hand column, we see the total number of entries for all CVET programmes within any one building work subcategory (absolute and relative values), while in the bottom line we see the total number of entries for any one process (absolute and relative values).
With regard to the building work subcategories, values range from 10.16% to 65.71%, with major fluctuations in particular in the field of energy generation. In the subcategories of *solar heating* and *PV*, some 40% (128 and 140 offerings) of CVET offerings are to be found, whereas *wind turbines* only account for 10.16% (32 of 315) of CVET offerings. Peak values are achieved in the subcategories of roofing (in the building envelope building work category) and in heating technology (in the building infrastructure category), each with over 60%.
Turning to the processes, the major focus here is on advisory and planning services, with values of 81.50% and 82.54% being achieved. Execution and customer acceptance lag 20% behind, at 51.75% and 58.41% respectively. Interestingly, customer acceptance, despite its close association with execution, has a higher value than execution. Disposal comes in last, being only mentioned in every 4.5th programme description.

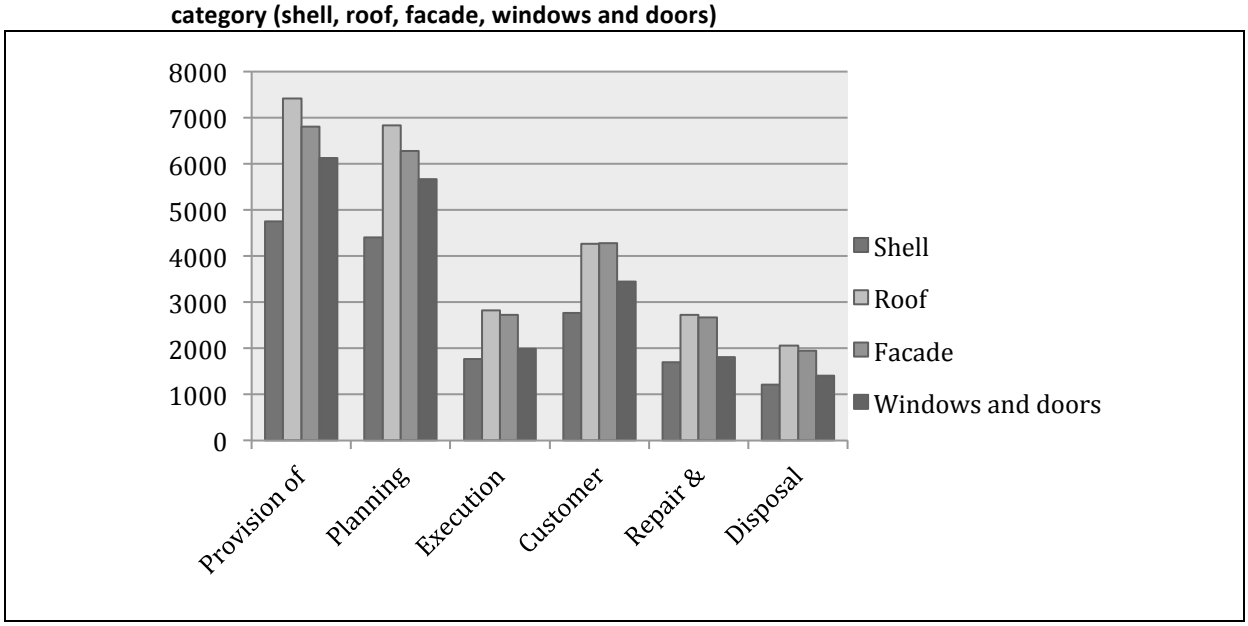
The next stage involves merging the 2009 - 2011 participation numbers (cf. Table 58):

Table 58: Participation numbers (2009 - 2011) by process and building work subcategory

