7.5.2 Best practice examples of comprehensive building refurbishment projects

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The examples shown below illustrate a wide range of comprehensive building refurbishment projects. In accordance with the categorisation of buildings done in association with the development of building sector scenarios (cf. Chapter 4.3), this section looks at detached and semi-detached houses, small and large blocks of flats and non-residential buildings. Data is taken from the German Energy Agency's "Effizienzhaus" pilot project.
The energy-related costs listed are to be seen as specific to the individual buildings concerned, taking into account the condition of the building and its proposed use. They cannot be generalised.

Detached house

50181 Bedburg, Erft, Langemarckstraße 22
Built in 1950, 2 floors, surface area: 205 m², one residential unit, refurbishment completed in 2006

1950's villa converted into a low-energy house

Old building plans show the typical character of this house, which the owners decided to restore. Guided by their concern for improving the house's energy efficiency and providing a good indoor climate, the old villa was transformed into a modern, energy-efficient building with remarkable energy consumption figures.

Energy consumption:

	before refurbishment	after refurbishment	under EnEV requirements for new buildings
Primary energy requirement QP''	484 kWh/m^2a	23 kWh/m^2a	77 %
Specific heat transmission loss HT'	1.24 W/m^2K	0.24 W/m^2K	55 %
Final energy requirement QE	428 kWh/m^2a	61 kWh/m^2a	
Primary energy savings	95 %		
CO2 savings	18 tonnes a year		

Measures affecting the building's envelope:

- Insulation of the outside walls with a 20cm-thick polystyrene composite insulation system (CIS) applied to the existing single-walled brick construction
- 18cm-thick insulation applied to the cellar walls
- Roof insulation with 26cm-thick mineral wool
- New triple-glazed wooden windows with thermal glazing and insulated frames

HVAC systems:

- Heating: Pellet-fired central heating
- Ventilation system in each room
- Central ventilation system
- 11 m^2 of solar heating panels for hot water and supporting the heating system

Costs and cost effectiveness:

Building costs	For the whole building	pro m^2 floorspace
Total building costs	104,003 €	507.34 €/m^2

Detached house

28201 Bremen, Meyerstraße 92

Built in 1898, 3 floors, surface area: 215 m^2, one residential unit, refurbishment completed in 2008

Wilhelminian villa, completely modernised

The so-called "Altbremer Haus" was completely refurbished and is now to all intents and purposes a passive house. As well as a very good insulation of the building's envelope, the high level of energy efficiency is achieved with pellet-fired central heating supported by a solar heating system and a ventilation system with combined heat recovery.

Energy consumption:

	before refurbishment	after refurbishment	under EnEV requirements for new buildings
Primary energy requirement QP''	237 kWh/m²a	23 kWh/m²a	73 %
Specific heat transmission loss HT'	1.37 W/m²K	0.32 W/m²K	51 %
Final energy requirement QE	203 kWh/m²a	42 kWh/m²a	
Primary energy savings	90 %		
CO2 savings	15 tonnes a year		

Measures affecting the building's envelope:

- Insulation of the outside walls with a 28cm-thick mineral wool applied to the existing single-walled brick construction.
- 18cm-thick insulation applied to the cellar walls
- Roof insulation with 45cm-thick mineral wool
- New triple-glazed wooden windows with thermal glazing

HVAC systems:

- Heating: Pellet-fired central heating
- Central hot water
- Ventilation system with combined heat recovery in each room working at 90% efficiency
- 11 m² solar heating system for hot water and supporting the heating system

Costs and cost effectiveness:

Building costs	For the whole building	pro m² floorspace
Total building costs	235.475 €	1,092 €/m²

Small block of flats (12 residential units)

12557 Berlin-Köpenick, Schönerlinderstraße 6

Built in 1888, 4 floors, surface area: 795 m², 12 residential units, refurbishment completed in 2010

Refurbishment of a listed residential building with no effect on the overall rent (rent + heating).

The building is part of a listed Wilhelminian complex located in Köpenick, the Berlin district with the most lakes and forests. The remarkable feature of this project is the preservation of the building's historical character, while at the same time achieving a high level of energy efficiency.

Energy consumption:

	before refurbishment	after refurbishment	under EnEV requirements for new buildings
Primary energy requirement QP‘‘	238 kWh/m²a	39 kWh/m²a	53 %
Specific heat transmission loss HT’	1.72 W/m²K	0.26 W/m²K	60 %
Final energy requirement QE	214 kWh/m²a	13 kWh/m²a	
Primary energy savings	83 %		
CO2 savings	112 tonnes a year		

Measures affecting the building's envelope:

- Insulation of the outside walls - stucco facade (street-side): 14cm-thick cellulose inside insulation
- Insulation of the outside walls - courtyard side 20cm-thick polystyrene as a composite insulation system
- Ground floor: 19.5cm-thick insulation
- Roof: 26 - 46cm-thick cellulose insulation
- New triple-glazed windows (wood windows at the front, plastics windows at the back)

HVAC systems:
- Central heating and hot water supplied by a heat pump with a 500 litre tank.
- Central VAC system with heat recovery operating at 90% efficiency
- Underfloor heating
- 31 m² of photovoltaic panels on the back roof with a performance of 3.78 kWp

Costs and cost effectiveness:

Building costs	For the whole building	pro m² floorspace
Total building costs	1,378,500 €	1,700 €/m²
Energy-related costs	713,500 €	897 €/m²

Rental costs/m²	per m²	By comparison: Conventionally modernised building
Net rent (without heating)	8.50 €	ø 7,50 €
Operating costs (without heating)	1.24 €	ø 1,53 €
Heating and hot water costs	0.25 €	ø 0,99 €
Total	9.99 €	ø 10,02 €

Through the reduction of heating requirements, the use of energy-efficient HVAC technology and renewable energy, heating costs are a lot lower. These are covered by the income from the PV system, equivalent to the forecast total heating costs of 1,400 €/p.a. The rental contracts contain a clause stating that tenants will not be charged for any heating costs.

Large block of flats (42 residential units)

81379 München, Zielstattstraße 133-137

Built in 1954, 4 floors, surface area: 3059 m², 42 residential units, refurbishment completed in 2009

Listed company accommodation - Boschetsrieder Siedlung

The listed company accommodation built by Siemens in the mid-1950s (architect: Emil Freymuth) is in the course of being refurbished, with all facilities being completely modernised. In conjunction with the heritage conservation authorities and the owners, the building complex was restored to its 1950s character, with a compromise being achieved between the design specifications of the conservation authorities and the energy-efficiency (EnEV: -50 %) and constructional requirements of the owners.

Energy consumption:

	before refurbishment	after refurbishment	under EnEV requirements for new buildings
Primary energy requirement QP''	60 kWh/m²a	10 kWh/m²a	87 %
Specific heat transmission loss HT'	1.05 W/m²K	0.31 W/m²K	53 %
Final energy requirement QE	138 kWh/m²a	52 kWh/m²a	
Primary energy savings	82 %		
CO2 savings	63 tonnes a year		

Measures affecting the building's envelope:

- Outside wall insulation with 10cm-thick polystyrene applied to the single-wall construction with additional 5cm-thick inside insulation
- 26cm-thick roof insulation
- New triple-glazed wooden windows

HVAC systems:

- Ventilation system in each room
- Conversion to district heating
- Conversion from decentral to central hot water supply

Costs and cost effectiveness:

Building costs	For the whole building	pro m² floorspace
Total building costs	5,202,876 €	1,700 €/m²
Energy-related costs	2,217,148 €	724 €/m²

Rental costs/m²	Before refurbishment / m²	After refurbishment /
Net rent (without heating) ø	7.33 €/m²	10.00 €/m²

Very large block of flats (977 residential units)

13439 Berlin-Märkisches Viertel, Wilhelmsruher Damm 103

Built in 1968, 6 - 18 floors, surface area: 67,769 m², 977 residential units, refurbishment completed in 2011

Refurbishment of a block of flats in a housing estate in Berlin

The whole Märkische Viertel is gradually being refurbished with a view to improving energy efficiency. Refurbishment of the group of buildings described here has been completed, and now acts as a pilot for the refurbishment of the remaining buildings. The Märkische Viertel won first prize in the BMVBS' competition for the best housing estate in Germany.

Energy consumption:

	before refurbishment	after refurbishment	under EnEV requirements for new buildings
Primary energy	237 kWh/m²a	37 kWh/m²a	40 %
Specific heat	1.41 W/m²K	0.45 W/m²K	16 %
Final energy	177 kWh/m²a	90 kWh/m²a	
Primary energy savings	53 %		
CO2 savings	375,519 tonnes a year		

Measures affecting the building's envelope:

- 16cm-thick mineral wool on the existing concrete outside walls
- Thicker insulation for the ground floor, cellar and roof
- Wooden windows replaced with double-glazed plastic windows (1.3 W/m²K)

HVAC systems:

- District heating with a high share of renewables
- Conversion from decentral to central hot water supply
- Heat pump for recovering heat from the VAC system, with heat used to pre-heat the hot water.

Costs and cost effectiveness:

Building costs	For the whole building	per m²
Total building costs	38,208,900 €	563.80 €/m²

Rental costs/m²	Before refurbishment /	After refurbishment /
Net rent (without heating)	3.94 €/m^2	4.74 €/m^2
Operating costs (including heating)	3.99 €/m^2	2.86 €/m^2
Total	7.93 €/m^2	7.60 €/m^2

As a result of the modernisation, energy efficiency has been greatly improved, leading to a significant reduction in energy requirements. The savings in operating costs (incl. heating costs) practically compensate the rise in rents due to the modernisation, meaning that tenants are basically paying the same.

A museum as an example of a non-residential building

Wilhelm-Hack-Museum in 67059 Ludwigshafen

Built in 1976 - 1979, surface area: 6,678 m2, refurbishment completed in 2009

Energy-related refurbishment taking heritage conservation aspects into account


The Wilhelm-Hack-Museum in Ludwigshafen was built in 1976 and features exposed concrete walls. The building was refurbished in 2008, with account being taken of heritage conservation aspects (a facade mosaic by Joan Miro). The refurbishment focus was on installing an innovative HVAC system, as the air-conditioning of the rooms and keeping them at the right humidity were the main items on the museum's energy bill. There was an urgent need for refurbishment, as melting water had already got into the concrete walls, causing damage and posing a threat to the museum's valuable collection of works of art.

Energy consumption:

	before refurbishment	after refurbishment	under EnEV requirements for new buildings
Primary energy requirement QP''	348 kWh/m²a	117 kWh/m²a	79 %
Specific heat transmission loss HT'	0.99 W/m²K	0.38 W/m²K	66 %
Final energy requirement QE	534 kWh/m²a	312 kWh/m²a	
Primary energy savings	73 %		
CO2 savings	592 tonnes a year		

Measures affecting the building's envelope:

- 16cm-thick mineral wool insulation on the uninsulated walls and damaged parts of the building
- Thicker insulation in the cellar, top ceiling and roof
- New double-glazed windows with thermal glazing and insulated frames

HVAC systems:

- Modernisation of the district heating system
- District heating for hot water
- Central VAC system with heat recovery (75% efficiency)
- New lighting system with daylight control
- Control of room climate via temperature, humidity and CO2 sensors
- 300 m² of photovoltaic panels producing 29 kW

Costs and cost effectiveness:

Building costs	For the whole building	pro m² floorspace
Total building costs	5,027,352 €	752.82 €/m²
Energy-related costs	4,651,043 €	696.47 €/m²

Once the project is finished, it is estimated that operating costs (incl. maintenance costs) will drop from 460,000 € to 190,000 € a year. Operating costs alone (without maintenance) are set to drop from 350,000 € to 130,000 € a year.

8 Labour force and skill needs up to 2020

8.1 Using quantitative simulation to calculate estimated workforce demand up to 2020

Robert Helmrich, Tobias Maier, Ines Thobe, Marc Ingo Wolter

Chapter 7.2 was devoted to looking at overall labour market developments in Germany, explaining the methodology used for calculating the BIBB-IAB Qualification and Major Occupational Field Projections and projecting potential labour supply for the selected building occupations. We now turn our sights to the demand side, looking at how potential demand for these building occupations is expected to develop. We start by explaining how the IAB-INFORGE model works, as this is used for projecting labour demand (Section 8.1.1). Using this as a base, Chapter 8.1.2 goes on to show how the previously discussed alternative scenario is implemented in the model.
The results (Section 8.1.3) show that the investment surge in the building industry caused by energy-related refurbishment measures can be expected to generate additional demand for 90,000 workers in the selected building occupations, and 200,000 workers overall in 2020. Comparing this alternative projection of demand for skilled workers in the selected building occupations with the available labour supply potential (Section 8.1.4), it becomes evident that additional supply potential will be needed to cope with the projected demand for skilled workers. Section 8.1.5.1 ends by pointing to ways of mobilising additional potential through changes in occupational flexibility patterns.

8.1.1 How the IAB-INFORGE model works

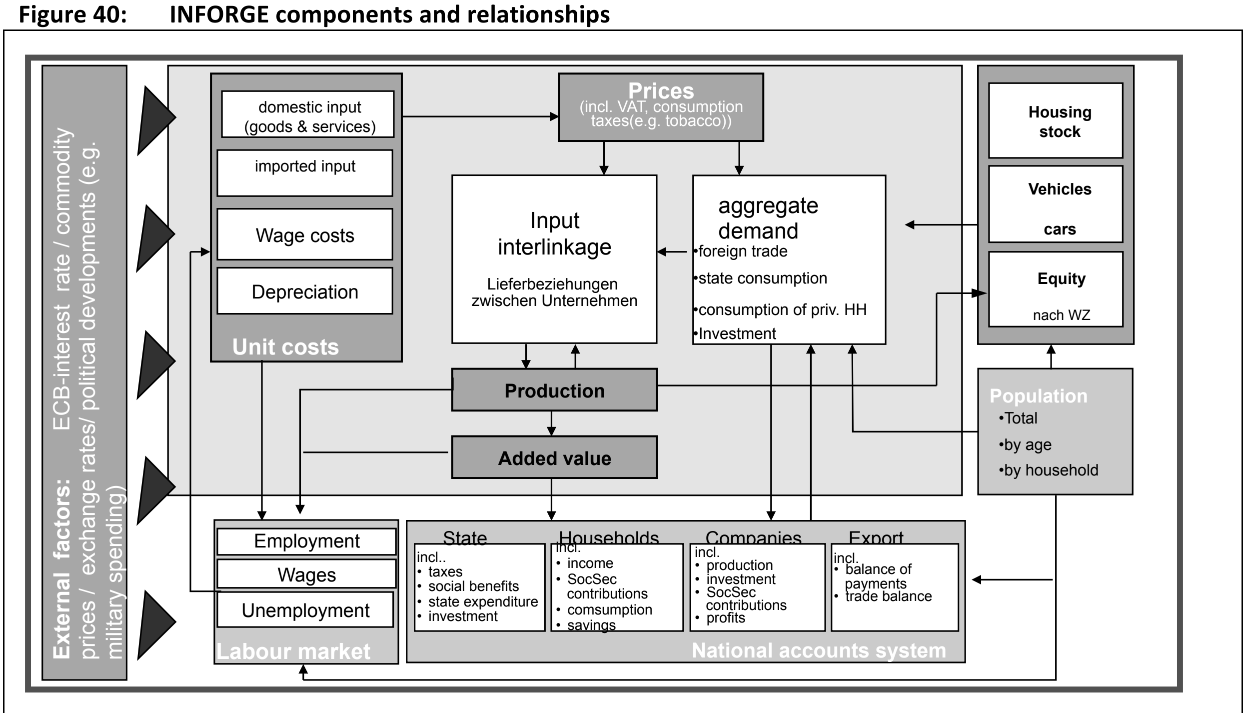
The project makes use of the IAB-INFORGE model, a model combining labour market demand aspects taken from the QuBe project and the INFORGE model. The INFORGE (INterindustry FORecasting GErmany) model is a macro-economic model grouped into sectors for Germany. The model has been regularly updated since the early 1990's, and has been consistently used for forecasts and scenario projections. A comparison of different models confirmed the INFORGE model’s capability to also simulate detailed scenarios. The model is classified by Holub and Schnabl (ibid. 1994, 328 f.) as an integrated model. Together with other modern macro-economic models, it is regarded as an important system for disaggregated input-output tables (Eurostat 2008).
The INFORGE model is based on a comprehensive database fed mainly by official data published by the Federal Statistical Office. This data includes the latest GDP figures and the input-output tables for the Federal Statistical Office's national accounts. The database version of the model used in the project reflects the September 2010 GDP figures (StBA 2010b). Through the inclusion of the National Accounts in the modelling, the financial consequences of the chosen scenarios for the market participants (the state, companies and private households) can be depicted within a consistent framework.

The exceptional performance of the INFORGE model is attributable to its integration into an international network of models (INFORUM) (see Almon, 1991). The model is based on the two construction principles "bottom-up" and "full integration". "Bottom-up" means that the individual sectors of the economy are modelled in great depth, with the macro-economic variables being obtained through aggregation within the model. This results in a complete and consistent presentation of the individual sectors in their macro-economic context and their inter-sectoral interlinkage, thereby providing explanations for macro-economic relationships and depicting the economy as the sum of its sectors. "Full integration" means the model is structured in such a way that the interlinkage between the individual economic sector can be depicted, with an explanation of how private households spend the income they derive from the individual sectors. Export demand is estimated on the basis of Germany's foreign trade links with the rest of the world.

Though the INFORGE model reflects a very high degree of endogeneity, is still requires exogenous input. Along with fiscal policy variables such as tax rates, this includes ECB interest rates, currency exchange rates and developments in commodity prices. World trade is also an exogenous factor, used in forecasting German exports, as is the labour supply potential calculated by the IAB.

Figure 40 provides a high-level overview of the model's components and relationships. A detailed description of the model can be found in Ahlert et al. (2009) and in Distelkamp / Hohmann / Lutz / Meyer / Wolter (2003). Current examples of the model's use are to be found *inter alia* in Maier / Mönnig / Zika (2012), Drosdowski / Wolter (2012) and Helmrich / Zika / Kalinowski / Wolter (2012).

Figure 40: INFORGE components and relationships



Source: GWS.