All CVET programmes Distribution to processes withing building category		Provision of advice					Planning					Execution					Customer acceptance / QA					Repair & maintenance					Disposal				
				Participation numbers					Participation numbers					Participation numbers					Participation numbers					Participation numbers					Participation numbers			
		Number	Total	2009	2010	2011	Number	Total	2009	2010	2011	Number	Total	2009	2010	2011	Number	Total	2009	2010	2011	Number	Total	2009	2010	2011	Number	Total	2009	2010	2011
A building's envelope	Shell	104	4754	2037	1605	1112	112	4408	1885	1466	1057	50	1762	622	682	458	72	2761	1178	915	668	40	1700	602	643	455	25	1209	396	447	366
	Roof	181	7418	3268	2288	1862	180	6836	3019	2086	1731	91	2829	1037	1015	777	118	4273	1873	1372	1028	72	2727	1017	957	753	47	2060	730	754	576
	Facade	151	6814	2848	2179	1787	154	6282	2601	1979	1702	75	2725	912	959	854	109	4278	1763	1318	1197	61	2668	915	911	842	42	1945	644	698	603
	Windows and doors	141	6127	2715	1911	1501	143	5670	2499	1728	1443	63	1984	685	706	593	96	3452	1537	1009	906	46	1806	629	620	557	34	1409	516	481	412
A building's infrastructure	Interior walls and floors	92	3861	1718	1226	917	82	3469	1542	1085	842	44	1486	557	518	411	70	2557	1113	761	683	51	1882	698	631	553	27	1157	444	364	349
	Electrics	134	4791	2016	1570	1205	134	4601	1911	1504	1186	71	2301	832	806	663	110	3332	1356	1062	914	69	2355	825	831	699	41	1643	573	609	461
	Heating	183	12609	5862	4202	2545	186	6654	2693	2075	1886	93	8744	4021	3030	1693	126	4114	1744	1291	1079	82	8600	4006	2996	1598	45	1888	677	638	573
	VAC	73	2944	1273	926	745	78	2849	1217	896	736	34	883	305	310	268	59	1758	795	539	424	30	885	322	333	230	20	743	273	247	223
A building's energy supply	Geothermal systems	79	2913	1394	926	593	84	2944	1403	936	605	39	1382	556	508	318	62	2230	1090	652	488	36	1259	502	448	309	26	967	351	313	303
	Biomass systems	48	1882	828	656	398	52	1796	775	632	389	22	872	318	376	178	36	1254	534	401	319	23	918	351	357	210	16	796	320	281	195
	Solar heating	118	4345	2017	1372	956	122	4305	1988	1358	959	64	2126	875	755	496	85	3002	1431	901	670	53	2053	858	717	478	34	1427	583	456	388
	PV systems	131	4674	2015	1479	1180	132	4562	1972	1465	1125	75	2550	897	895	758	99	3417	1453	1052	912	67	2526	880	868	778	37	1570	550	571	449
	CHP systems	87	2944	1292	941	711	90	2878	1239	917	722	35	1257	442	463	352	66	2048	893	624	531	36	1296	468	444	384	26	1067	399	351	317
	Wind turbines	28	699	282	255	162	30	699	282	255	162	18	518	210	230	78	25	314	108	96	110	18	420	174	190	56	11	238	86	76	76

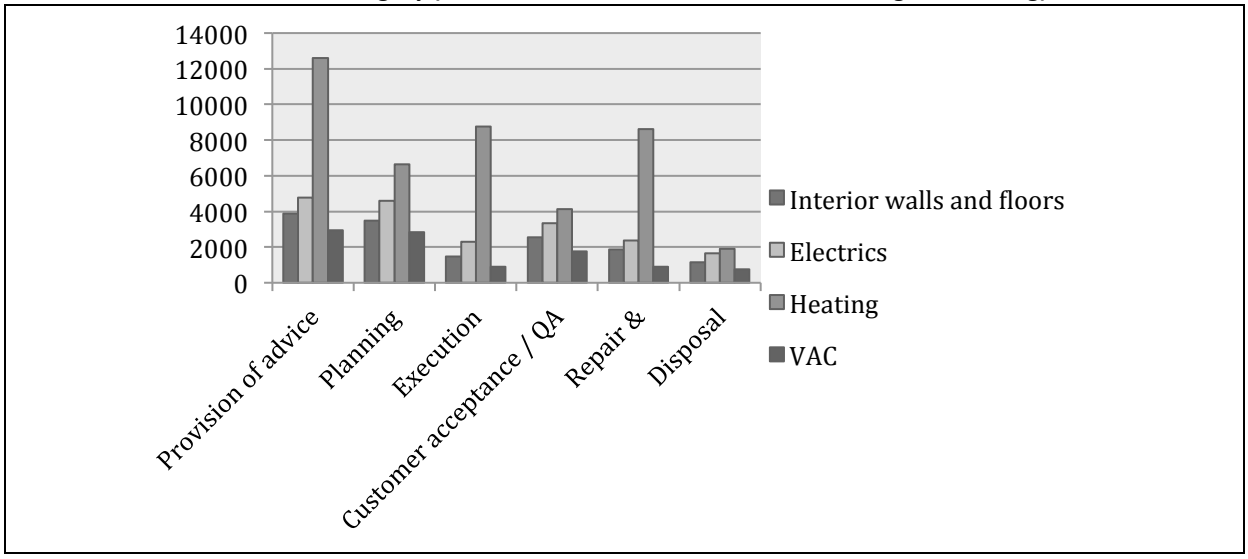
This detailed presentation form does not initially allow any differentiated statements to be made. In analogy to the above-described distribution of the CVET programmes to the processes and building work subcategories, high participation rates are to be found in the subcategories *roof*, *heating technology*, *solar heating* and *photovoltaic systems*. A further high-flyer is the *facade* subcategory. What is striking in this form of presentation is that participation numbers in all fields have been dropping since 2009. One possible explanation for this is the high level of orders currently seen in the construction sector.
Detailed information on the distribution of participation numbers within the building work subcategories and processes is to be found in Figures 2 - 4:

Figure 35: Distribution of participation numbers (totals) to the processes within the building envelope category (shell, roof, facade, windows and doors)



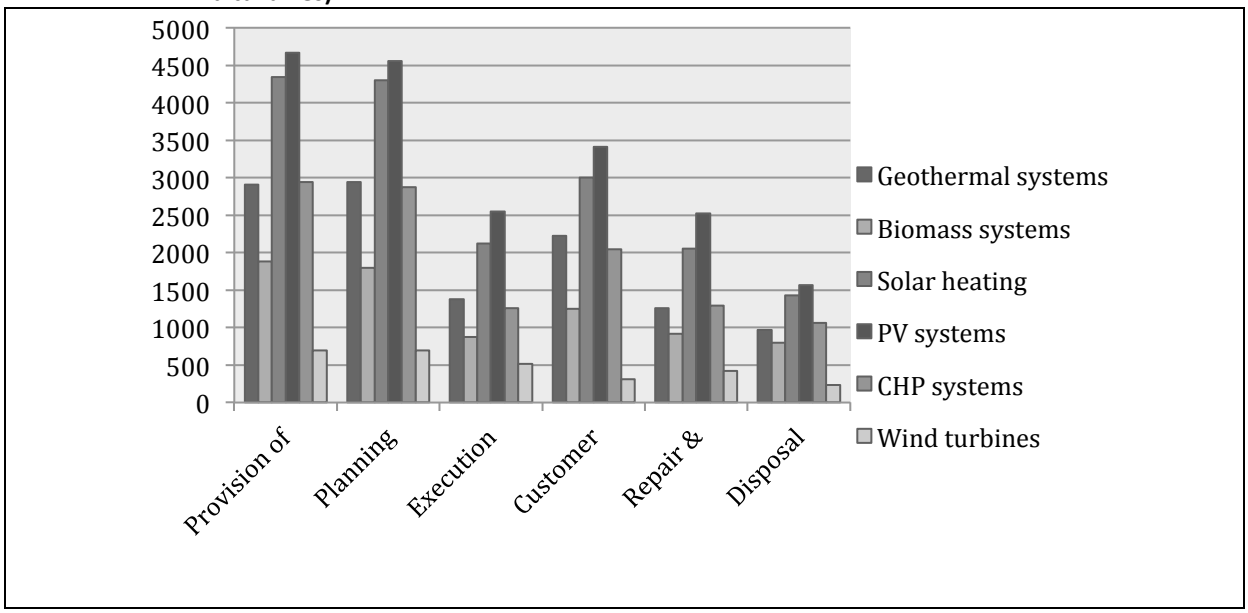
In the building envelope category, the subcategory *roof* is the dominant CVET participation field (7418 participants), followed by the *facade* (6814 participants). The *shell* subcategory attracts the least participants (4754). The chart also shows that the *provision of advice* and *planning* are the main focuses of the CVET programmes. As already seen in Table 1, despite the close connection between *execution* and *customer acceptance*, the latter seems to be more important in the CVET field. Similarly the *disposal* subprocess seems relatively insignificant, attracting between 1209 and 2060 participants.

Figure 36: Distribution of participation numbers (totals) to the processes within the building infrastructure category (interior walls and floors, electrics, heating and cooling)



In the building infrastructure category, heating technology attracts the highest number of participants, whereby participation numbers assigned to the *execution* subprocess are higher than in *planning* or *customer acceptance*. This can be interpreted as meaning that the practical work has greater importance. Moreover, the subcategory *heating technology* is the only one having higher participation numbers in the field of *execution* than in *customer acceptance*.

Figure 37: Distribution of participation numbers (totals) to the processes within the energy supply category (geothermal systems, biomass systems, solar heating, photovoltaics, CHP systems and wind turbines)



Again, the chart shows that participation numbers are higher for *customer acceptance* than for *execution*. Similarly, the *disposal* process attracts the least number of participants. Within the energy supply category, most participants are to be found in the *photovoltaic* and *solar*