IT-based models are frequently used for analysing economic policy measures. These have the advantage of being able to process large amounts of data in a very short time, and are therefore a great help in analysing complex issues within a consistent framework. The model's closed framework plays an important role here, ensuring that all effects of the measures are taken into consideration. At the same time partial analyses can ignore important aspects. Such models generally work with scenarios, with two or more scenarios being quantitatively described and compared with each other. In our case, the one scenario is our reference scenario, which describes a development ignoring the measures to be analysed (in this case the QuBe projection). The other scenarios are policy scenarios integrating these measures (in this case the additional energy-related refurbishment of buildings). Different results can then be traced back to the introduction of the measure. The differences in relative or absolute variance are the main result of these model calculations.

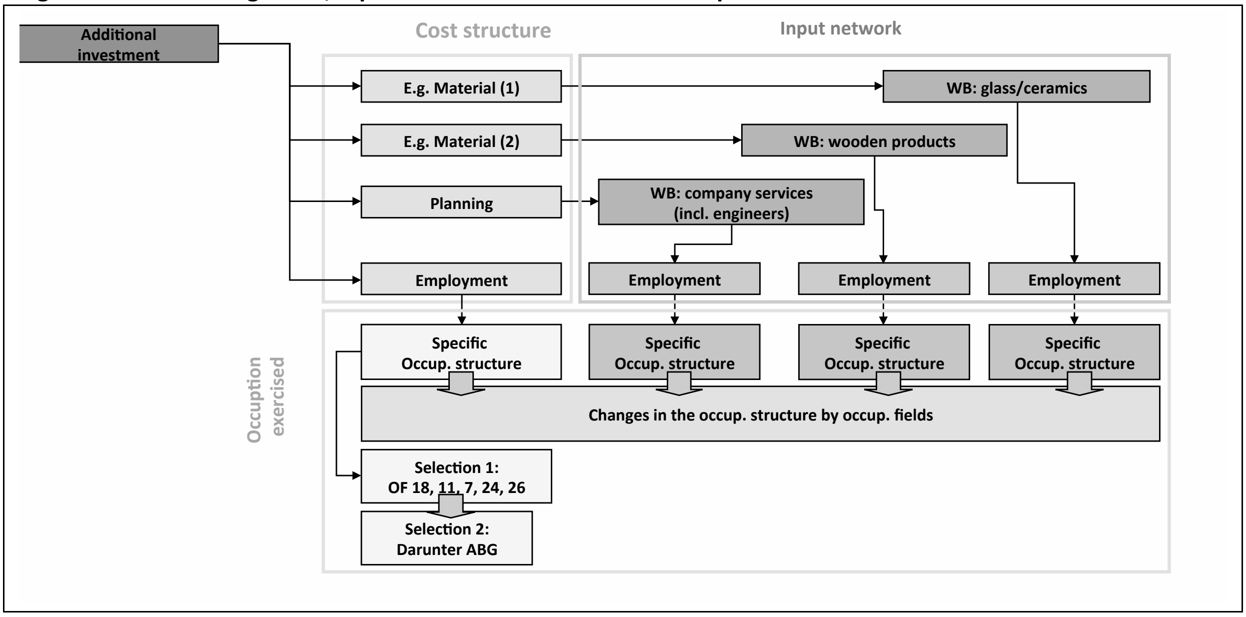
8.1.2 Scenario calculation: Increased energy-related refurbishment to 2020

In the previous chapter 7.2, the construction of the scenario spotlighted here has been described in depth. The resultant quantitative scenario parameters serve as the basis for the IAB-INFORGE simulations. Alongside the necessary increase in building investment volumes needed to achieve a higher refurbishment rate, the funding of this investment volume is also taken into consideration. We start by explaining the relationships within the model which are of importance for calculating the scenario, showing to what extent structural information on the workforce in the selected building occupations is taken into account in the model.

8.1.2.1 The impact of increased building investment volumes: their relationships within the model and workforce structure

The building trade is part of an 'input network' (*Vorleistungsverbund*). The IAB-INFORGE model links up building sector relationships with the sectors of the economy providing input to the building trade via the cost structures of these sectors. Also implemented are the employment effects and the respective industry-specific occupational structures (see Figure 41).

Figure 41: Building trade, input network and individual occupations

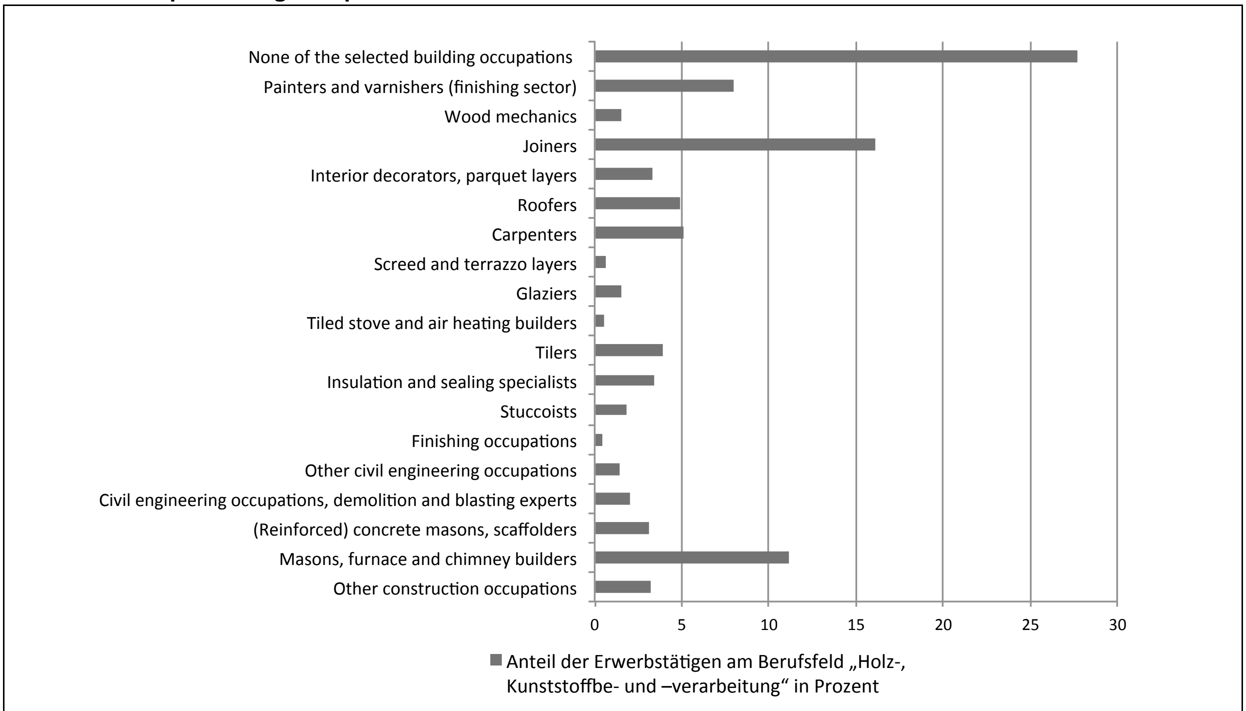


Source: GWS presentation, QuBe project; based on the Federal Statistical Office's input-output table.

Additional investment in the building sector leads indirectly to increased demand in other sectors of the economy. In line with the increased production of the building sector, additional input goods and services are ordered, leading to production increases in the supply sectors within the input network. Some 30% of the building sector's production value involves input goods (StBA 2010b). The majority of such goods come from the ceramics, processed stone and earth, glass and metal sectors. Electricity generation equipment also features high on the list. Somewhat more than a quarter of the production value involves services, with a further quarter covered by wages. Though any increase in the rate of energy-related building refurbishment would primarily impact employment in the building sector, other sectors would also benefit from the additional investment.

To assess the impact of such an increase on the selected building occupations, a greater differentiation of these occupations is implemented in the model. To achieve this, data from the 2008 microcensus is used (see Chapter 7.2.2). As already seen in Chapter 7.2.5, most of those working in the selected building occupations (ca. 40%) are to be found in the field of "construction, woodworking, plastics manufacture and processing occupations". Large numbers are similarly found in "electrical occupations" and in "metal construction, plant construction, sheet metal construction, installation, fitters". The implementation of the greater differentiation of the occupations is therefore focused on these three occupational fields, which together account for some 80% of the total workforce in the building fitting and finishing sector. The results also take into account the occupational fields of "engineering draughtsmen" and "specialist skilled technicians", as over half of workforce in these fields works in the selected building occupations (see Table 33). Together, these five occupational fields represent some 94% of the labour force working in the selected building occupations. However the workforce in these occupational fields does not just consist of those working in the selected building occupations, but also of people not greatly involved in energy-related refurbishment work, such as for instance about a quarter of those in "woodworking, plastics manufacture and processing occupations". In the calculations, such workers are grouped together in a separate category: "none of the selected building occupations". Figure 42 provides greater insight into the occupational field, showing the distribution of the workforce in the selected building occupations within the occupational field. The most frequent fitting and finishing occupations are joiners, "masons", "furnace and chimney builders" and "painters and varnishers". Whereas the 1992 classification of occupations (*Klassifikation der Berufe 1992*) makes a distinction between a "painter and varnisher" and a "painter and varnisher in the finishing trade" at the 3-digit level of occupational categories, no such differentiation is available for joiners. The latter therefore represent the occupational category with the largest population within the occupational field. By contrast, the populations of "builders of tiled stoves and air heating systems", "other building occupations" and "screed and terrazzo layers" are relatively small.

Figure 42: Share of each occupational group in the total "woodworking, plastics manufacture and processing occupations" workforce in 2008



Source: StBA, microcensus, BIBB, QuBe; Extended evaluation in the context of Qualergy (BIBB).

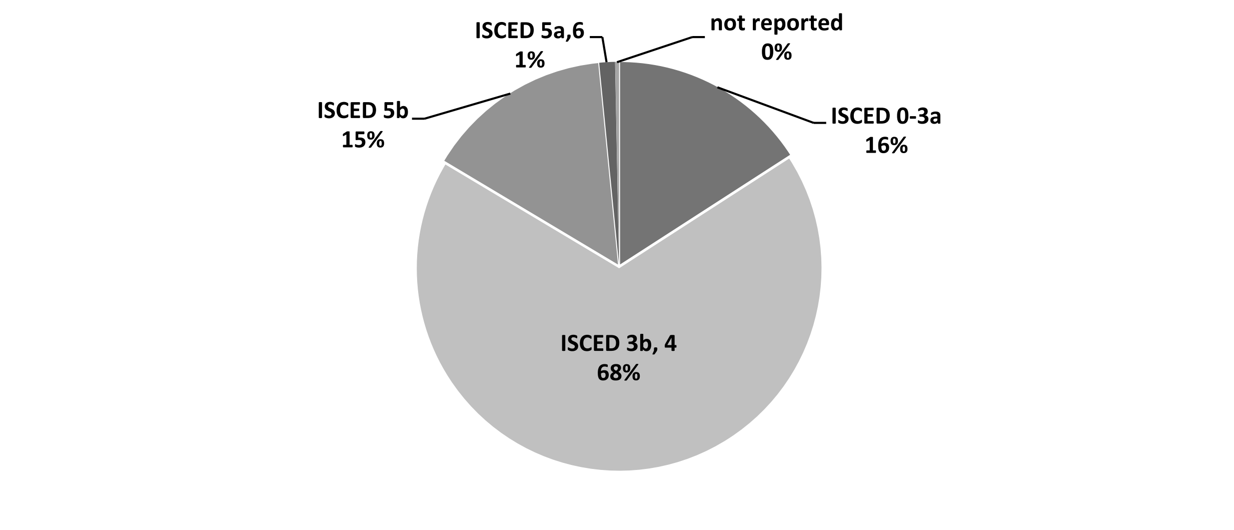
The microcensus data shown here have been integrated into the IAB-INFORGE model in greater differentiation and implemented using a 'constant share' approach. This means that the individual occupational categories within the occupational field evolve in line with the superordinate occupational field. Any increase in the refurbishment rate would consequently affect all occupational categories of the respective occupational field in the same way. Due to a comparative lack of information on different impacts of refurbishment measures on the individual selected building occupations within the selected occupational fields, it was not possible to conduct the modelling with any greater degree of accuracy. In our view, it would be a good idea to look into possible different impacts of refurbishment measures on the selected building occupations from a qualitative perspective.

The skill structure of the building workforce in question can similarly be extracted from the 2008 microcensus, as can be seen in Figure 43 This shows that just over two-thirds of those working in the selected building occupations have an IVET qualification corresponding to the middle-qualification level (ISCED[122] levels 3b and 4). Of the remaining one-third, about half have an ISCED level 5b master/engineering vocational qualification, whereas the other half have no vocational qualification (solely ISCED level 0-3a). The selected building occupations are therefore to a great extent dependent on workers with middle-level qualifications, meaning that an increase in demand for these occupations will have the biggest effect on this skill level. Within the occupational fields of the selected building occupations, the same skill levels are assumed for both the reference and the alternative scenario. Since no major changes compared to the base year are to be expected in these three major occupational fields relevant for the selected building occupations[123], the skill structure of those working in the selected building occupations will proportionally remain the same in 2020 as seen in Figure 43.

[122] ISCED: International Standard Classification of Education.

[123] The reference scenario forecasts a decline in the percentage of unskilled workers working in "construction, woodworking, plastics manufacture and processing occupations" from 22% in 2010 to 19% in 2020. In the other two occupational fields, "electrical occupations" and "metal construction, plant construction, sheet metal construction, installation, fitters", the percentages of unskilled workers are forecast to remain constant (at 21% and 25%) (Source: IAB-INFORGE model).

Figure 43: Skill structure of those working in the selected building occupations



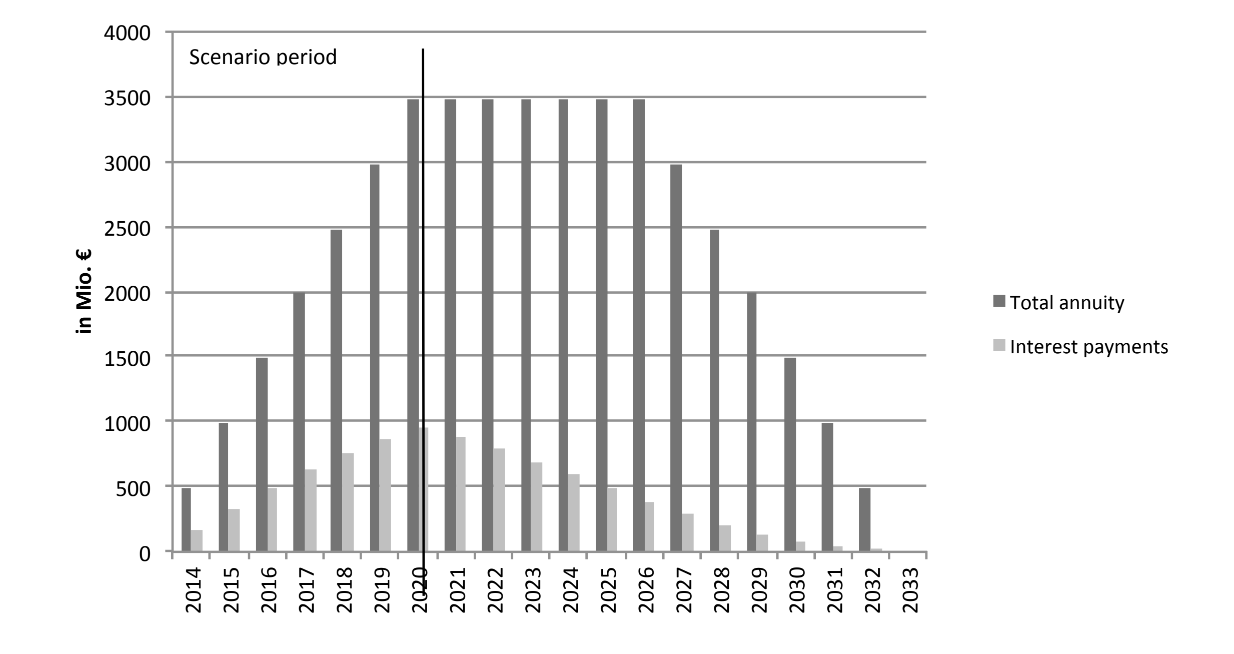
Source: 2008 Microcensus; BIBB calculations.

8.1.2.2 An overview of how the scenario is implemented

On the basis of the available literature and expert forecasts (cf. Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**), the consequences of an increase in the rate of energy-related refurbishment in both the housing and non-residential sectors are calculated. The scenario provides for a €23.6 billion increase in the building investment volume over a period of 7 years (2014 - 2020). These additional building refurbishment measures will be financed by private households, the state and commercial companies, including housing companies and private landlords.

The scenario assumes that 21% of the total investment volume will be shouldered by private households. It is further assumed that all measures will be 100% credit-financed, at an interest rate of 3.5%. Similarly a 6.5% repayment rate is assumed, meaning that the investment sums will be fully repaid after 12 years. The annuity payments can be expected to restrict the financial leeway of private households, meaning that a portion of available income will no longer be available for consumption.

Figure 44: Annuity and interest payments of households to 2020



Source: Own calculations.

Figure 44 shows the development of cumulative annuity and interest payments for private households. The annuity, i.e. the sum of interest payments and repayments, remains at a peak from 2020, the year the final investment projects are started, until 2026 when the first refurbishment measures (implemented in 2014) are fully repaid. This projection assumes that the refurbishment rate falls back to 1% from 2021 onwards. This will take 12 years, i.e. until 2026. It will not be until 2032 that the last annuity payments are made. The period after 2020 will see demand steadily dropping when the refurbishment rate drops back to 1%. In the scenario developed in this project it is however assumed that the higher refurbishment rate will be maintained, meaning that the peak burden for private households will not be reached until 2026 and will remain at that level.

Funding will for the most part be provided by the construction sector (68%) with the remaining 11% coming from the state. Additional investment by housing companies leads to a rise in depreciation, which will find its way into their cost calculations. The result will be rent increases. The model is however only able to produce a rough estimate of the size of this effect. §559 of the German Civil Code (*Bürgerliches Gesetzbuch* or BGB) allows rent increases of up to 11% for buildings that have undergone energy-related refurbishment. However, in the scenario used (cf. Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**) the percentage of additional buildings needing refurbishment in relation to the building stock is so small that the effect of rent increases is expected to be negligible.