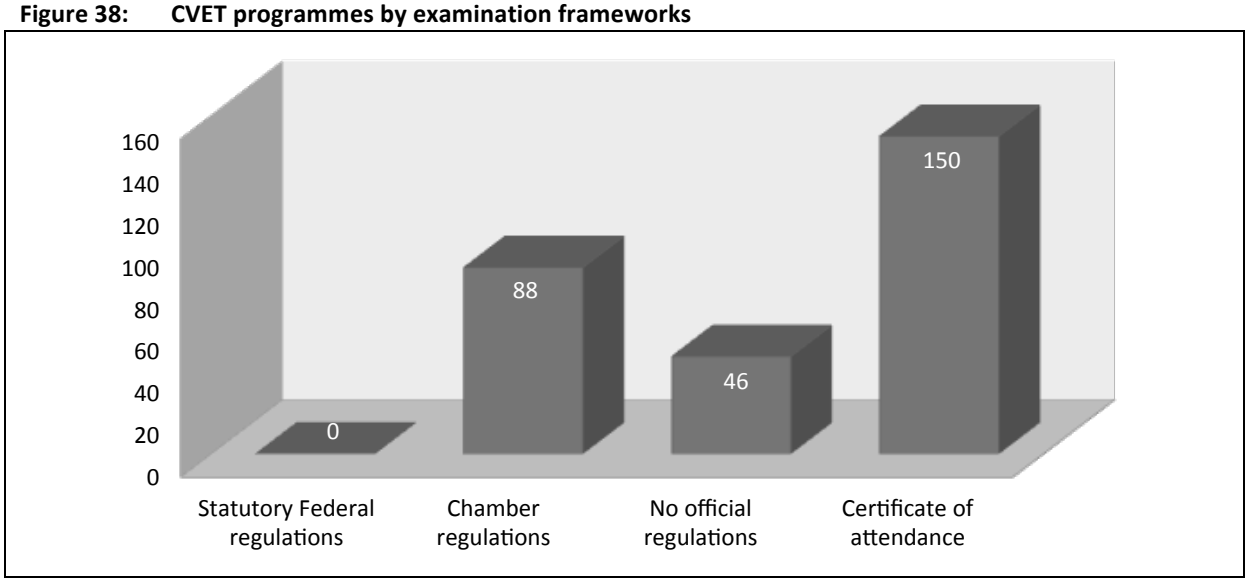
heating subcategories. Moreover *biomass systems* and *geothermal systems* attract similar numbers of participants.

In addition to looking at the distribution of CVET programmes to processes and building work subcategories and of participation numbers between 2009 and 2011, the fields of examination frameworks and programme duration (in hours) were also looked at. The examination frameworks were first divided into the following categories:

- CVET examination regulated at Federal level
- CVET examination subject to chamber regulations
- CVET examination without any official regulation
- No examination (certificate of attendance)

. Figure XX shows the distribution to the different categories.

Figure 38: CVET programmes by examination frameworks



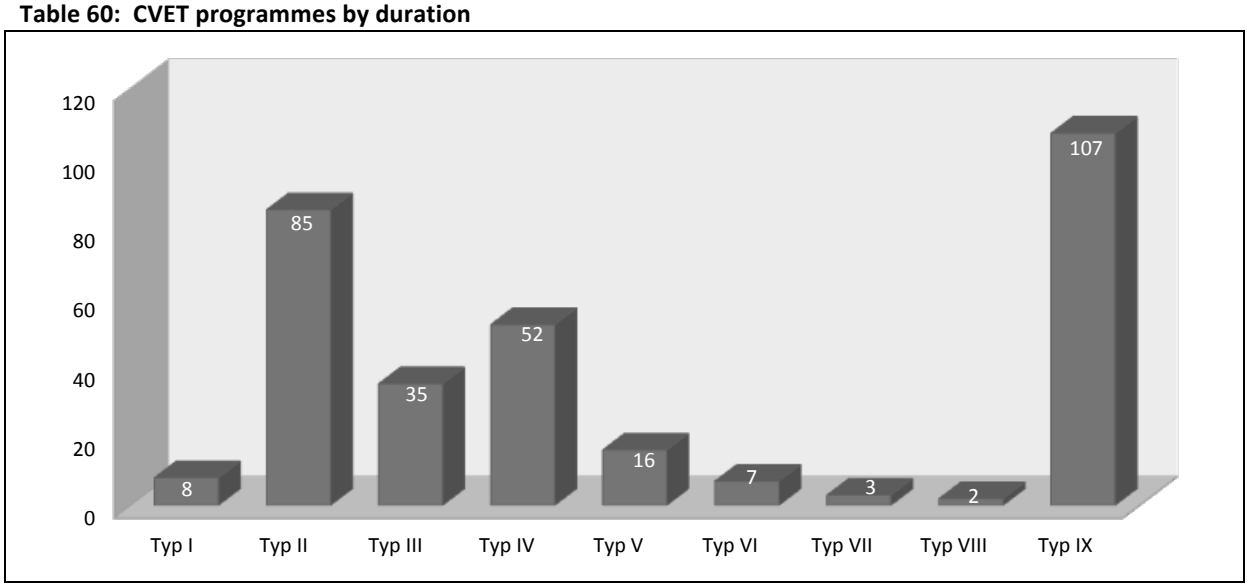
As the CVET programmes for gaining a master craftsman qualification are looked at separately, distribution is concentrated on the last three categories. In the category of examinations subject to chamber regulations, the CVET programmes leading to a qualification as an *HWK-certified energy advisor* and as a *specialist for solar technology* dominate. Of the 315 CVET programmes evaluated, 46 are examined on a non-official basis. 150 end merely with the issuance of a certificate of attendance. To be able to link the examination framework with programme duration, it is first necessary to form different duration categories. This categorisation, together with a definition of each category, is to be found in Table 59.