The state will fund its share through taking out new loans. As the additional building investment leads to an increase in the country's GDP, therefor expanding the tax base, the state - though only contributing 11% of the funding - can expect higher tax revenues.

8.1.3 Results of the alternative scenario

In the following section the results of the scenario calculation are presented and discussed. The relative and absolute variances between the alternative scenario and the reference scenario are described, whereby the focus is on labour demand.
Looking at the economy as a whole, the comparison with the reference scenario shows GDP growth in 2020 1% higher.[124] The main growth driver is increased building investment[125] (ca. 11%). The resultant wage levels in the building sector and their positive effects on other sectors in the input network lead to higher available income in private households, thereby generating higher consumer demand. Compared with the reference scenario, the relative increase in consumer demand slows down in the course of the simulation period (cf. Table 62). This development is attributable to the rising annuity payments of private households in connection with the additional refurbishment measures. Due to the improved situation on the labour market, the state can reduce its expenditure on social benefits.

Table 62: Results for the economy as a whole

Scenario:					
Variables	**Definition**	**2014**	**2016**	**2018**	**2020**
	Percentage variance to reference scenario				
BIPR	Gross domestic product	1,2	1,1	1,0	0,9
CBIPRH	Consumption of private HH and orgs.	0,6	0,6	0,4	0,3
CSR	State expenditure	-0,1	-0,1	-0,1	-0,2
IAR	Investment in plant and equipment	1,8	1,5	1,2	1,0
IBR	Investment in buildings (housing, commercial and govt. buildings)	10,6	10,9	11,0	11,2
EXBIPR	Export	0,0	0,0	0,0	0,0
IMBIPR	Import	0,7	0,7	0,6	0,5
	Labour market and redistribution				
	Percentage variance to reference scenario				
APE	Labour productivity	0,6	0,5	0,5	0,4
ETS	Workforce	0,6	0,6	0,5	0,5

Source: IAB-INFORGE.

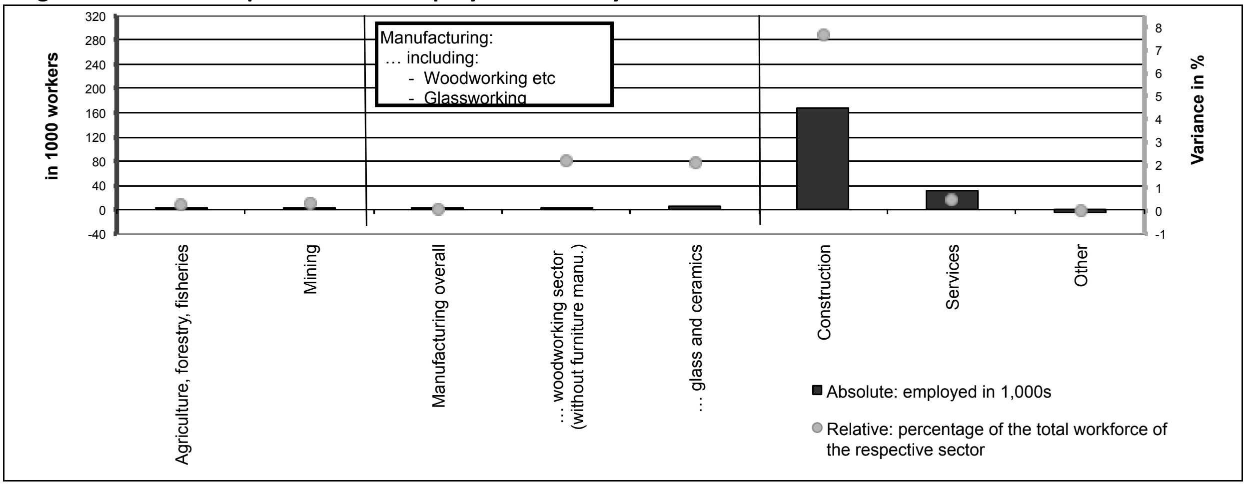
Of particular relevance are the changes in employment resulting from the scenario, reflecting the increased demand for skilled labour. The variances in the development of the size of the workforce as a result of the annual investment figure of €23.6 billion are larger at the beginning of the period covered by the scenario, due to the fact that the effect of the initial increase of the investment amount in 2014 is greatest in most dimensions at the beginning of the simulation period. This is reflected by the peak employment effect being reached in 2014. On average the resultant increased demand for labour throughout the economy is estimated at 230 000 workers a year. Comparing these results with studies on

124 Effects possibly arising from the energy savings are not modelled.

125 The assumption in the reference scenario is that building investment basically remains flat; in 2020 it would be just 0.3% higher than in 2010. Given the current economic situation of the building sector, which was not yet known when the reference scenario was calculated, it can be assumed that the development will be more positive, reaching a higher level. The size of the building workforce would therefore be larger.

the employment effects of for instance upgrading the CO2 building refurbishment programme (Lutz / Meyer, 2008), we find that the results are similar.

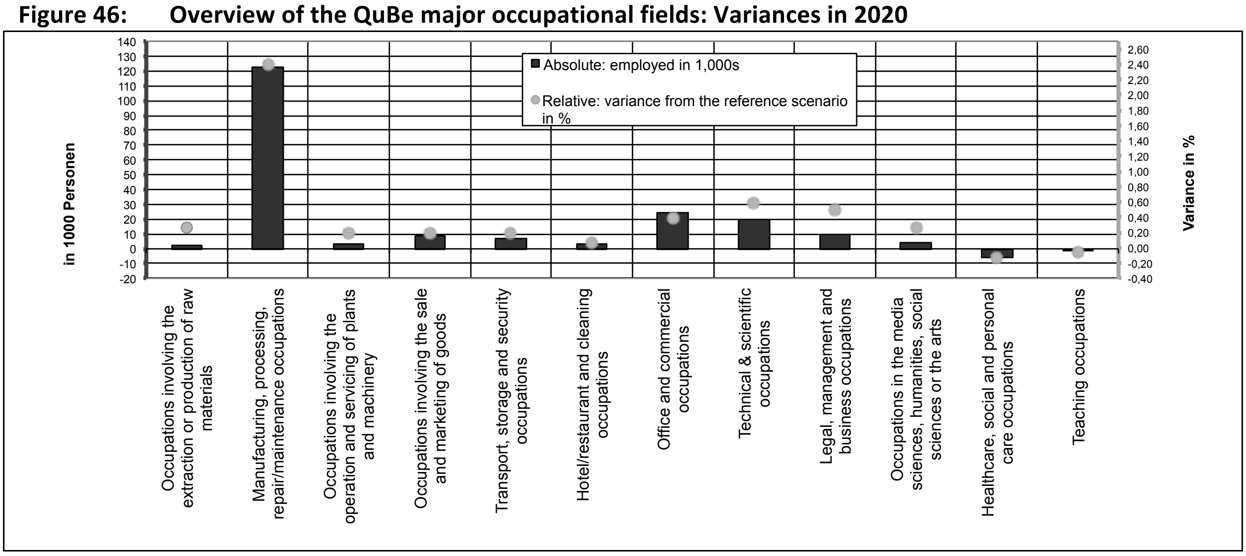
Figure 45: Development of the employment rate by sector



Source: IAB-INFORGE.

The positive effect on employment is seen in particular in the construction sector and in sectors belonging to the input network (cf. Figure 45). As is to be expected, the main employment effect is in the construction sector itself, where employment is forecast to rise by around 8%. In addition, employment in the manufacturing sectors providing input to the construction sector, including the wood- and glass-working sectors, also benefits from the increased investment, with increased demand for building materials boosting labour demand. In addition, employment in service companies also increases slightly, attributable not just to demand within the input network, but also to the overall positive development of the economy.

Figure 46: Overview of the QuBe major occupational fields: Variances in 2020

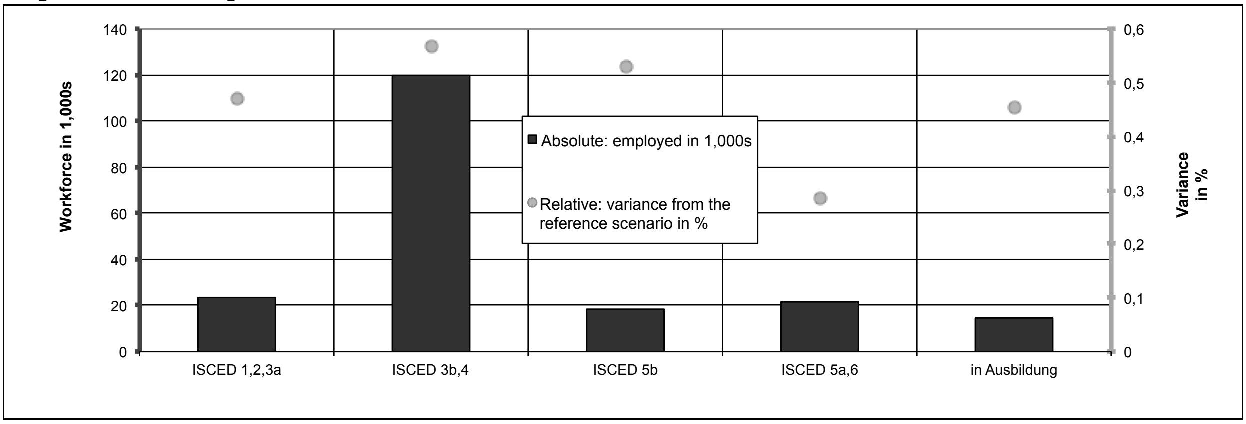


Source: IAB-INFORGE.

Alongside the building occupations, "technical and scientific occupations", "legal, management and business occupations" and "office and commercial occupations" benefit most from the increased investment. The relative variances in these occupations are around 0.4%.

In the selected building occupations, most of those employed work as joiners, "masons", "furnace and chimney builders", electricians, "painters and varnishers" or as "construction mechanics". As a result of the "constant-share" approach used (which means that the individual occupational categories evolve in line with their superordinate occupational field), the absolute demand for labour increases more significantly in occupations with high workforces. In the results, the direct effects of the additional investment are redistributed to the benefit of employees not working in the selected building occupations in the largest occupational field. To do this, the areas affected were identified and adjusted, and added to the other selected building occupations. In accordance with the scenario rules, no weighting of the occupations benefiting most or least from the increase in refurbishment rates is undertaken (see Section 8.1.2.1). Also needing to be considered is the fact that there are occupations in which the occupational categories are assigned to the relevant building occupations, but where those working in these occupations are not solely involved in fitting and finishing work. This applies for instance to joiners and furniture joiners. These data-specific features need to be taken into account when interpreting and drawing conclusions from the labour demand effects in specific occupations.

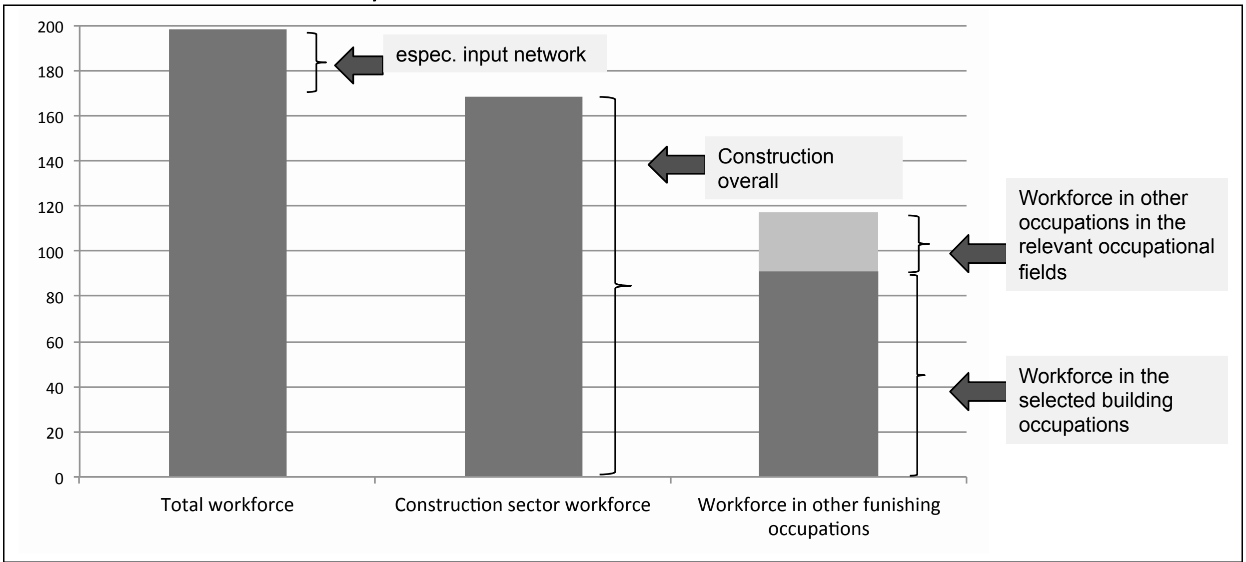
Figure 47: Changes in skill levels: variances in the workforce in 2020



Source: IAB-INFORGE.

As already ascertained in Section 8.1.2.1, middle-level skills are the ones most needed in the building sector. Figure 47 shows that the absolute and relative variances in these are highest in 2020, with 120,000 workers with middle-level skills benefiting from the higher refurbishment rate. By contrast, high-level skills (ISCED 5a, 6) are least affected, with the relative variance only 0.3%.

Figure 48: Addtional labour demand as a result of the increase in investment levels (variances in thousands in 2020)



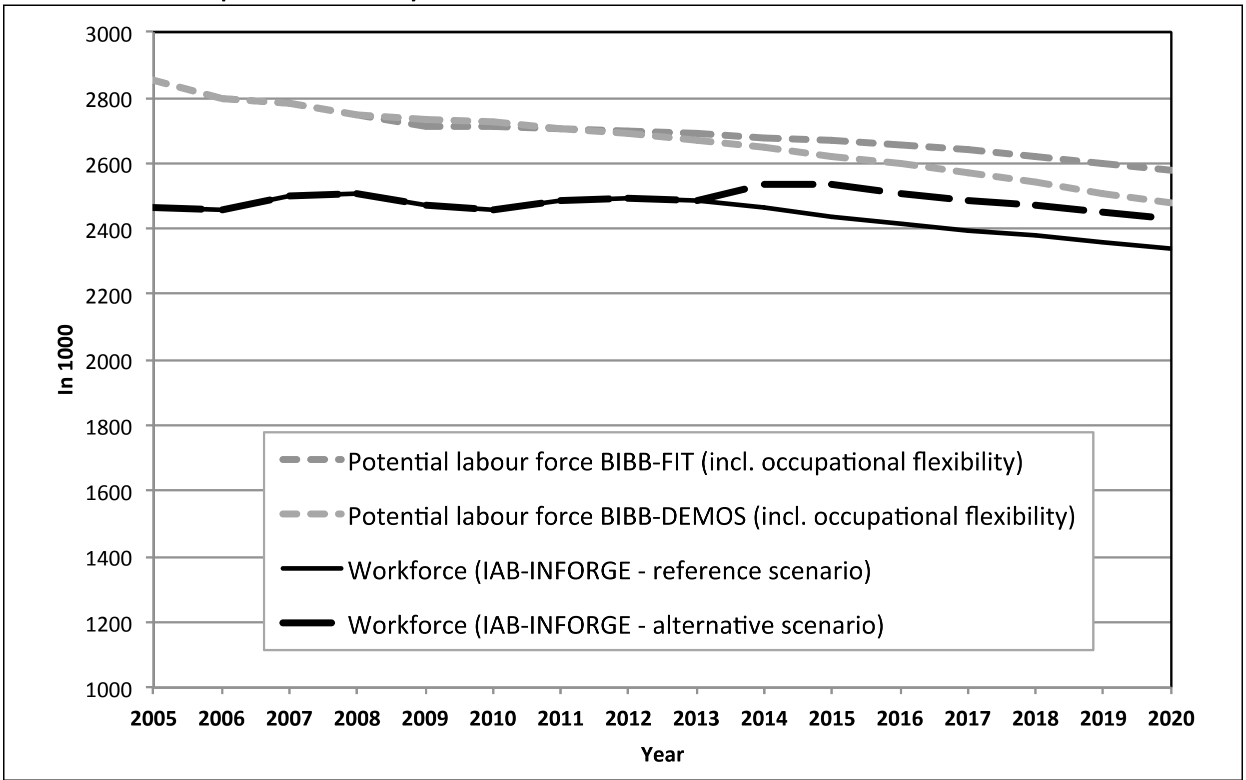
Source: IAB-INFORGE.

Figure 48 provides an overview of the changes in the size of the total workforce, the construction workforce and the selected building occupations in 2020, showing that some 200,000 additional workers will be required in 2020. This figure includes both workers in the occupations directly affected by the increased investment levels (fitting and finishing occupations) and workers in occupations belonging to the input network and therefore indirectly affected (for example woodworking occupations). Though not all those working in the construction sector can be assigned to building occupations - for instance architects, office staff -, they still benefit from the increase investment levels. This is the reason why the number of additionally required workers throughout the building sector is 170,000 higher than that of those actually working in the building occupations (120,000 higher than in the five occupational fields most important for the selected building occupations). When only taking the selected building occupations in these occupational fields into account, the figure drops to 90,000 additionally required workers in 2020. This means that roughly 50% of the additional demand for workers as a result of upgrading the energy-related refurbishment rate is for workers in the selected building occupations.

8.1.4 Comparison of the labour demand and supply between the reference and alternative scenario

The labour supply figures for the building occupations calculated using the BIBB-FIT and BIBB-DEMOS models have already been compared with the demand for workers in the reference scenario (see Chapter 7.2.2.3) The conclusion here was that there would be an excess supply of workers amounting to 240,000 (BIBB DEMOS) or 140,000 (BIBB-FIT) in 2020. Taking the results of the alternative scenario (Figure 49) into account, we see that the additional demand for ca. 90,000 workers in 2020 reduces the above-mentioned supply-side surplus to 150,000 (BIBB-DEMOS) / 50,000 (BIBB-FIT). It should be remembered that this is a mathematical supply-side surplus for the whole of Germany. It can be expected that there will be regional labour shortages in the selected building occupations, should demand develop in line with the demand projections of the alternative scenario and should there be no increase in supply.

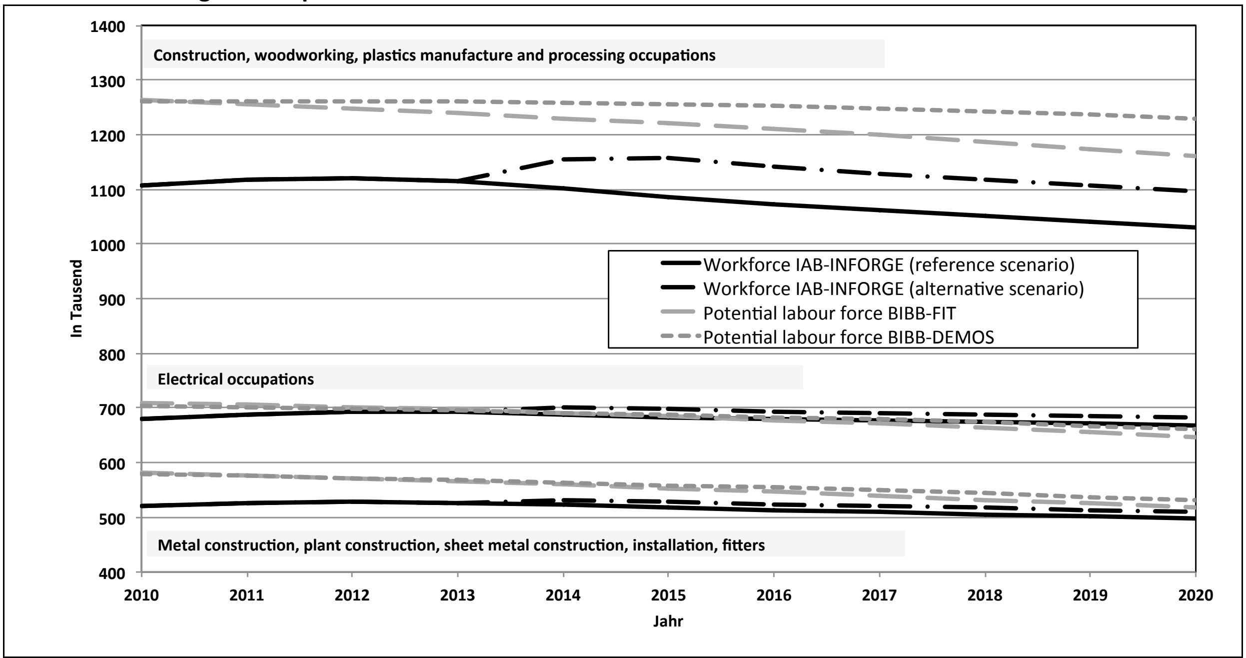
Figure 49: Labour supply and demand projection to 2020 in the selected building occupations, taking occupational flexibility into account: reference and alternative scenarios



Source: QuBe project, 2nd wave.

Possible shortages are seen as being possible in Germany as a whole when looking at the development within the three largest occupational fields ("metal construction, plant construction, sheet metal construction, installation, fitters", "electrical occupations" and "construction, woodworking, plastics manufacture and processing occupations" (Figure 50). Whereas the "construction, woodworking, plastics manufacture and processing occupations" can expect a mathematical supply-side surplus of 74,000 (BIBB-FIT) / 142,000 (BIBB-DEMOS) workers in 2020, the alternative scenario forecasts a shortage in "electrical occupations" even before the scenario period begins (in 2014). Data available points to recruitment problems from 2010 onwards, as supply is only slightly higher than demand. The way the model is constructed, this means that there were only few unemployed people in 2010 with the right skills to take up a job in an electrical occupation. Looking at the third field, that of "metal construction, plant construction, sheet metal construction, installation, fitters", the alternative scenario shows that it will be difficult to cover projected labour demand towards the end of the projection period.

Figure 50: Labour supply and demand in the selected building occupations to 2020 within the three largest occupational fields: reference and alternative scenarios



Source: QuBe project, 2nd wave.

8.1.5 Potential for increasing the size of the labour force

The results of the comparison between the supply of labour and demand for it on the basis of the reference and alternative scenarios show that, towards the end of the projection period, it will become increasingly difficult to adequately cover demand. It should be further noted at this juncture that the bulk of the 'baby-boomers' will not be entering retirement until after 2020. As the 40 - 44 age bracket constitutes the largest cohort of the potential labour force in the relevant building occupations (see Figure 34), there is a high possibility of labour supply decreasing even more rapidly from around 2030 onwards. But even before this date, shortages can be expected in certain geographical regions and in certain building occupations, for instance electrical occupations. Against this background the questions arises of the extent to which further labour force potential in these occupations can be exploited in the short and long term. Measures aimed at increasing the supply of skilled workers generally focus on skill upgrade programmes, immigration and measures for increasing the employment rate (cf. Bonin, et la. 2007). The way the model is constructed, it is however also possible to look closer at the effects of occupational flexibility in the selected building occupations, as this constitutes a further instrument for tapping further potential in the short term.

8.1.5.1 Occupational flexibility as a way of increasing labour force potential

Table 35 shows that about half of all people having done an apprenticeship in one of the building occupations actually works in this occupation. These so-called 'stayers'[126] also account for about two-thirds of those working in the building occupations Table 36. What is however also known is that occupational flexibility can vary dependent on age, gender and qualification level (see for instance Maier, Schandock, & Zopf, 2010). For the building occupations, it therefore makes sense to look at occupational flexibility separately by age bracket and qualification level, establishing where there is further potential for increasing labour supply. No separate assessment by gender is made at this stage, as, at least in 2008, only 5.6% of the total labour force in the construction sector was female[127].

Table 63: Occupational flexibility in the selected building occupations by occupation originally trained for and age

Finishing occupations within the occupational fields	15-29 age bracket			30-39 age bracket			40-49 age bracket			50-99 age bracket		
	Stayers in the occup. category (in %)	Stayers in the occup. field (in %)	No. of cases in originally trained-for occup	Stayers in the occup. category (in %)	Stayers in the occup. field (in %)	No. of cases in originally trained-for occup	Stayers in the occup. category (in %)	Stayers in the occup. field (in %)	No. of cases in originally trained-for occup	Stayers in the occup. category (in %)	Stayers in the occup. field (in %)	No. of cases in originally trained-for occup
Stoneworking, construction materials production, ceramics, glass related occupations	64,5	64,5	50	41,7	41,7	56	35	35	73	31,3	31,3	54
metal construction, plant construction, sheet metal construction, installation, fitters	41,7	54,3	967	28,9	39,4	1755	22,4	32,6	3041	19,6	30,4	2619
Electrical occupations	41,6	52,6	1285	28,1	38,9	2046	22,6	33,7	2704	25,2	34,9	2562
Construction, woodworking, plastics manufacture and processing occupations	44,9	55,9	1941	41,5	53,8	2960	36,8	49,3	4160	32,6	44,7	2929
Technicians	18,5	39,4	37	35,9	47,8	220	37,3	48,9	423	22,7	33,2	375
Specialist skilled technicians	67,4	71,5	111	40,9	43,7	226	27,6	32	347	21,1	23,7	416
Engineering draughtsmen, related occupations	84,8	84,8	88	56	56	123	39,9	39,9	253	32,6	32,6	264
Cleaning and waste disposal occupations	80,7	80,7	28	77	77	41	76,4	76,4	58	79,5	79,5	33
Total	44,8	55,6	4507	35,1	45,9	7427	29,4	40,1	11059	26,1	36,2	9252

Source: 2008 microcensus of the Federal Statistical Office; BIBB calculations based on extrapolated figures, whereby the number of cases reflects the actual sample size.

Table 63 shows the percentage of stayers within the occupational fields by age bracket. A distinction is made here between the stayer percentage in the occupational category and the percentage within the superordinate occupational field. The stayers in the occupational category represent those working in their originally trained-for occupation, whereas stayers in the occupational field represent those exercising either their originally trained-for occupation or a similar one belonging to the same category. What can be seen is that in all occupational fields the proportion of stayers declines as workers get older - on average by 5% for each older age bracket. Looking at the building occupations with the largest workforces in the occupational fields "metal construction, plant construction, sheet metal construction, installation, fitters", "electrical occupations" and "construction, woodworking, plastics manufacture and processing occupations", we see that there is hardly any change in the proportion of stayers from the age of 40 onwards. What can also be seen is that the

[126] The term 'stayer' refers to a person who stays in the occupation he originally trained for. The converse term, 'mover', refers to a person who switches occupations.

[127] Source: 2008 microcensus of the Federal Statistical Office

proportion of stayers is highest in the last-named occupational field, with this applying to all 30+ age brackets. In the "metal construction, plant construction, sheet metal construction, installation, fitters" occupational field, the absolute numbers of workers in the 40 - 49 age bracket is by far the highest. And this is the age bracket that will be leaving the labour market in about 20 years' time. Were these workers to continue showing their current flexibility patterns, i.e. taking their low occupational flexibility to the next cohort, the proportion of skilled workers available in the projection period could easily be raised.

Given the large number of people having successfully completed an apprenticeship in the building sector, even small changes in occupational flexibility patterns can have large effects on labour supply. With the right incentives, it would undoubtedly be possible to retain people originally having trained for a building occupation in this occupation. The occupational flexibility patterns of the 50+ age bracket resemble those of the 40 - 49 age bracket. The decision to switch occupations is therefore generally taken before a worker reaches the age of 40. Once this age has been reached, the proportion of stayers, at least in the larger occupational fields, is around one third, even if the proportion in younger age cohorts is slightly higher than that of the older cohorts. One plausible scenario could therefore be a further adjustment of occupational flexibility patterns for two older age cohorts:
Should there be no change in the occupational flexibility patterns of the current 40 - 49 age bracket, with it thus being transposed over time to the 50 - 50 age bracket, this would swell the future supply of the skilled workforce in the occupations in question.

Occupational flexibility patterns are not just dependent on age but also on the level of qualification. People with a master craftsman qualification (ISCED 5b) tend to stay longer in the occupation they originally trained for than people with a lower-level qualification (ISCED 3b and 4). Table 64 reflects these flexibility patterns dependent on the level of qualification. It should be noted here that we are looking at the occupational flexibility of specific occupational categories, i.e. the apprenticed occupation or a master craftsman title looked at belongs to this category. However not all people assigned to the category have an occupational qualification associated with the building sector. For example, people with an ISCED 5b qualification working in an "electrical occupation" or as a "technician" may also be found working in engineering and scientific fields (cf. Table 35). This is the reason why the proportion of stayers in these occupational fields is only 41.6% or 43.6%. In all other occupational fields, the proportion of stayers with an ISCED 5b qualification is around two-thirds or more. The causes for this can be found in human capital theory: Due to a person's higher investment in his training, workers with a master craftsman qualification have less incentive to switch occupations than people who have 'only' successfully completed an apprenticeship. Even if some 43% of those working in building occupations and having a master craftsman qualification are self-employed[128], a CVET programme helping blue-collar

[128] with and without employees. Source: 2008 microcensus of the Federal Statistical Office.

workers to upgrade their skills would seem to be an incentive for them to stay in the occupation they originally trained for.

Table 64: Occupational flexibility in the selected building occupations by occupation originally trained for and level of qualification

Ausbauberufe innerhalb der Berufsfelder	ISCED 3b and 4			ISCED 5b		
	Stayers in the occup. category (in %)	Stayers in the occup. field (in %)	No. of cases in originally trained-for occup	Stayers in the occup. category (in %)	Stayers in the occup. field (in %)	No. of cases in originally trained-for occup
Stoneworking, construction materials production, ceramics, glass related occupations	31,6	31,6	192	92,1	92,1	41
Metal construction, plant construction, sheet metal construction, installation, fitters	24	34,4	7907	48	65,6	475
Electrical occupations	28,1	38	7792	23,6	41,6	805
Construction, woodworking, plastics manufacture and processing occupations	34,9	47,9	10521	64,9	69,8	1469
Technicians	27,8	35	88	31,6	43,6	967
Specialist skilled technicians	32,9	36,3	1080	-*	-*	20
Engineering draughtsmen, related occupations	46,7	46,7	709	-*	-*	19
Cleaning and waste disposal occupations	60,6	60,6	79	96,4	96,4	81
Total	30,3	40,9	28368	46,2	56,9	3877

* not shown due to the low number of cases.

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

8.1.5.2 Further labour supply potential through increased labour force participation rates.

Figure 34 in the supply projection as well as the case numbers in Table 63 show that the majority of the workforce having learned a trade in one of the selected building occupations is older than 40. At the same time, we see that the labour market participation rate of older people has risen significantly over the last 10 years (see Figure 48). Should this trend continue at a rate above that set in the reference scenarios, it would be possible to further increase labour supply in the future.[129] What needs to be taken into account here though is the fact that the potential for increasing potential is limited, as the "baby-boomers" will all be retired by 2030.

Along with the increase in the employment rate of older people, another trend currently being seen is the increasing employment rate of women (see Helmrich, et al. 2012). As however the selected building occupations are predominantly "male occupations"[130], it cannot be expected that they will benefit from this trend. To facilitate such a trend, what would be needed are measures increasing the attractiveness of the occupations for women.

[129] The increase in the retirement age in Germany is not taken into account (see Helmrich, et al. 2012).

[130] According to the 2008 microcensus, the percentage of women working in the selected building occupations is 5.6%.

8.2 Qualitative analysis of skill sets needed in the future

Katrin Rasch, Rolf R. Rehbold, Susanne Rotthege

Parallel to the analysis of existing skill sets in current IVET and CVET programmes (cf. Chapters 7.3 and 7.4), a further intention of the study was to identify those skill sets relevant now and in the future for achieving the energy targets in the building sector.
Two hypotheses serve as the starting point for the analysis in this work package:

1. The technologies needed for the energy-related refurbishment of buildings and the use of renewables exist and are sufficiently developed and that there will be no major changes in these technologies in Germany between now and 2020 (cf. Chapter 4.3). This in turn means that there will be little change in the associated work processes. It also means that, when analysing the required skill sets, those *currently needed* represent a suitable base for determining *current and future* (up to 2020) skill requirements.
2. In Germany, apprenticeship frameworks (as the basis for standardised IVET programmes throughout the country) are compiled by the state as the regulatory authority, in close cooperation with experts from the social partners and VET specialists (cf. Chapter 6) and with current requirements from the field being taken into direct account. It can therefore be assumed that the current apprenticeship frameworks already cover a large section of currently needed skill sets. In doing so, they constitute an important source for the analysis of necessary skill sets possibly needing to be expanded to take future developments into account.

On the basis of these initial hypotheses, the following - for the most part hermeneutic - methodology was used for determining the necessary skills, closely interrelated with the analysis of the apprenticeship frameworks and the skills existing therein (for steps 1 - 3, cf. - Chapters 7.1 and 7.3):

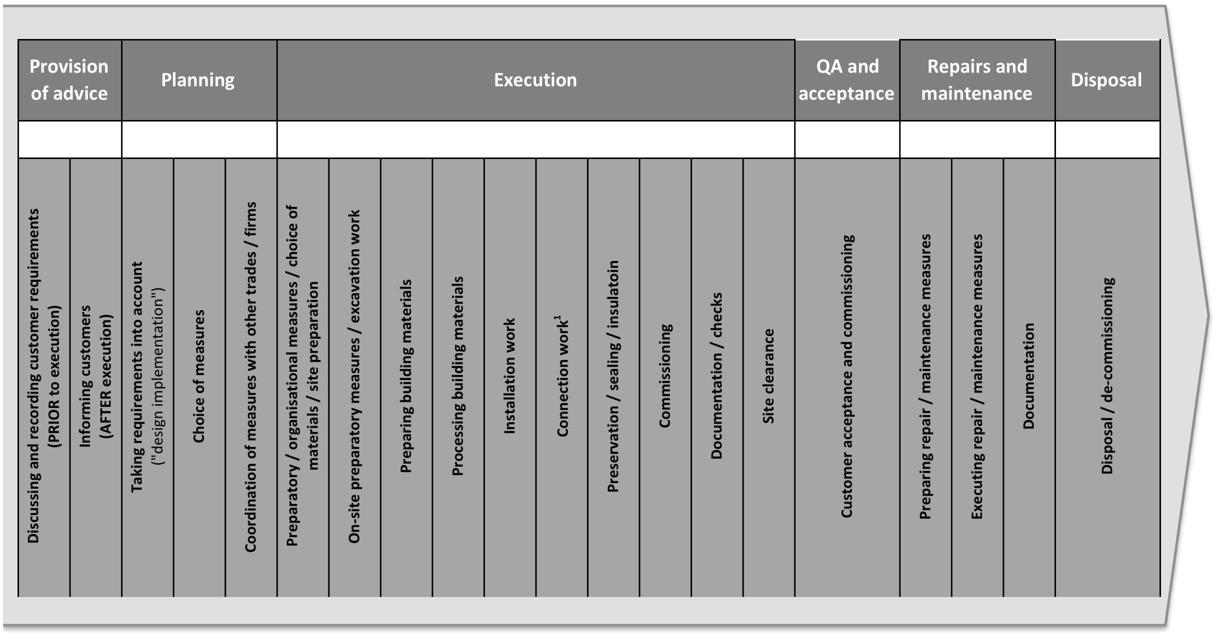
1. *Identification of the building work categories in which blue-collar workers are to be found.* This step has already been conducted in conjunction with the analysis of existing and *needed skills, and serves as a dimension in the joint evaluation matrix. It also involved focusing on all technologies - in agreement with the HPI findings - relevant for achieving the EU's energy targets, without regard to whether they are currently often used or whether they are relevant in the scenario for determining the total amount of investment* needed. This leads to the creation of a data base of required skills going in its conclusiveness beyond the scenario used in this project for the quantitative projections.
2. *Identification of the process categories for describing the value chain on a superordinate and less-detailed level.* As part of the evaluation matrix used for recording existing skills, the process categories needed for building a matrix, together with the technologies determined in Step 1, were ascertained. This matrix was then used for mapping skills (cf. Table 27).