Table 59: Duration-related categorisation of CVET courses

	Duration (in hours)	Description
I	< 5 hours	A half-day course (ca. 4 hours).
II	5 - 12 hours	A one-day course (ca. 8 hours).
III	12 - 20 hours	A two-day / weekend course
IV	20 - 40 hours	A course covering 4 Saturdays (32 hours) or one week (ca. 40 hours)
V	40 - 80 hours	A one-/two-week course
VI	80 - 120 hours	A two-/three week course
VII	120 - 160 hours	A three-/four-week course
VIII	160 - 200 hours	A four-/five-week course
VIX	> 200 hours	A course involving more than 200 hours

Mapping all 315 CVET programmes to these categories, the following picture emerges (Table 60):

Table 60: CVET programmes by duration



The chart shows on the one hand that 85 of the 315 programmes do not last longer than one working day. On the other hand 107 responses point to programmes lasting longer than 200 hours of instruction. Through cross-tabulating the examination frameworks and course duration, a differentiated statement can be made with regard to the distribution of the CVET programmes (Table 61).

Table 61: CVET programmes by examination framework and duration

	Programme duration									Total
	Type I	Type II	Type III	Type IV	Type V	Type VI	Type VII	Type III	Type IX	
2 Chamber regulations	0	0	2	1	2	4	2	1	76	88
3 No official regulations	2	6	7	15	5	1	1	0	9	46
4 Certificate of attendance	6	77	23	30	8	0	0	1	5	150

Cross-tabulation confirms the assumption that the CVET programmes examined under chamber regulations involve programmes with a duration of 200 hours or more (Type IX) in 76 of 88 cases (86.36%). By contrast, CVET programmes ending merely with a certificate of attendance last no longer than 10 hours (Type II) in 77 of 150 (67%) cases. Programmes examined but without a state-regulated legal basis for such examinations are mainly to be found in categories III (30 - 45 hours) and IV.

These explanations close the analysis of the CVET market. In the context of the following gap analysis – to be conducted at a later date – further aspects will be taken into account.

7.5 Best practice examples in the fields of IVET and CVET, and in the refurbishment of buildings.

In the context of this last chapter of the status quo analysis, existing best-of-breed IVET and CVET offerings in Germany are presented, together with examples of successful energy-related building refurbishment projects.

For instance, with its offer of a dual university/company study programme leading to a Bachelor of Engineering, the Münster Skilled Crafts Chamber, in its capacity as one of the 14 Building and Energy Competence Centres for in Germany, is currently showing how the teaching of theoretical knowledge can be successfully linked with practical IVET at a high qualification level. Also presented is the inter-company apprentice teaching programme (*Überbetriebliche Lehrlingsunterweisung* or ÜLU), in which companies acting as training institutions can support the apprenticeship system outside the company where the apprenticeship is actually being done. This is an arrangement used in particular by smaller skilled craft companies. In the CVET field, a career development concept initially focusing on site foremen is described. This targets SME building companies, providing their staff with the opportunity of advancing their careers. This overview of current developments in the skilled craft sector ends with a description of the recommendation for a decree, scheduled for late 2012 or at the latest early 2013, on a Germany-wide CVET programme for becoming a "certified specialist in renewable energies" (*Geprüfte Fachkraft für Erneuerbare Energien*). The intention of this programme is to provide both journeymen and master craftsmen with the necessary capabilities, knowledge and skills to identify the energy-saving potential of commercial and residential buildings, to install facilities improving energy efficiency and to carry out the necessary repair and maintenance work.

Examples illustrating successful energy-related refurbishment projects are then shown, taken from the categories of detached and semi-detached houses, small and large blocks of flats, and non-residential buildings. These examples show the energy requirements before and after refurbishment, and give details (and costs) of the measures taken on the building's envelope and heating system.