Figure 51: 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						

3. *Entering existing skill sets into the evaluation matrix*. The work in this step involved desk research, looking through apprenticeship frameworks and their associated curricula (cf. Chapter 7.3) and entering the skills into the matrix.
4. *Compilation of a first detailed process matrix*. The first step in the detailed analysis of the process steps (and thereby of the skill sets) involved looking closer at the existing skill descriptions within the (still non-detailed) process steps with regard to the activities involved (verb analysis) and finding suitable terms for the process steps common to all occupations. We looked first at the more recent apprenticeship frameworks, using a hermeneutic spiral to gradually include older frameworks. The result was a more-detailed matrix which was then used as a basis for a renewed look at the skill sets in the apprenticeship frameworks.
5. *Extension of the overall process matrix to cover master craftsman processes.* The German skilled craft system features the master craftsman level, a qualification needed for example to run one's own skilled craft company. One of the specific features of a master craftsman qualification is that certain processes within the value chain are reserved for this level. These focus on providing customers with comprehensive advice, on designing individual solutions and on planning.
6. *Discussion and modification of the process matrix with experts*. The matrix developed was then presented to the VET experts from the relevant trade associations and discussed with them. This saw certain terms being clarified, others added and in some cases a further differentiation being made. This in turn led to new discussions and modifications in the evaluations done for other trades, constituting a hermeneutic spiral.

Figure 52: Skill sets at journeyman level

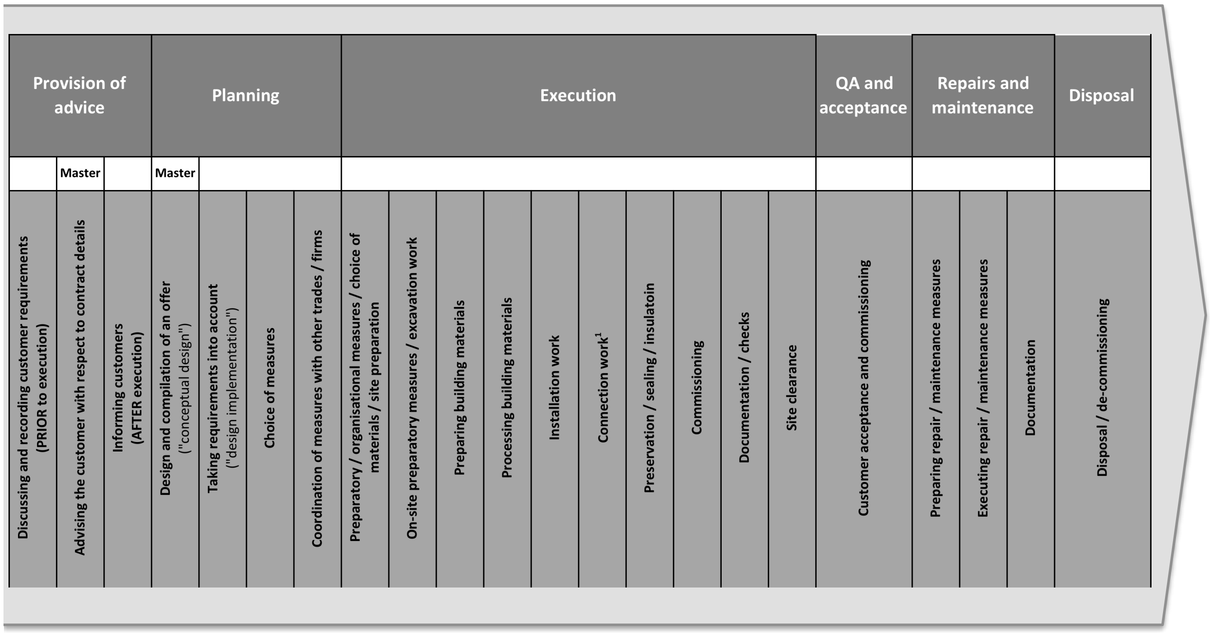


As a result of this iterative process with its desk research and interviews with the experts from the trade associations, the following process matrices emerged - skill sets at journeyman level (Figure 52) and skill sets at journeyman and master level (Figure 53). The skills sets are understood here as the capabilities needed to complete a certain process or activity and are correspondingly named in association with the process in question. The key result of the matrix covering all occupations is that all processes - apart from 'commissioning' and 'connecting up a system' - are common to all building work (sub)categories. As verified by the VET experts from the trade associations,[131] all these skills sets need to be covered. What is however not necessary - and in part either not possible or not desired - is that the whole process be covered by a single occupation. A prerequisite and starting point for later considerations on gaps are the interfaces between the trades. There follows a short description of the individual processes and their associated skill sets.

It should be first mentioned that though these skill sets are presented in a linear manner in the value chain, in practice there is no linear execution of the process steps involved, with some being missed out and others repeated. For instance, a maintenance process can trigger the process of a customer being advised on other work needed, e.g. the installation of a new system, with this entailing planning and execution steps. Similarly the 'provision of advice' process covers all steps, even when they occur after the execution phase.

[131] At the time this report was compiled, not all trade associations had been interviewed.

Figure 53: Skill sets at journeyman and master craftsman level



Skill sets needed in the context of providing advice:

A twofold differentiation would seem to be applicable here. On the one hand we have advisory processes which take place before an order is confirmed / work is executed and others which take place after execution (e.g. instruction on the handling of the heating system). On the other hand, with regard to the required skill sets for advisory processes before a contract is executed, a distinction is made between providing a customer with preliminary information or "recording a customer's requirements" and comprehensive "order-related customer advice". The latter includes contract negotiations.

Skill sets in connection with planning:

Planning starts with the "planning and preparing an offer" sub-process covering all planning activities associated with preparing an offer. This includes taking technical considerations into account and pricing the offer, as well as compiling a work schedule. Such activities are normally done at master craftsman level. After this initial planning step and before a customer actually places his order (and which may be amended at a later date), planning involves inspecting the building site to check whether possible requirements have been fulfilled, and detailing the next steps/measures needing to be done. In addition, schedules may need to be further coordinated with those involved. The sub-process "Coordinating work with the others involved" does not involve providing the customer with comprehensive advice and coordinating the overall project, but instead focuses on coordinating execution work mainly with other trades working on the site.

Skill sets in the context of the execution process:

The process category with the widest range of sub-processes is "execution". The process starts with 'preparatory measures / selection of the right materials / setting up the building site' - a sub-process involving making available all necessary tools and materials (possibly including scaffolding) in full compliance with safety regulations.

It is followed by 'on-site preparatory work / excavation work', which includes such activities as pouring foundations or making holes in a wall for the installation of a new heating or PV system.

The ensuing sub-processes of 'preparing materials' and 'processing materials' differentiate between purely preparatory work such as graining, marking and cutting, and further processing steps, such as bending materials to shape.

Though not always easy to exactly determine when the last step ends[132], the next step is that of attaching/fixing/installing the system / materials to the building ('Assembling and installing components and systems'), for instance installing a PV system on the roof or facade and pushing the necessary cables and pipes through the building's envelope.

A clear distinction is made - in part also in the assignment of occupations - between this work and actually connecting up the systems, with the latter work involving connecting up the cables and pipes to the house's existing electrical and plumbing system.

Associated work involves conducting the necessary protective, sealing, waterproofing and insulation work, including insulating heating pipes in the cellar or protecting cables against damp.

The next step is that of actually commissioning the system, and only applies to the two categories, the building's infrastructure and its energy supply, as these are areas where systems are commissioned. Also involved in this step is the actual configuration of the system, i.e. setting the parameters in line with the building's circumstances.

As part of the 'documentation / system tests' sub-process, measurements are taken, the completed work documented and also evaluated on the basis of the measurement results.

The execution process ends with clearing up and vacating the building site, with all tools and scaffolding being removed.

Skill sets in the context of customer acceptance / quality assurance:

These include on the one hand the activities associated with handing over the completed work to the customer, for instance conducting control measurements, assessing the quality of the work done, and checking that everything works properly. In a number of trades, these activities are carried out by the master craftsman, in others by the journeyman. Such activities (and possibly further ones associated with quality assurance) may also be performed by authorised third parties (chimney sweeps), meaning that the required skill sets are divided up between two levels (that of the company performing the work, and that of the company with the statutory duty of inspecting the work). There can be a certain amount

[132] For instance, a roofer will process a piece of slate while up on the scaffolding and immediately nail it into place before starting work on the next slate.

of overlapping here, with the chimney sweep for instance checking the emission parameters, while the plant mechanic checks that the whole system is watertight and works properly.

Skill sets in the context of repair and maintenance:

The repair and maintenance sub-processes are secondary processes, performed to ensure the continued functioning of the installed system. When for instance a repair leads to a facade needing to be completely renewed or a heating system replaced, the value chain will restart, with the customer being advised on what to do.

With regard to the repair and maintenance process with their relatively short mention in the respective documentation, the process was only divided up into three sub-processes: the pre-execution phase of determining repair and maintenance needs (diagnosis); the actual execution and any post-execution work (documenting the work performed).

Skill sets in the context of the disposal process:

Last but not least, the disposal process involves making sure that the materials/systems are properly disposed of at the end of their life-cycle. The identification of the materials, i.e. assessing what they are made of and how they need to be disposed of, lies at the core of this process.

9 Gap analysis

Katrin Rasch, Rolf, R. Rehbold, Susanne Rotthege

This chapter determines potential needs. It uses as its basis

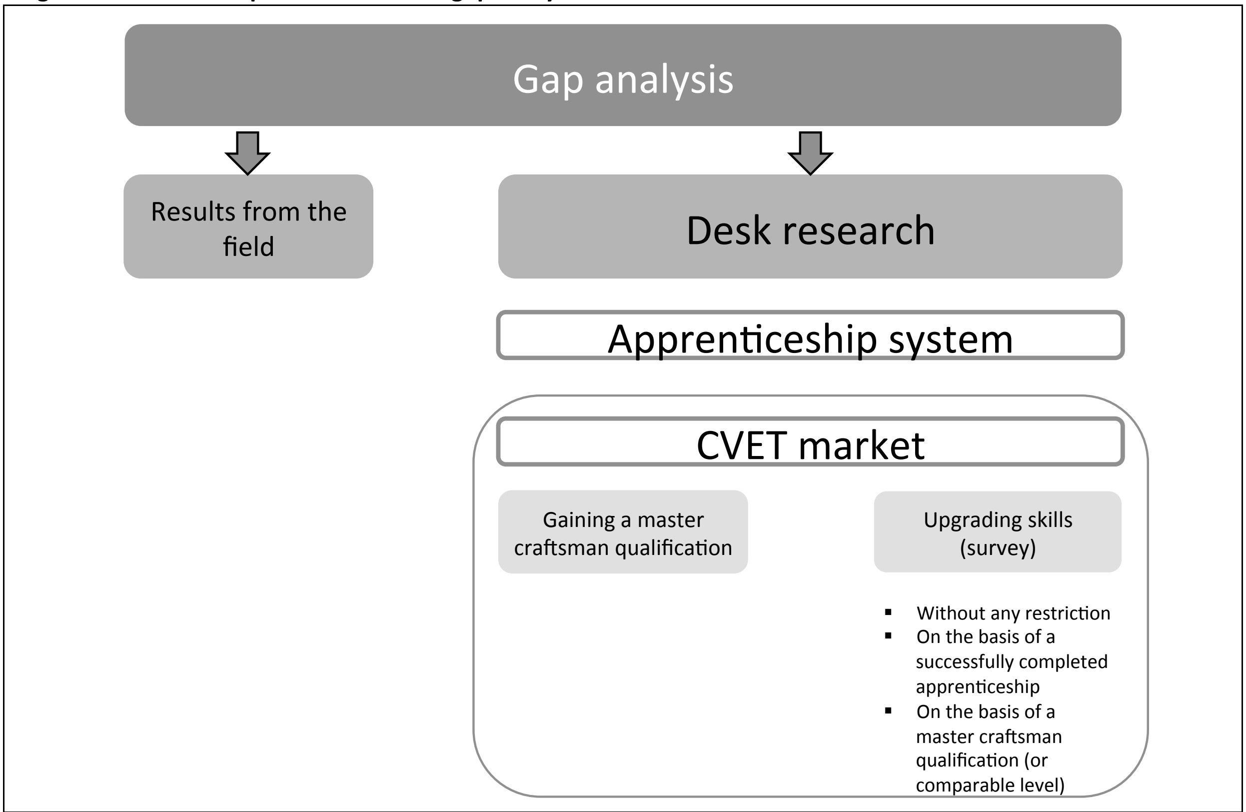
- the calculated number of skilled workers available in the selected occupations and the extrapolated forecast to 2020, as well as the status quo with regard to skills, and
- the number of skilled workers and their respective skill sets up to 2020.

The results can in turn be used for deriving recommendations for action and for developing a roadmap.

To enable this, the **quantitative surveys** were integrated into Chapter 8.1. They show, in particular in sections 8.1.4 and 8.1.5, the expected development in the size of the labour force up to 2020.

Turning to the **qualitative analysis**, alongside the already mentioned desk research, a second perspective was used. This involved integrating findings and practical experience into the chapter. These take the form of studies on building work deficits or important remarks on sustainable construction and modernisation, providing valuable information for further skill needs. An overview of how we went about conducting the qualitative gap analysis is to be found in Figure 54.

Figure 54: The steps involved in the gap analysis



Starting with the desk research step, we see that a) the identification of gaps takes place at two levels (journeyman level[133] and the CVET market) and that b) a further distinction needs to be made at CVET level between programmes for gaining a master craftsman qualification and other CVET programmes specifically in the field of energy efficiency and renewable energy. The differentiation by journeyman-level qualifications and CVET offerings (skill upgrade programmes below the master craftsmen level, programmes for gaining a master craftsman qualification, programmes above the master craftsmen level) was drawn to a certain extent in line with the career development concept existing in the skilled craft sector. The aim of the concept, understood as a systematic matrix, is to illustrate the IVET and CVET opportunities available in individual occupations, thereby charting typical career development options for all cohorts in a particular occupation (Rehbold / Heinsberg 2011, p. 3). In the analysis, the gaps existing at journeyman level are first determined and looked at closer. The spotlight then shifts to the CVET level, looking first at the federally regulated programmes for gaining a master craftsman qualification. As with the IVET programmes, these are also based on national curricula - cf. Chapter 6. This enables us to gain a common base for the analysis. For the different types of CVET programmes in the field of renewables and energy efficiency, a second step looks specifically at offerings on different qualification levels (without any access restrictions, restricted to workers with a journeyman qualification, and to those with a master craftsman qualification), and subject to different examination frameworks (chamber-regulated, certified by an end-of-course examination, or just a certificate of attendance) (cf. Chapter 7.4).

The starting point for the gap analysis - as detailed in Figure 54 - is the following key questions:

1. Can an apprenticeship in one of the occupations involved in one of the building work categories cover all process steps?
2. To what extent can gaps identified at journeyman level be covered by skill upgrade opportunities in the CVET market)?

[133] The term “journeyman level” refers to the point in time in a skilled worker’s career, when he has just successfully completed his apprenticeship.

9.1 Identification of skill gaps at journeyman level

The following section exemplifies how requirements are determined in the sample building work subcategory of *a building's shell*. The methodology used here is then used as a basis for a summary analysis of all building work subcategories.

The skills analyses presented in Chapter 7.3 represent the starting point. A gap is deemed to exist when in the trades involved in a certain building category either (1) a process is not covered, or (2) the process is not covered with regard to a specific point of reference. An example for this second aspect in the solar heating subcategory is the "plant mechanic", who at first sight covers all processes. However a gap can be seen in the "customer acceptance / QA" process, as the "plant mechanic", as is the case with all other relevant occupations, does not cover this process with regard to installing solar heating on the roof or facade (a point of reference in the solar heating subcategory). Generally speaking, every empty cell in the evaluation matrix represents a potential skill gap, whereby, on account of the number and types of occupations involved in each (sub)category and the often different focuses of their activities, the following aspects need to be taken into account:

1. Looking at two or more occupations when determining a gap

   On account of the two-stage apprenticeships prevalent in the construction sector, apprenticeships are always looked at from an overall perspective, i.e. combining the two stages. For example when looking at the *shell* subcategory, the two occupations of a "construction finishing worker" specialised in carpentry and a carpenter (i.e. an apprentice having completed the second stage) are dealt with as one. This has the following consequence when identifying skill needs:

Construction finishing worker, specialised in carpentry (§ 11 No x)			x (Nr. 5)	x (Nr. 5)	x (Nr. 5)	x (Nr. 6,7,8,9,10 11)		x (Nr. 11,12)	x (Nr.10, 12)			x (Nr.10, 11,12)		x (Nr. 5, 19)	x (Nr. 6, 11)					x (Nr. 6)
Carpenter, in addition to Construction finishing worker specialised in carpentry (38 No x)				x (Nr. 5)	x (Nr. 5)	x (Nr. 6, 7)				x (Nr. 7)					x (Nr. 6)		x (Nr. 5)			

   The black-framed cells are not seen as gaps, as corresponding skills were already taught during the first stage of the apprenticeship (i.e. in the IVET programme for a "construction finishing worker"). As gaining an IVET qualification as a carpenter is the second stage, it is assumed that both stages of the apprenticeship are successfully completed, with a basic set of professional capabilities being already acquired in the first stage. The occupations mainly affected by this approach are the "construction finishing worker", the "building construction worker" and the "civil engineering worker" with their respective specialisations and second-stage programmes (cf. Chapter 6).

   In the same vein, occupations involving the acquisition of common knowledge and skills in a first stage before second-stage specialisation are looked at as one.

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)

As before, the black-framed cells for a glazier are not identified as gaps, as the corresponding skills have already been acquired in the first stage common to all specialisations. By contrast, cells marked with an "X" constitute potential gaps, as the glazier specialised in windows and glass curtain walling, despite the joint first stage, has skills different to those acquired by a glazier specialised in glazing.

2. Bundling of occupations for each building work subcategory

   In connection with the key question for the gap analysis, i.e. whether the occupations involved in a certain building work category cover all process steps, a further aspect is whether they do so in sufficient depth. The questions here are (a) how many occupations - when looking at a building work subcategory involving many occupations - must cover any one process, and (b) which occupations, dependent on their activity within the subcategory, are essential for covering certain steps.

   The occupations relevant here are those mainly involved in the subcategory. Attention was paid here to the points of references within a subcategory process (e.g. plant mechanics or fitting solar panels to a roof or facade), making sure that these were also covered.

Taking these aspects into account, the next step involved a qualitative comparison of the skill analyses for each building subcategory and the necessary skill sets (described in Chapter 8.2). This presentation also contains the additional master-level subprocesses in the *provision of advice* and *planning* processes, which do not feature at journeyman level. This implies that we can already see a skill requirement at journeyman level for the subprocesses *order-related customer advice* (within the *provision of advice* process step) and *planning and order preparation* (within the *planning* process step). While Table 65 provides an overview of all potential gaps within the *building shell* subcategory[134], Table 66 provides (and for the *building shell* especially the first line), an overview of the skill deficits of relevance for the next analyses. These are justified as follows: In the *provision of advice* process we see that the required skills for both sub-processes are only taught in the occupations of the "metal worker" specialised in construction technology and the chimney sweep. A gap can be seen for the occupations determined as being relevant and therefore for the sub-processes. The *planning* process step by contrast shows a lot less gaps, identified in just three of the occupations identified as being relevant for the building work subcategory: the "pre-fab concrete element manufacturer", the "concrete block and terrazzo manufacturer", and the "painter and varnisher" specialised in building and corrosion protection. This basically means that there is no overall gap. Similarly, with regard to *execution*, any gaps seen are in occupations of no great relevance to the subcategory. This means that, with regard to the requisite skills, this process is covered. In the field of *customer acceptance*, there are no

134 The sub-processes introduced at master craftsman level are shaded light grey.

occupations with the requisite skills. Turning to *maintenance*, and looking there at the subprocess "determining needs", a gap can be seen, as the occupations most frequently involved do not gain the required skill until specialisation has taken place. The other two subprocesses, "execution" and "documentation" similarly show skill deficits. Last but not least, the *disposal* step shows no gap.

Table 65: Gap analysis for the *building shell* - by way of example

				Processes																					
				Provision of advice			Planning				Execution											Quality assurance	Repairs and maintenance			Disposal
				Discussing and recording customer requirements (PRIOR to execution)	Advising the customer with respect to contract details	Informaing customers (AFTER execution)	Design and compilation of an offer („Conceptual design")	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	Docuementation	Disposal / de-commissioning
Building work categories	Building envelope	Shell	Construction finishing worker, specialised in carpentry (§ 11 No x)	X	X	X	X	x (Nr. 5)	x (Nr. 5)	x (Nr. 5)	x (Nr. 6,7,8,9,10 11)	X	x (Nr. 11,12)	x (Nr.10, 12)	X		x (Nr.10, 11,12)		x (Nr. 5, 19)	x (Nr. 6, 11)	X	X	X	X	x (Nr. 6)
			Carpenter, in addition to Construction finishing worker specialised in carpentry (38 No x)	X	X	X	X		x (Nr. 5)	x (Nr. 5)	x (Nr. 6, 7)	X			x (Nr. 7)					x (Nr. 6)	X	x (Nr. 5)	X	X	
			Building materials tester, specialised in geo-technology and specialised in cement and concrete technology (§ 5 No x)	X	X	x (Nr. 15)	X	x (Nr. 6, 7, 10)	x (Nr. 6)	x (Nr. 6)	x (Nr. 6, 7, 8, 9, 10, 11, 12)	x (Nr. 9, 12, 13)	x (Nr. 8)	X	X		X		x (Nr.14, 16)	x (Nr. 6)	X	X	X	X	X
			Pre-fabricated concrete producer (§5 No x)	X	X	X	X	X	X	X	x (Nr. 6, 10, 11, 12, 13, 16)	X	x (Nr. 10, 11, 12, 13, 16)	x (Nr. 10, 13)	x (Nr. 12, 13, 14, 16)		x (Nr. 15)		X	x (Nr. 16)	X	X	X	X	X
			Concrete bloc and terrazzo manufacturer (§5 No x)	X	X	X	X	X	X	X	x (Nr. 6, 10, 11, 12, 13, 16)	X	x (Nr. 10, 11, 12, 13, 16)	x (Nr. 10, 13)	x (Nr. 12, 13, 14, 16)		x (Nr. 15)		X	x (Nr. 16)	X	X	X	X	X
			Roofer, specialised in roof, wall and waterproofing technology (§ 4 Para. 1 No x)	X	X	X	X	x (Nr. 5, 8)	x (Nr. 5)	x (Nr. 5)	x (Nr. 6,7,8,9)	x (Abs, 2 Nr. 1 b, e)	x (Nr. 9)	x (Nr. 9)	x (Nr. 9)		X		x (Nr. § 4 Abs. 2 Nr. 1g)	x (Nr. 6)	X	X	X	X	x (Nr. 6)
			Roofer, specialised in reed-thatch roofing techniques (§ 4 Para. 1 No x)	X	X	X	X	x (Nr. 5, 8)	x (Nr. 5)	x (Nr. 5)	x (Nr. 6,7,8,9)	x (Abs, 2 Nr. 2 b, e)	x (Nr. 9)	x (Nr. 9)	x (Nr. 9)		X		x (Nr. § 4 Abs. 2 Nr. 2g)	x (Nr. 6)	X	X	X	X	x (Nr. 6)
			Building construction worker, specialised in (reinforced) concrete work (§ 5 Nox)	X	X	X	X	x (Nr. 5)	x (Nr. 5)	x (Nr. 5)	x (Nr. 6,7,8,9, 10, 11)	x (Nr.18)	x (Nr. 10,11,12)	x (Nr. 10, 11, 12)	x (Nr. 10, 11, 12)		x (Nr. 10,11,12)		x (Nr. 10, 5 11,21)	x (Nr. 6, 11)	X	X	X	X	X
			Concreter (§ 28 No x), in addition to Building construction worker, specialised in (reinforced) concrete work	X	X	X	X		x (Nr. 5)	x (Nr. 5)	x (Nr. 6)			x (Nr. 7)	x (Nr. 7, 8)		X		x (Nr. 10)	x (Nr. 6)	X	x (Nr. 5, 9)	x (Nr. 9)	X	X
			Building mechanic for demolition and concrete cutting (§ 37a No x), in addition to Building construction worker, specialised in (reinforced) concrete work	X	X	X	X	X	x (Nr. 5,6,11)	x (Nr. 5)	x (Nr. 7)	X	X	X	X		X		x (Nr. 11)	x (Nr. 6)	X	x (Nr. 8)	x (Nr. 8)	X	x (Nr. 10)
Technologie	Gebäudehülle	Rohbau [1]	Building construction worker, specialised in furnace and chimney building work (§ 5 No x)	X	X	X	X	x (Nr. 5)	x (Nr. 5)	x (Nr. 5)	x (Nr. 6,7,8,9, 10, 11)	x (Nr.18)	x (Nr. 10,11)	x (Nr. 10, 11, 12)	x (Nr. 10, 11, 12)		x (Nr. 10,11,12)		x (Nr. 5,10,11, 21)	x (Nr. 6, 11)	X	X	X	X	x (Nr. 6)
			Furnace and chimney builder (§ 33 No x), in addition to Building construction worker, specialised in furnace and chimney building work	X	X	X	X	X	x (Nr. 5)	x (Nr. 5)	x (Nr. 6, 7)			x (Nr. 7,8)	x (Nr. 9)		x (Nr. 7)		x (Nr 12)	x (Nr. 6)	X	x (Nr. 5, 11)	x (Nr. 11)	X	
			Building construction worker, specialised in brickwork (§ 5 No x)	X	X	X	X	x (Nr. 5)	x (Nr. 5)	x (Nr. 5)	x (Nr. 6,7,8,9, 10, 11,12)	x (Nr. 18)	x (Nr. 10,11)	x (Nr. 10, 11,12)	x (Nr. 10, 11, 12)		x (Nr. 10,11, 12)		x (Nr. 5, 10, 11,21)	x (Nr. 6,)	X	X	X	X	x (Nr. 6)
			Mason (§ 23 No x), in addition to Building construction worker, specialised in brickwork	X	X	X	X		x (Nr. 5)	x (Nr. 5)	x (Nr. 6, 8)			x (Nr. 7,8, 10)	x (Nr. 7, 9)		x (Nr. 8)		x (Nr. 12)	x (Nr. 6)	X	x (Nr. 5, 11)	x (Nr.11)	X	
			Painter and varnisher, specialised in building and anti-corrosion protection (§ 6 No 3 Point x)	X	X	x (Buchstabe e)	X	x (Buchstabe f)	x (Buchstabe f)	X	x (Nr. 8; Buchstabe g, i)	X	X	X	x (Buchstabe h, i)		x (Buchstabe h, i)		x (Buchstabe m)	x (Nr. 8)	X	x (Buchstabe k)	x (Buchstabe i, k)	x (Buchstabe m)	X
			Metal worker, specialised in construction technology (§ 4 Para. 2 Section x No x)	x (A Nr. 5)	X	x (A Nr. 5)	X	x (A Nr. 5)	x (A Nr. 6)	x (A Nr. 6)	x (A Nr. 5, 6, 8, 10, 11, 18; B Nr. 2, 3)	x (A Nr. 8, B Nr. 4)	x (A Nr. 8, 9, 10, 11, 13, 14, 15, 16, 18, B Nr. 3, 4)		x (A Nr. 9, 18, B Nr. 5)		x (A Nr. 16, B Nr. 5)		x (Nr. 5, 6, 7, 13)	x (B Nr. 2)	X	x (Abschnitt B Nr. 7)	x (Abschnitt B Nr. 7)	x (Abschnitt B Nr. 7)	X
			Chimney sweep (§3 Para. 2 Section x No x)	x (A Nr. 10, B Nr. 5)	X	x (A Nr. 10, B Nr. 5)	X	x (A Nr. 1, 2, 4, 11)	x (A Nr. 11, B Nr. 6)	x (A Nr. 11)	X	X	X	X	X		X		X	X	X	x (A Nr. 8, 9)	X	x (A Nr. 9)	x (B Nr. 8)

Extending the use of this methodology to all categories of building work, the gaps presented in Table 66 emerge. The summary presentation allows a differentiated view taking sub-processes into account, with the following characteristics for deficits at journeyman level being derived.

- Due to the newly introduced sub-processes at master craftsman level all apprenticed occupations and therefore all building work categories have a gap in the processes *provision of advice* (sub-process *order-related customer advice*) and *planning* (sub-process *planning and order preparation*).
- In the *provision of advice* process, skill deficits are also seen in the *recording of customer requirements* sub-process in seven of the fourteen building work subcategories. The main focus of the deficits is in the category of a building's envelope.
- In eleven of the fourteen building work subcategories, *customer acceptance* after the execution phase is either insufficiently covered or not at all. For this process step, a major skill deficit is therefore registered.
- In the field of *repair and maintenance*, deficits with regard to skills, knowledge and capabilities are to be seen in the sub-process of *determining repair and maintenance needs*. This similarly applies to the *documentation* sub-process, whereby we need to take into account here that no repair or maintenance measure can be triggred without any qualification in the field of diagnosing needs. It follows that there would be nothing to document.

As stated above, these findings only constitute the first of the two steps required to carry out a comprehensive gap analysis. The next section therefore looks at the CVET market.

Table 66: Gap analysis at journeyman level (differentiated view at sub-process level)

Anzahl berücksichtigter Rückmeldungen = 315			Prozesse																					
			Beratung			Planung				Realisierung										Abnahme / Übergabe	Reparatur / Wartung / Instandhaltung			Entsorgung
			Discussing and recording customer requirements (PRIOR to execution)	Advising the customer with respect to contract details	Informaing customers (AFTER execution)	Design and compilation of an offer („Conceptual design")	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	Docuementation	Disposal / de-commissioning
Building work categories	Building envelope	Shell	X	X	X	X														X	X	X	X	
		Roof	X	X	X	X														X				
		Facade	X	X		X														X	X		X	
		Windows and doors	X	X		X														X				
	Building infrastructure	Interior walls and flooring	X	X	X	X									X (1)		X (2)			X	X			
		Electrics		X		X										X (3)								
		Heating		X		X														X	X			
		Ventilation and air-conditioning		X		X																		
	Energy supply	Geothermal systems	X	X	X	X										X (4)				X	X			
		Biomass systems		X		X														X	X		X	
		Solar heating		X		X														X	X			
		Photovoltaic systems		X		X																	X	
		CHP		X		X											X (5)			X				
		Wind turbines		X		X														X			X	

X = Identified Gap

In the field of *repair and maintenance*, the relevant set of skills is here again acquired in the course of gaining a master craftsman qualification. In the currently used structural blueprint, the wording is found: "to conduct quality assurance measures, analyse and remedy errors, deficits and faults, check and document results" (Heinsberg / Rehbold 2011, p. 7). The analysis of all relevant master craftsman examination profiles (cf. Appendix C) shows however that there are major differences in the wording used in the different trades - the result of these profiles being compiled at different times - (see also Chapter 7.4). Generally speaking we can however assume that the deficits existing for the whole process can be closed.

Summing up, we see that all gaps identified at journeyman level can be closed through the CVET programmes taken to gain a master craftsman qualification.

9.2.2 Skill upgrade opportunities in the CVET market not subject to standard Federal regulations

With regard to the question to what extent the existing CVET programmes in the field of renewables and energy efficiency (cf. Chapter 7.4) contribute to closing identified skill gaps at journeyman level, the first step involves identifying the relevant CVET programmes for each gap. To do this we first compared the content of the CVET programmes with the gaps related to specific processes and building work (sub)categories. As the CVET questionnaire did not differentiate between processes and building work (sub)categories (cf. Appendix D), with the differentiation in sub-processes only being developed after completion of the survey phase, the skill requirements determined in Table 66 could only be assigned to the overall process with its six steps. This means that with regard to the CVET programmes, no statement can be made on their contribution to closing gaps at sub-process level. The justification for not drawing up a list for the following gaps is as follows: Gaps 1 and 2 (cf. Table 66) were not taken into account, as connecting up and commissioning systems are of no relevance in the *interior walls and floors* building work subcategory. Due to the fact that only one occupation (the electronics technician specialised in energy and building management systems (in both the skilled craft and industrial sectors) was seen as being of any great relevance in the *electrics* subcategory, Gap 3 (cf. Table 66) was only identified in connection with the electronics technician specialised in building and infrastructure systems. As we can assume that insulating / protecting cables constitutes an elementary part of an electronics technician's basic training and that all other *execution* sub-processes are covered, this gap is similarly rated as not being relevant, and therefore no longer looked at. Looking at CHP systems, the gap regarding commissioning (no. 5) is specifically identified for the "plant mechanic". It is however also not further looked into, as it can be assumed that, on the basis of the skills and knowledge acquired in the other "energy supply" subcategories and the explanations found in Chapter 7.3, a journeyman will have the right skills.

The modified presentation for the gap analysis at journeyman level is to be found in Table 67 and includes for each gap the number of CVET programmes identified as relevant. This presentation clearly shows that, due to the large number of hits for individual cells, it is not feasible (at least not in the scope of this interim report) to look in detail at each gap and the CVET programmes for closing them. Instead, the CVET programmes identified for closing the gaps are looked at and characterised on the basis of the following three questions:

1. How are the CVET programmes for each gap distributed in the context of the list of keyword categories?
2. What conclusions can be drawn with regard to access restrictions to certain CVET programmes within a gap?
3. What is the ratio between the duration of individual CVET programmes and the scope of content? Or in other words: how many process steps and building work (sub)categories are covered by any one CVET programme and how long does such a programme take?

Table 67: Gaps at journeyman level (not differentiated) and the number of CVET programmes relevant for closing them

			Processes									
			Provision of advice		Planning		Execution	Quality assurance and acceptance		Repairs and maintenance		Disposal
Building work categories	Building envelope	Shell	X	92	X	110		X	71	X	38	
		Roof	X	164	X	178		X	117			
		Facade	X	137	X	152		X	108	X	59	
		Windows and doors	X	127	X	143		X	95			
	Energy supply	Interior walls and flooring	X	83	X	80		X	69	X	49	
		Electrics	X	122	X	133						
		Heating	X	163	X	185		X	125	X	81	
		Ventilation and air-conditioning	X	67	X	77						
	Energieversorgung	Geothermal systems	X	71	X	83		X	61	X	35	
		Biomass systems	X	41	X	51		X	35	X	22	
		Solar heating	X	104	X	122		X	84	X	52	
		Photovoltaic systems	X	118	X	136				X	66	
		CHP	X	80	X	89		X	65			
		Wind turbines	X	23	X	29		X	24	X	17	

X = Identified Gap

How are the CVET programmes for each gap distributed in the context of the list of keyword categories?

On the basis of the keyword categorisation of CVET programmes undertaken in Chapter 7.4 (cf. Appendix F), a statement is to be made on distribution of the CVET programmes assigned to a gap. Despite the weakness that each CVET programme can only be assigned to a single category, the results presented in the appendix provide a first impression of the distribution and thereby on the type of CVET programmes.

Which access restrictions are to be seen within a gap?

The intention of the question on access restrictions is to provide an initial insight covering all CVET programmes into which conditions need to be fulfilled to either take part in a programme or to be examined at the end of it. In addition, for CVET programmes which require a journeyman or master craftsman (or equivalent) qualification, the scope of the restriction is looked at, i.e., ascertaining how many occupations are authorised for a certain area.

To do this, for each gap a table is compiled containing information on the minimum (access) level and the degree of restriction. In line with the CVET questionnaire (cf. Chapter 7.4 and the Appendix), the "minimum level" parameter has three possible values: *journeyman*, *master craftsman or equivalent level* and *no restriction*. The degree of restriction describes whether there is only a "low" access restriction to a CVET programme (i.e. many authorised occupations), or a "medium" or "high" one (i.e. only a handful of authorised occupations). Using cross tabulation, a differentiated picture emerges for each established gap. Due to the wide range of responses and the total of 48 areas to be looked at, we look at the gaps in each building work subcategory, developing a table for each subcategory. As the findings are very voluminous, we restrict ourselves to a selection of the most important information for interpreting the findings. Further details can be gained via an in-depth analysis of the tables.