7.5.1 IVET and CVET best practices

Elisa Majewski

7.5.1.1 KOMZET – The CONSTRUCTION and ENERGY Competence Network

Within the framework of KOMZET, 14 competence centres throughout Germany in the construction and energy sector have been cooperating with each other since 2008. The individual centres with their core tasks of providing inter-company IVET and CVET programmes differ in size, ownership and the training and advisory services offered. Each has a different focus in the construction and energy sector, ranging from "green" construction and refurbishment via vocational training and guidance, to involvement in construction technology research. Nevertheless they all have the common goal of promoting sustainability, wanting to ensure that new technological developments are directly transferred into the routine work of skilled craft companies and that energy-saving technologies are introduced into the sector on a wide scale. Measures used include the exchange of experts, the development of standards, and the development and testing of innovative VET programmes with the accompanying course material (Diekmann / Lutz / Mahrin 2011). In doing so, they focus on providing more effective vocational training and guidance within the network, thereby improving work quality and making the knowledge existing in each competence centre and the VET offerings developed there available to a wide specialist audience (Holle / Kuhlmeier / Meyser o.J.). Whatever the VET requirements, the wide range of individual VET offerings and skills and the ability to bundle them in individual packages enables requirements to be met.
A number of the centres work with polytechnics and universities, offering innovative and exemplary dual theory/practice study programmes – such as the Bachelor programme "*Bauen im Bestand*" (building refurbishment) offered by the Münster HBZ centre or the combination of an apprenticeship with a dual study programme under the so-called "*Biberacher Model*", combining a carpentry apprenticeship, an engineering study programme, a CVET course (e.g. to become a site foreman) and a master craftsman examination (Diekmann et al. 2011). Two exemplary projects of KOMZET partners are presented below.

"*Bauen im Bestand*" - a future trend: The building engineer study programme at the HBZ Münster

Knowledge in the field of sustainable construction is made available at the Münster Construction and Energy Competence Centre. The training centre has its own construction and energy demonstration centre, with one of its features being the 500 different meters continually measuring energy flows, temperature and many other parameters, thereby making the centre one of the most modern skilled craft training centres in Germany (HWK Münster o.J.). Training programmes in the fields of construction physics, construction

techniques and eco-construction are developed here, focused on the IVET and CVET requirements of the construction sector. The main focus is on teaching capabilities, knowledge and skills in the fields of renewable building and insulation materials and the different forms of renewable energy used in heating and cooling. In close proximity to the competence centre, a new centre is currently being built. Based in a heritage site, the new centre will focus on the refurbishment of historical timber-framed/oak-beamed buildings.

In 2009, the HWK Münster introduced a bachelor study programme on "*Bauen im Bestand*", in which 17 students are being taught everything about refurbishment (Diekmann et al. 2011). More than half of all investment in the German building sector (with an upward trend) is going into the refurbishment of existing buildings. As this means that the conservation, refurbishment and modernisation of Germany's building stock is gaining in importance, the Münster Polytechnic and the Skilled Craft Chamber have cooperated in developing a curriculum focused on providing the necessary practical knowledge and skills in this field. The new study programme with its focus on practical skills is offered on the campus of the Academy for the Skilled Construction Crafts (*Akademie Bauhandwerk*), itself part of the Münster HWK's training centre.

Students taking part in the programme are taught skills in such fields as the initial building survey, the analysis of damage to the building, the design of new plans taking modern requirements into accounts, the creation of energy-related refurbishment concepts and the planning of new energy and heating systems. Practical projects involving real buildings are used by the students, working in small teams, to apply their new knowledge and skills. All activities of relevance in a building's life-cycle, whether belonging to the field of construction engineering or architecture, are covered.

"Learning by doing" is the motto of this unique study programme with its focus on practical work. Students learn how to handle complex constructional challenges without losing sight of creative and original solutions. A further focus is put on interdisciplinary cooperation and the associated skills (HWK Münster o.J.).

A maximum of 25 students per semester can take the 6-semester full-time study programme leading to a bachelor degree in construction engineering. The programme is made possible through a number of cooperation projects with the Münster Polytechnic and other organisations, with lecturers coming not just from the Polytechnic and the Skilled Crafts Chamber but also from surveyors, construction companies and building material manufacturers.

As part of the selection process, applicants are tested with regard to fulfilling academic requirements and whether they have the right personal motivation.

Looking at the students currently taking the programme, we find masons, roofers, carpenters, joiners, chimney sweeps and preservation specialists. This wide range of previous qualifications is seen as an opportunity for promoting interdisciplinary discussions. This example of a study programme focused on practical work illustrates how training in the skilled craft sector can open the door to an interesting career in the construction sector, whether in planning, site management or company management (Diekmann et al. 2011).

From an apprentice to a site foreman - career development concepts for SMEs.

A further competence centre we are focusing on is in Kerpen. Here, advisory services showing career development opportunities in the construction sector are offered for SMEs offering apprenticeships in the sector and for school-leavers interested in an apprenticeship in the sector. A special career development concept has been developed, aimed at improving the management of an apprenticeship from first attracting potential apprentices right up to the final examinations (Holle et al. o.J.).

Against a background of demographic change and the looming shortage of skilled workers, the competence centre has given itself the task of using specific cooperation projects and information sessions to attract suitable trainees, and to assess the individual performance and management potential of apprentices with a view to explicitly qualifying them as site foremen or site managers. The measures range from trial work placements in the training centre to the acquisition of potential companies offering apprenticeships.

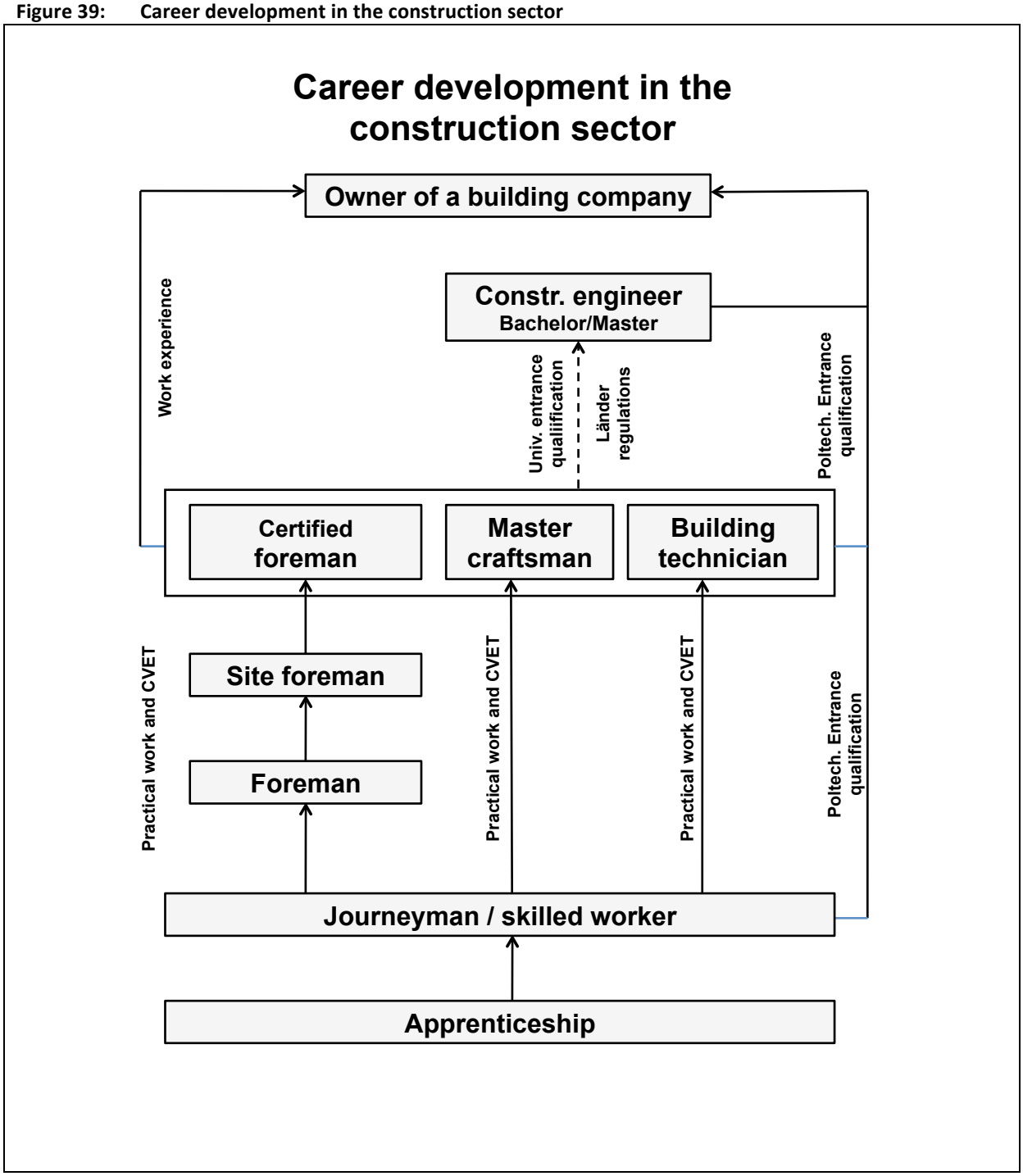
Through the direct contacts the centre has with the staff of local schools, close cooperation is being developed, allowing talented and motivated young people to be gained for an apprenticeship in the construction sector. Through the development of a pool of applicants, the centre is also able to pass on relevant application files to member companies, often ending in the successful conclusion of an apprenticeship contract. This type of comprehensive support and acquisition constitutes a successful example in the field of IVET in the construction sector.

But support does not stop once an apprenticeship contract has been signed. In the competence centre, students, apprentices but also skilled workers can work on individually developing their potential. The development of new IVET and CVET measures, as well as further expanding the network of schools, companies and chambers, are further measures being promoted by the centre.