Access restrictions in the *building shell* subcategory

Process *Advice*

n = 92		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	8	6	27	1
	medium	4	3		
	low	17	24		
	No specification	0	2		
	Total	29	35	27	1

Process *Planning*

n = 110		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	11	8	27	0
	medium	12	7		
	low	17	24		
	No specification	2	2		
	Total	42	41	27	0

Process *Customer Acceptance*

n = 71		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	5	7	17	0
	medium	4	5		
	low	16	13		
	No specification	2	2		
	Total	27	27	17	0

Prozessschritt *Maintenance*

n = 38		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	4	1	11	0
	medium	6	3		
	low	5	5		
	No specification	2	1		
	Total	17	10	11	0

Looking at a building's *shell*, our first finding is that, for the gaps identified in the processes "provision of advice", "planning" and "customer acceptance", the journeyman and master craftsman minimum levels are equally represented. In the "provision of advice" field, we find that all three values are almost equally represented. By contrast, in the field of "maintenance", there are many more CVET programmes with access at journeyman level. With regard to the access restrictions in the "planning" process, we see many more occupations with a "high" access restriction at journeyman level than at master craftsman level, whereas in the "provision of advice" and "customer acceptance" processes access requirements are generally more open at both journeyman and master craftsman levels.

Access restrictions in the *roof* subcategory

Process *Advice*

n = 164		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	28	12	31	2
	medium	11	8		
	low	27	40		
	No specification	2	3		
	Total	68	63	31	2

Process *Planning*

n = 178		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	30	12	31	1
	medium	19	12		
	low	26	40		
	No specification	4	3		
	Total	79	67	31	1

Process *Customer Acceptance*

n = 117		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	18	10	16	0
	medium	6	9		
	low	26	25		
	No specification	4	3		
	Total	54	47	16	0

In the *roof* subcategory, a first finding is that the number of relevant CVET programmes at journeyman and master craftsman level is almost twice as large as that of CVET programmes without any access restriction. What is of note here is that in both the "provision of advice" and the "planning" processes for journeymen, the number of CVET programmes with high access restrictions is about equal to that of programmes with low access restrictions. By contrast, the requirements at master craftsman level tend to be more open.

<u>Access restrictions in the *façade* subcategory</u>

Process *Advice*

n = 137		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	17	11	30	2
	medium	5	7		
	low	24	37		
	No specification	1	3		
	Total	47	58	30	2

Process *Planning*

n = 152		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	20	12	29	1
	medium	13	11		
	low	23	37		
	No specification	3	3		
	Total	59	63	29	1

Process *Customer Acceptance*

n = 108		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	16	10	17	0
	medium	4	9		
	low	23	23		
	No specification	3	3		
	Total	46	45	17	0

Prozessschritt *Maintenance*

n = 59		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	17	2	13	0
	medium	4	3		
	low	10	7		
	No specification	2	1		
	Total	33	13	13	0

In the *facade* field as well, the ratio between the journeyman and master craftsman levels is roughly equal. In all three fields, there are generally more occupations with low restrictions than ones with high restrictions. One interesting point is that a lot less CVET programmes are assigned to the facade/maintenance gap than in other fields.

<u>Access restrictions in the *windows and doors* subcategory</u>

Process *Advice*

n = 127		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	9	8	31	2
	medium	5	8		
	low	21	40		
	No specification	1	2		
	Total	36	58	31	2

Process *Planning*

n = 143		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	12	9	29	1
	medium	14	12		
	low	21	40		
	No specification	3	2		
	Total	50	63	29	1

Process *Customer Acceptance*

n = 95		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	6	7	18	0
	medium	5	9		
	low	20	25		
	No specification	3	2		
	Total	34	43	18	0

From a relative perspective, there are many more CVET programmes in the *windows and doors* subcategory requiring a master craftsman (or equivalent) qualification for access. Moreover, the access restrictions tend to be generally relatively low, as can be seen in "customer acceptance". In the "planning" field, there are comparatively more offerings with a medium-level restriction than ones with a high restriction.

Access restrictions in the *interior walls and floors* subcategory

Process *Advice*

n = 83		Minimum level			
		Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	15	5	22	0
	medium	4	5		
	low	16	16		
	No specification	0	0		
	Total	35	26	22	0

Process *Planning*

n = 80		Minimum level			
		Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	13	6	16	0
	medium	5	8		
	low	14	16		
	No specification	2	0		
	Total	34	30	16	0

Process *Customer Acceptance*

n = 69		Minimum level			
		Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	10	6	14	0
	medium	4	7		
	low	15	11		
	No specification	2	0		
	Total	31	24	14	0

Prozessschritt *Maintenance*

n = 49		Minimum level			
		Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	13	1	14	0
	medium	4	3		
	low	9	3		
	No specification	2	0		
	Total	28	7	14	0

Within the *interior walls and floors* subcategory, there are just as many CVET programmes with high access restrictions as ones with low restrictions in the fields of "provision of advice" and "planning" at journeyman level. However at master craftsman level, all processes feature a majority of CVET programmes with more open access requirements. In the maintenance field, we also see that just 14.4% of all CVET programmes require a master craftsman (or equivalent) qualification as the minimum level, whereby the relationship between the journeyman and master craftsman groups is 4:1.

Access restrictions in the *electrics* subcategory

Process *Advice*

n = 122		Minimum level			
		Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	29	8	18	0
	medium	4	6		
	low	26	27		
	No specification	3	1		
	Total	62	42	18	0

Process *Planning*

n = 133		Minimum level			
		Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	30	8	22	0
	medium	5	9		
	low	25	27		
	No specification	6	1		
	Total	66	45	22	0

in the two processes looked at in the *electrics* field, the ratio between the access levels of journeyman, master craftsman and none can be described as 50% : 35% : 15%. Within the master craftsman level, there is a ratio of 1:3.75 between programmes with high access requirements and those with low requirements. At journeyman level this ratio is basically balanced.

Access restrictions in the *heating* subcategory

Process *Advice*

n = 163		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	29	11	31	1
	medium	11	9		
	low	29	37		
	No specification	3	2		
	Total	72	59	31	1

Process *Planning*

n = 185		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	28	13	43	1
	medium	12	13		
	low	29	37		
	No specification	7	2		
	Total	76	65	43	1

Process *Customer Acceptance*

n = 125		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	23	11	15	0
	medium	6	10		
	low	27	23		
	No specification	8	2		
	Total	64	46	15	0

Prozessschritt *Maintenance*

n = 81		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	26	2	11	0
	medium	9	4		
	low	15	7		
	No specification	6	1		
	Total	56	14	11	0

At journeyman level, the ratio between CVET programmes with high and low access requirements is basically balanced. However in this field there are hardly any programmes with medium-level requirements.

Access restrictions in the *air-conditioning and refrigeration* subcategory

Process *Advice*

n = 62		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	7	5	14	1
	medium	3	5		
	low	12	14		
	No specification	0	1		
	Total	22	25	14	1

Process *Planning*

n = 77		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	8	6	21	1
	medium	4	7		
	low	11	14		
	No specification	4	1		
	Total	27	28	21	1

In this subcategory with just two gaps, we see an equal number of CVET programmes open to journeymen and master craftsmen levels. In both cases, we also see that there are many more CVET programmes with low or medium access restrictions than ones with high restrictions.

Access restrictions in the *geothermal systems* subcategory

Process *Advice*

n = 71		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	13	5	14	1
	medium	1	2		
	low	12	21		
	No specification	1	1		
	Total	27	29	14	1

Process *Planning*

n = 83		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	13	7	20	1
	medium	1	3		
	low	12	21		
	No specification	4	1		
	Total	30	32	20	1

Process *Customer Acceptance*

n = 61		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	9	7	9	0
	medium	1	3		
	low	12	14		
	No specification	5	1		
	Total	27	25	9	0

Prozessschritt *Maintenance*

n = 35		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	12	0	5	0
	medium	1	2		
	low	6	5		
	No specification	3	1		
	Total	22	8	5	0

Similarly in the field of *geothermal systems* the ratio between CVET programmes at journeyman level and those at master craftsman level is roughly equal in the processes "provision of advice", "planning" and "customer acceptance". The "maintenance" field however has many more CVET programmes open to journeymen, though access requirements are high.

Access restrictions in the *biomass systems* subcategory

Process *Advice*

n = 41		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	5	3	10	1
	medium	2	1		
	low	8	11		
	No specification	0	0		
	Total	15	15	10	1

Process *Planning*

n = 51		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	5	5	14	1
	medium	3	2		
	low	7	11		
	No specification	3	0		
	Total	18	18	14	1

Process *Customer Acceptance*

n = 35		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	2	4	7	0
	medium	2	2		
	low	8	6		
	No specification	4	0		
	Total	16	12	7	0

Prozessschritt *Maintenance*

n = 22		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	4	0	5	0
	medium	3	1		
	low	2	4		
	No specification	3	0		
	Total	12	5	5	0

There are no outstanding features in this field, though there are more than twice as many CVET programmes at journeyman level, with master craftsman level programmes only accounting for little more than 20% of all programmes.

<u>Access restrictions in the *solar heating* subcategory</u>

Process *Advice*

n = 104		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	17	8	16	1
	medium	7	2		
	low	19	30		
	No specification	3	1		
	Total	46	41	16	1

Process *Planning*

n = 122		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	21	9	24	1
	medium	8	3		
	low	19	30		
	No specification	6	1		
	Total	54	43	24	1

Process *Customer Acceptance*

n = 84		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	17	8	9	0
	medium	3	3		
	low	18	18		
	No specification	7	1		
	Total	45	30	9	0

Prozessschritt *Maintenance*

n = 52		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	15	1	5	0
	medium	6	1		
	low	11	7		
	No specification	5	1		
	Total	37	10	5	0

The already mentioned low number of CVET programmes at master craftsman (or equivalent) level in the maintenance process is also to be seen in the field of *solar heating*. Otherwise, in direct comparison with the previous field, biomass systems, we see that there are a lot more CVET programmes in the field of solar heating.

<u>Access restrictions in the *photovoltaic systems* subcategory</u>

Process *Advice*

n = 118		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	29	8	17	0
	medium	6	5		
	low	19	30		
	No specification	3	1		
	Total	57	44	17	0

Process *Planning*

n = 136		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	32	9	24	0
	medium	8	6		
	low	19	30		
	No specification	7	1		
	Total	66	46	24	0

Prozessschritt *Maintenance*

n = 66		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	23	2	6	0
	medium	6	4		
	low	11	8		
	No specification	5	1		
	Total	45	15	6	0

In this field with regard to the "provision of advice" process, we see that 29 of the 57 CVET programmes at journeyman level are subject to high access requirements. By contrast, access requirements at master craftsman level are much more open, with nearly 70% of CVET programmes only having low access requirements. This finding is repeated in the planning process.

Access restrictions in the *CHP systems* subcategory

Process *Advice*

n = 80		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	9	7	16	1
	medium	2	1		
	low	17	25		
	No specification	1	1		
	Total	29	34	16	1

Process *Planning*

n = 89		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	10	9	19	1
	medium	2	2		
	low	16	25		
	No specification	4	1		
	Total	32	37	19	1

Process *Customer Acceptance*

n = 65		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	6	8	9	0
	medium	2	2		
	low	16	16		
	No specification	5	1		
	Total	29	27	9	0

Prozessschritt *Maintenance*

n = 35		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	8	1	6	
	medium	2	1		
	low	7	6		
	No specification	3	1		
	Total	20	9	6	0

As already seen in several subcategories, the *CHP* field also has a balanced ratio between journeyman level programmes and master craftsman level programmes. Similarly there are many more occupations with a low access requirement than highly restricted ones. One exception is the maintenance process, where master (or equivalent) level programmes account for less than a third of all programmes.

Access restrictions in the *wind turbines* subcategory

Process *Advice*

n = 23		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	5	2	4	0
	medium	3	0		
	low	5	4		
	No specification	0	0		
	Total	13	6	4	0

Process *Planning*

n = 29		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	5	2	6	0
	medium	4	0		
	low	5	4		
	No specification	3	0		
	Total	17	6	6	0

Process *Customer Acceptance*

n = 24		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	4	2	2	0
	medium	3	0		
	low	5	3		
	No specification	5	0		
	Total	17	5	2	0

Prozessschritt *Maintenance*

n = 17		Minimum level: Journeyman	Master Craftsman	No restriction	No specification
Degree of restriction	high	5	0	2	0
	medium	4	0		
	low	1	1		
	No specification	4	0		
	Total	14	1	2	0

This is the category with the least CVET programmes. We also see that the ratio between journeyman and master craftsman level programmes is at the most 2:1. In the maintenance field it is much lower, with only one of 17 programmes being explicitly for master craftsmen. Also of note is the fact that, compared with the other subcategories, the proportion of CVET programmes without any access restrictions is relatively low.

How many process steps and building work (sub)categories are covered by the individual CVET programmes and how long do these programmes take?

Analysing the duration of the CVET programmes by the duration categories established in Chapter 7.4 allows us to first make a general statement on which duration categories are most well represented within a gap. As regards the coverage of process steps and building work subcategories, this aspect can be used to determine whether CVET programmes have for example a focus on a certain building work subcategory or process, or whether they cover the whole process, thereby presenting an overall picture. A further look at the coverage degree of processes and building work subcategories and the duration of CVET programmes enables us to gain insights into the depth of the material taught. It can for instance be assumed that a programme covering many processes, yet only lasting two days, will be less intensive than a 2-day course explicitly focused on advising customers.

Table 68 shows an example of the methodology used and the way the presentation is structured. This is followed by a short summary of all 48 tables (the actual tables are to be found in Appendix G).

Each table has nine columns reflecting the duration categories established in Chapter 7.4. A software programme is then used to determine the number of processes and building work subcategories covered through programme participation. The offerings contributing to closing the shell/advice gap (used as an example) are then added up (the column total) and set in relation to programme duration (the line total). Table 68 shows that 39 of 92 CVET programmes cover three process steps, whereby 15 belong to duration category IX (duration > 200 hours) and 9 programmes last 12 hours at the longest. Turning to coverage of building work subcategories, the fluctuations are not so great, though it needs to be taken into account here that 62 of 92 CVET programmes (67.4%) cover 7 or more building work subcategories within one course, with about half the programmes belonging to the maximum duration category. In the distribution of CVET programmes by duration we also see that there are no programmes in Category VII (160 - 200 hours) and that otherwise the focus is on the Categories II, III, IV and IX.

Table 68: The shell/advice gap: extent to which processes and building work subcategories are covered.

		I	II	III	IV	V	VI	VII	VIII	IX	
		< 5 h	5 - 12 h	12 - 20 h	20 - 40 h	40 - 80 h	80 - 120 h	120 - 160 h	160 - 200 h	> 200 h	Total
Number of processes	1	0	4	1	0	0	0	0	0	1	6
	2	1	1	1	1	2	0	0	0	10	16
	3	2	9	4	3	2	2	0	2	15	39
	4	1	1	3	3	0	1	0	0	5	14
	5	0	1	2	2	0	0	0	1	2	8
	6	0	1	0	2	1	0	0	1	4	9
	Total	4	17	11	11	5	3	0	4	37	92
Number of building work categories	1	0	0	0	0	0	0	0	0	0	0
	2	0	1	0	0	0	0	0	0	0	1
	3	0	2	0	1	0	0	0	0	0	3
	4	1	4	0	0	2	0	0	1	0	8
	5	1	5	2	2	0	1	0	0	2	13
	6	0	0	1	0	0	1	0	0	3	5
	7	0	1	4	1	0	0	0	0	2	8
	8	0	0	0	0	0	0	0	0	3	3
	9	0	2	0	2	1	0	0	0	3	8
	10	0	1	1	1	0	0	0	0	6	9
	11	0	0	0	0	1	0	0	0	6	7
	12	1	1	2	4	1	0	0	1	8	18
	13	1	0	0	0	0	1	0	2	3	7
	14	0	0	1	0	0	0	0	0	1	2
	Total	4	17	11	11	5	3	0	4	37	92

The proportionally largest distribution to the Categories II, III, IV and IX is a phenomenon common to all identified gaps, as can be seen in Table 69, whereby Category IX in nearly all cases has the highest number of assigned programmes.

Looking at the analyses for each gap in detail, we see that with regard to processes the majority of CVET programmes cover 2 - 4 processes. The exceptions are the programmes for the gaps roof/planning and facade/advice, which show a high coverage for two or more processes. Within the building work subcategories, three groups emerge: programmes covering 4 - 6 subcategories, 9 - 10, and 12. Here as well, there are exceptions for certain gaps. The gaps roof/planning, window and door/planning, geothermal systems/advice, geothermal systems/planning, geothermal systems/customer acceptance and CHP systems/planning all focus on the field of 9 - 12 subcategories. A nearly uniform distribution with only one peak in the field of 12 subcategories is to be found in the gaps biomass/advice, biomass/planning, biomass/customer acceptance, wind turbines/advice, wind turbines/planning, and wind turbines/customer acceptance.