This example of a career development concept shows how suitable junior staff can be recruited or motivated for an apprenticeship or further career development not just in industry but also in the skilled craft sector in Germany.

The diagram below shows possible career development paths in the construction sector from an apprentice to a site foreman and beyond:

Figure 39: Career development in the construction sector



Source: ZDB diagram.

*7.5.1.2 The Federal CVET programme "certified specialist in renewable energies" (***Geprüfte Fachkraft für Erneuerbare Energien***)*

A legal opinion commissioned by the Federal Ministry of the Environment in 2009/2010 came to the conclusion that skilled craft fitters in Germany already fulfilled all requirements deriving from the EU Directive 2009/28/EC on the promotion of the use of energy from renewable sources, due to their IVET qualifications (in particular "plant mechanics for sanitary, heating and air conditioning systems", "electronics technicians" and roofers), and that they were therefore qualified to perform all work associated with renewable energy. Despite this legal opinion, a working group consisting of experts from the relevant trade associations and chambers was established at the ZDH for the purpose of compiling a new CVET programme under §42a HwO in the field of renewable energy. This new programme is scheduled to become available in late 2012 or early 2013 at the latest. In the context of a CVET examination regulation, the CVET fields of biomass boilers, heat pumps, PV systems, solar heating systems and geothermal systems will be regulated. The associated framework curricula have also been developed as a quality assurance measure. On successfully passing the exam in one of the aforementioned skilled craft chambers, participants receive the official CVET certificate certifying their new qualification.
In the context of this CVET programme, participants are taught the capabilities, knowledge and skills needed to identify the energy-saving potential of commercial and residential buildings, to install facilities improving energy efficiency and to carry out the necessary repair and maintenance work. Skills in selecting, configuring and sizing the facilities represent a further learning outcome of the programme. The CVET programme also allows older fitters in particular to upgrade their qualifications in the latest renewable energy technologies.

*7.5.1.3 A quality assurance instrument - the inter-company apprentice teaching programme (***Überbetriebliche Lehrlingsunterweisung *or* ÜLU***)*

The purpose of an apprenticeship in the skilled craft sector is to enable apprentices to become experts in the many facets and constantly changing requirements of their working environment, able to come up with solutions for the complex tasks they are faced with.
In Germany, IVET takes place via the apprenticeship system. VET colleges are there to provide the theoretical basis, while companies and inter-company VET centres offer a practical setting. Together they form the environment for gaining an initial vocational qualification.
Small skilled craft companies in particular, with their often specialised production or service organisations, are not always in a position to cover all the necessary aspects of an apprenticeship. For this reason, Germany provides the additional instrument of the "inter-company apprentice teaching programme" (*Überbetriebliche Lehrlingsunterweisung* or ÜLU) under §5 BBiG and §26 HwO. This instrument enables certain parts of an apprenticeship programme to take place outside the company where the apprentice is employed. The ÜLU

programme thus constitutes a qualification instrument specific to certain occupations on the basis of the respective apprenticeship framework. The programme takes place in inter-company workshops established by guilds or chambers. Skilled training staff is available to enable apprentices to develop a basic set of professional capabilities. Courses specific to individual occupations are offered, with 6 - 12 apprentices from member companies taking part. Courses are full-time and normally last 3 - 4 weeks.

The ÜLU programme is of particular importance for the construction sector, as, due to work taking place on different building sites, it is often not possible to set up a long-term learning environment. The result is that apprentices in the construction industry spend 26 weeks of their apprenticeship in ÜLU training centres. In 2011, more than 429,000 apprentices in Germany took part in some 49,000 ÜLU courses.[121]

The content of the ÜLU courses is developed by the respective trade associations together with the HPI in accordance with the respective apprenticeship framework, which in turn is defined by the two social partners in conjunction with the Federal Government. The ÜLU programmes are subsidised by the state, with the Federal Government, the *Länder* and the skilled craft companies bearing the running costs. In individual cases recourse may be had to the European Social Fund.

The ÜLU programme plays a decisive role in ensuring the quality of an apprenticeship in the skilled craft sector, complementing and further developing the instruction received on-the-job and promoting the systematic development of apprenticeship content. It ideally complements an apprenticeship in a company with specialised production or service organisation. In the face of such changing overall conditions as greater use of technology, demographic change and deficits in the IVET maturity of young people, ÜLU is gaining in importance as a compensatory function and as a technology transfer instrument. In the context of ÜLU courses it is for example possible to raise the IVET level of young people to meet certain basic standards. New curricula for new technologies - also in the context of Germany's "*Energiewende*" - can be developed and implemented quickly and in sync with requirements.

ÜLU can therefore be seen as an innovative and high-performance partner of companies in the construction sector, constituting a central pillar in ensuring quality and overcoming the challenges IVET is faced with.