Table 69: Distribution of CVET programmes by duration (with a gap comparison)

Building work categories within the field of *building envelope*

		I	II	III	IV	V	VI	VII	VIII	IX	
		< 5 h	5 - 12 h	12 - 20 h	20 - 40 h	40 - 80 h	80 - 120 h	120 - 160 h	160 - 200 h	> 200 h	Total
Shell	Adivce	4	17	11	11	5	3	0	4	37	92
	Planning	4	24	14	14	9	3	0	6	36	110
	Customer acceptance	2	12	10	11	5	3	0	5	23	71
	Maintenance	2	8	5	9	3	0	0	4	7	38
Roof	Adivce	5	39	19	17	9	5	1	14	55	164
	Planning	5	44	22	19	11	4	2	16	55	178
	Customer acceptance	3	25	16	14	8	5	0	12	34	117
Facade	Adivce	5	31	18	19	7	3	0	7	47	137
	Planning	5	39	19	22	9	3	0	8	47	152
	Customer acceptance	3	26	16	18	6	3	0	7	29	108
	Maintenance	2	13	10	15	5	0	0	5	9	59
Windows and doors	Adivce	4	30	15	15	6	3	0	7	47	127
	Planning	5	37	17	17	9	3	0	8	47	143
	Customer acceptance	3	23	13	14	5	3	0	6	28	95

Building work categories within the field of buildings infrastructure

		I	II	III	IV	V	VI	VII	VIII	IX	
		< 5 h	5 - 12 h	12 - 20 h	20 - 40 h	40 - 80 h	80 - 120 h	120 - 160 h	160 - 200 h	> 200 h	Total
Interior Walls and flooring	Adivce	4	19	15	10	1	3	0	6	25	83
	Planning	4	17	12	10	3	3	0	7	24	80
	Customer acceptance	2	15	12	12	3	3	0	6	16	69
	Maintenance	3	12	9	13	2	0	0	4	6	49
Electrics	Advice	4	20	9	17	6	4	2	14	46	122
	Planning	4	23	12	19	7	3	3	16	46	133
Heating	Adivce	5	37	12	22	5	4	2	17	59	163
	Planning	5	46	15	24	8	4	2	19	62	185
	Customer acceptance	3	31	11	14	4	4	1	15	42	125
	Maintenance	2	18	6	14	3	1	1	13	23	81
Ventilation and air-conditioning	Advice	1	7	6	12	1	1	0	4	30	62
	Planning	1	15	7	14	3	1	0	5	31	77

Building work categories within the field of *energy supply*

		I	II	III	IV	V	VI	VII	VIII	IX	
		< 5 h	5 - 12 h	12 - 20 h	20 - 40 h	40 - 80 h	80 - 120 h	120 - 160 h	160 - 200 h	> 200 h	Total
Geothermal systems	Adivce	4	14	3	10	2	2	2	4	30	71
	Planning	4	19	5	10	4	2	2	6	31	83
	Customer acceptance	3	14	3	6	0	2	1	5	27	61
	Maintenance	2	8	2	5	0	1	1	4	12	35
Biomass systems	Adivce	3	1	5	5	2	1	2	3	19	41
	Planning	3	6	7	5	3	1	2	5	19	51
	Customer acceptance	2	4	4	2	0	1	1	4	17	35
	Maintenance	2	3	4	2	0	0	1	3	7	22
Solar heating	Adivce	3	15	3	14	4	2	1	14	48	104
	Planning	4	21	5	15	6	2	2	18	49	122
	Customer acceptance	3	16	4	8	1	2	0	15	35	84
	Maintenance	1	8	3	5	1	0	0	13	21	52
Photovoltaic systems	Adivce	3	19	9	17	5	3	1	14	47	118
	Planning	3	24	11	18	5	2	2	18	48	131
	Customer acceptance	1	12	7	10	2	1	0	13	20	66
CHP	Adivce	4	17	4	13	3	2	2	3	32	80
	Planning	4	21	6	14	3	2	2	5	32	89
	Customer acceptance	3	17	4	8	1	2	1	4	25	65
	Maintenance	2	9	3	7	0	0	1	3	10	35
Wind turbines	Adivce	0	2	2	4	1	1	1	3	9	23
	Planning	0	6	3	4	1	1	1	4	9	29
	Customer acceptance	0	5	2	3	0	1	1	3	9	24
	Maintenance	0	3	3	3	0	0	1	2	5	17

Last but not least, in the context of the initially mentioned aspect of focusing on individual subcategories / process steps, a short look is taken in Table 70 at the ratio of CVET programmes concerned to total programmes. What we clearly see here with regard to the gaps pertaining to a *building's envelope* is that CVET programmes covering just one process step account for just 7% of all programmes. By contrast, for all subcategories apart from the *roof*, the corresponding coverage rate for subcategories is 0. Turning to the *building infrastructure* category, though the relative values are no higher, there are proportionally more CVET programmes concentrated on just one subcategory.

Table 70: Percentage of CVET programmes by gap with n = 1 (absolute and relative)

Building work categories within the field of *building envelope*

		n	Processes (n = 1)		Building work categories (n = 1)	
			absolute	relative	absolute	relative
Shell	Adivce	92	6	6,52%	0	0,00%
	Planning	110	7	6,36%	0	0,00%
	Customer acceptance	71	0	0,00%	0	0,00%
	Maintenance	38	0	0,00%	0	0,00%
Roof	Adivce	164	10	6,10%	4	2,44%
	Planning	178	7	3,93%	4	2,25%
	Customer acceptance	117	1	0,85%	0	0,00%
Facade	Adivce	137	8	5,84%	0	0,00%
	Planning	152	6	3,95%	0	0,00%
	Customer acceptance	108	1	0,93%	0	0,00%
	Maintenance	59	0	0,00%	0	0,00%
Windows and doors	Adivce	127	9	7,09%	0	0,00%
	Planning	143	7	4,90%	0	0,00%
	Customer acceptance	95	1	1,05%	0	0,00%

Building work categories within the field of *building infrastructure*

		n	Processes (n = 1)		Building work categories (n = 1)	
			absolute	relative	absolute	relative
Interior Walls and flooring	Adivce	83	6	7,23%	5	6,02%
	Planning	80	0	0,00%	3	3,75%
	Customer acceptance	69	0	0,00%	2	2,90%
	Maintenance	49	0	0,00%	4	8,16%
Electrics	Advice	122	3	2,46%	1	0,82%
	Planning	133	2	1,50%	1	0,75%
Heating	Adivce	163	6	3,68%	7	4,29%
	Planning	185	8	4,32%	7	3,78%
	Customer acceptance	125	1	0,80%	3	2,40%
	Maintenance	81	0	0,00%	6	7,41%
Ventilation and air-conditioning	Advice	62	2	3,23%	0	0,00%
	Planning	77	1	1,30%	0	0,00%

Building work categories within the field of *energy supply*

		n	Processes (n = 1)		Building work categories (n = 1)	
			absolute	relative	absolute	relative
Geothermal systems	Adivce	71	1	1,41%	1	1,41%
	Planning	83	3	3,61%	2	2,41%
	Customer acceptance	61	0	0,00%	1	1,64%
	Maintenance	35	0	0,00%	1	2,86%
Biomass systems	Adivce	41	0	0,00%	0	0,00%
	Planning	51	2	3,92%	0	0,00%
	Customer acceptance	35	0	0,00%	0	0,00%
	Maintenance	22	0	0,00%	0	0,00%
Solar heating	Adivce	104	2	1,92%	0	0,00%
	Planning	122	6	4,92%	1	0,82%
	Customer acceptance	84	0	0,00%	2	2,38%
	Maintenance	52	0	0,00%	1	1,92%
Photovoltaic systems	Adivce	118	2	1,69%	5	4,24%
	Planning	131	5	3,82%	6	4,58%
	Customer acceptance	66	0	0,00%	5	7,58%
CHP	Adivce	80	1	1,25%	0	0,00%
	Planning	89	1	1,12%	1	1,12%
	Customer acceptance	65	0	0,00%	1	1,54%
	Maintenance	35	0	0,00%	1	2,86%
Wind turbines	Adivce	23	0	0,00%	0	0,00%
	Planning	29	1	3,45%	0	0,00%
	Customer acceptance	24	0	0,00%	1	4,17%
	Maintenance	17	0	0,00%	1	5,88%

This picture is confirmed in the energy supply category, where the relative percentages with their uniform distribution over all process steps and building work subcategories do not exceed a value of 5.88%.

9.3 Practical experience

The report compiled by the Institute for Building Research (*Institut für Bauforschung*) on "Damage caused in the course of energy-related construction and modernisation" (IFB 2011) shows that building work faults in the course of modernisation measures on account of bad planning and execution are steadily rising. With the objective of "identifying building areas in which defects and damage occurs in the course of energy-related construction and modernisation, recording their causes and who is responsible, and then deriving remedial recommendations" (p.5), the areas of thermal insulation and heat loss bridges, airtightness, HVAC systems and systems using renewable energy were looked at. A summary of the main findings follows. Readers wishing for more details should consult the publicly available study. The research team starts by differentiating between planning and execution errors. Planning errors are described as "errors in architectural or engineering services on which building measures are based" (p.9), whereas execution errors are seen as "general breaches of generally accepted technical rules or contractual agreements by the contracting persons" (p.21). In the field of planning errors, errors in planning thermal insulation account for more than 60% of all errors. The corresponding figure for execution errors is almost 50%. Whereas in the planning field, the main causes lie in the planning, composition and choice of materials for composite insulation systems, in the field of execution the main defects result from non-insulated hollow spaces in the insulation, insufficient attachment and the use of non-standard components. In addition, execution defects are often found in places where an airtight layer adjoins a flanking part of a building, damage of the airtight layer, or the installation of new windows without ensuring their airtightness. The report does not however provide any indication of the skill levels of the contracting companies and persons.

A further publication comes from the Austrian Federal Ministry of Transport, Innovation and Technology, and contains guidelines supposed to help in "the implementation of sustainable aspects in building practice" (p.7). Readers are provided with tips on the choice of building materials, fuels and in design and construction questions. The result of close cooperation between the actors, comprehensive checklists are provided, helping readers to choose between different refurbishment and modernisation options and fostering their successful realisation (bmvit 2005).

9.4 Summary

The gaps identified at **journeyman level** are to be found in the processes of provision of advice, planning, customer acceptance/QA and repair and maintenance (cf. Table 66). Alongside the sub-processes *order-related customer advice* (provision of advice) and *planning and order preparation* (planning), which are reserved for a master craftsman qualification and therefore show gaps at journeyman level, the following fields can be seen to have skill deficits:

Process	Sub-process	Gap frequency
Provision of advice	Recording customer requirements (before execution)	7 of 14 subcategories (shell, roof, facade, windows and doors, walls and floors, geothermal systems, CHP systems)
Provision of advice	Providing customers with information (after execution	4 of 14 subcategories (shell, roof, walls and floors, geothermal systems)
Customer acceptance	Quality assurance and customer acceptance	11 of 14 subcategories (shell, roof, facade, windows and doors, walls and floors, heating systems, geothermal systems, biomass systems, solar heating, CHP systems, wind turbines)
Maintenance	Determining repair and maintenance needs (diagnosis)	7 of 14 subcategories (shell, roof, facade, walls and floors, heating systems, geothermal systems, biomass systems, solar heating)
Maintenance	Performing repair and maintenance work	2 of 14 subcategories (shell, facade)
Maintenance	Documenting repair and maintenance work	5 of 14 subcategories (shell, facade, biomass systems, PV systems, wind turbines)

In interpreting the results, the following considerations should be taken into account.

- The determination of the gaps is based on qualitative desk research using the latest regulatory texts and comparing these with the skill sets deemed as necessary in the overall process. This means on the one hand that for older workers further deficits may exist, insofar as their apprenticeship took place a long time ago and no CVET measures have been taken since. Similarly, the realisation of the IVET curricula contained in the various apprenticeship frameworks can differ from one company to another.
- When looking at the evaluation tables, readers also need to take into account that (a) no differentiation is made at sub-process level within the processes, and (b) the building work subcategories do not take the lower differentiating level of points of reference (e.g. plant mechanics, attachment to the roof or facade) into account. When interpreting a gap in the maintenance phase, one needs to take into consideration whether deficits are the result of missing skill sets in the fields of diagnosis, execution or documentation. What we

see here is that most deficits are to be found in determining needs and in the documentation.

Looking at the **master craftsman level**, desk research first shows that all identified gaps can be closed.
As the additional skills in the provision of advice, planning and customer acceptance processes are closely associated with running one's own company, the question needs to be asked when assessing the programmes offered on the CVET market which are not subject to Germany-wide federal regulation to what extent these gaps need to be closed at all. For instance the customer acceptance process is intricately associated with potential warranty and liability claims against the company, with this legal aspect giving sole responsibility to the master craftsman as owner of the company.
Last but not least, the maintenance process needs to be mentioned, where the texts in the relevant regulations contain different wordings which in turn lead to slight problems when entered into the table. There is for an example a difference between the terms "repair" (*instand setzen*) and "maintain" (*instand halten*). Nevertheless they are both assigned to the maintenance process. Also assigned to this process is the wording found in the master craftsman skill profile: "to carry out quality controls, to check for and remedy errors, deficits and faults, and to document the work done (Heinsberg / Rehbold 2011, p. 7). By contrast, the wording "have a good command of the measures needed to remedy deficits" is for instance only to be assigned to the execution process within maintenance.

Comparing the gaps existing at the end of an apprenticeship with the CVET programmes available on the **CVET market**, we can conclude that these gaps can in principle be closed. On the basis of this finding, we next checked the extent to which restrictions regarding a minimum qualification level or the occupation exercised governed access to the CVET programmes. For a structured analysis (survey) of the CVET market a distinction was made between different access levels, in line with the career development concept in the skilled craft sector. Of the 315 programmes looked at, 79 (25.1%) had no restrictions at all, 139 required a successfully completed apprenticeship (44.1%) and 84 (26.7%) a master craftsman (or equivalent) qualification. The analyses clearly show that the relatively large number of programmes with low-level access restrictions once a basic journeyman or master craftsman qualification has been attained offers sufficient opportunities for workers to upgrade their skills.
Looking at the programmes themselves, these are seldom confined to any one specific building work subcategory or process (cf. Table 70), in many cases covering at least three processes and 5 or 12 subcategories.

Last but not least, existing studies of **building work faults** show that a lot of problems exist in the field of planning and executing thermal insulation work. These lead to additional costs for remedial work and higher energy consumption. The publications presented in the text are not sufficient for providing a comprehensive overview of practical experience in the field, and need to be dwelt upon by experts in the further course of the study.

10 Barriers

Katrin Rasch, Rolf R. Rehbold, Susanne Rotthege

In this chapter a qualitative assessment is used to identify possible barriers which could lead to not enough blue-collar workers being in possession of the right skills.
In doing so, we look here at the qualitative aspects of training and skill development. The quantitative aspects, i.e. the expected developments of the labour force, have already been discussed in depth in Chapter 8.2 and taken into account in the conclusions.

We focus on the following questions in assessing possible barriers to gaining the right skills:
1. *To what extent do apprentices have access to training in the fields of energy efficiency and renewables within their apprenticeship?*
2. *To what extent are skill upgrade opportunities for workers having finished their apprenticeships restricted by company circumstances?*
3. *To what extent are skill upgrade opportunities restricted due to problems within the CVET system?*
4. *To what extent do skill monitoring systems exist allowing CVET programmes to be adapted to current developments?*

1: Barriers preventing access to training during an apprenticeship
The IVET system in Germany (cf. Chapter 6) provides for minimum standards allowing for the exercise of a skilled trade at journeyman level on completion of an apprenticeship generally lasting three years. These minimum standards are defined without specific reference to any one technology, allowing companies to keep their apprentices abreast of technological changes (for instance in the fields of energy efficiency and renewables). In the case of any major innovations, the respective apprenticeship frameworks are revised. In addition inter-company training centres are responsible for transferring know-how to apprentices, meaning that apprentices working in companies without any great innovative focus are nevertheless confronted with new technologies. The analysis of the relevant occupations in Chapter 7.3 and the gap analysis in Chapter 9 have shown that the relevant processes (apart from the subprocesses "order-related customer advice" (within the provision of advice process) and the "planning and preparing an offer" (within the planning process) and building work subcategories are all covered by the skills acquired in the context of an apprenticeship in conjunction with the IVET framework curricula. This means that in theory and for the most part in practice, apprentices have access to the necessary training programmes. There are however two restrictions to be made: Firstly, the use of the theoretical knowledge and development of practical capabilities in the technology in question are greatly dependent on the degree of innovation and the quality of instruction in the individual companies. Not all companies in the building sector are specialised in energy efficiency and renewables. Moreover, even when the general level of IVET instruction is satisfactory, there can still be differences in the quality of instruction from one company to

the next. Secondly, older workers who did their apprenticeships under older IVET curricula often do not have the latest skill sets. In this case, a check needs to be done whether a CVET programme - either formal or informal - can help the person in question upgrade his skills to attain the required skill set.

2: Barriers rooted in company structures

Looking at barriers rooted in company structures, the focus is on skilled craft companies and SMEs in the industrial sector. Apart from these, there are also large industrial companies with more or less standardised procedures, and micro subcontractors, sometimes from abroad, where it is often difficult or not possible at all to gain an insight into their structures. We can basically assume that it will be in the interest of a company owner to have employees with the skills necessary for fulfilling tasks at a high level of quality. One of the main factors here is that the companies are for the most part owner-run, with the quality of work performed intimately linked with the family's repute. Nevertheless, the size of such small, family-run businesses can often be a barrier preventing employees from taking part in formal CVET programmes. As soon as the local economy starts booming and capacity utilisation increases, the potential for "slotting in" a CVET programme decreases. By contrast, when the local market is stagnant, companies do their best to retain their employees. This however puts pressure on margins, meaning that there are often not sufficient financial resources available to pay for CVET programmes.

Time as a factor in boom periods and money as a factor in slack periods therefore constitute barriers preventing employees from participating in CVET programmes. At the same time, what can also be seen with regard to skill profiles is that all master craftsmen have skills in planning and conducting training courses, meaning that internal training sessions that put no or only little pressure on a company's time or financial resources are always possible (even if their informal character means that they are not covered by our survey).

3: Barriers rooted in the CVET system itself

The analysis of the CVET system has shown that there is a wide range of CVET programmes available (cf. Chapter 7.4). However, on account of different terms used for the same programmes or similar sounding names for different programmes under different regulations, no clear picture can be gained. One way of remedying this situation is standardisation. An example of this is the current compilation of a Germany-wide recommendation for a regulation for a "renewable energy specialist" (*Fachkraft für Erneuerbare Energien*) (cf. Chapter 7.5.1.2). This way of going about standardisation is also applicable for other CVET programmes. One possible task for the future therefore involves going through all existing CVET programmes and checking their potential for standardisation. Once this has been done, the corresponding processes would need to be triggered.

A further aspect influencing the uptake of CVET programmes is the extent to which people have information on what is currently on offer. In our view it is to be expected that uptake would grow if more skilled workers knew about what CVET programmes were available. What first needs to be done here is to register all programmes. Though trade associations and chambers inform their members of the programmes they themselves are offering and though there are CVET databases, these are not used enough in the renewable energy field by the relevant CVET providers. Some of the possible causes needing to be further investigated are:

- Due to the low use rates of such databases by the target groups, the providers see no sense in including their own offerings.
- With regard to their data entry functions, the databases do not meet up to the functional or content-related expectations of the CVET providers.
- The databases are run by institutions outside the focus of the CVET providers.
- The databases do not adequately cater for the required balance between regionalism and centralisation. A system for regularly registering CVET programmes must be in a position to meet up to regional needs as well as being a Germany-wide source of information. Communication with potential participants takes place at regional level. Opportunities for accessing information must therefore also be embedded in regional structures. At the same time, a centralised administration of such a database allows entries to be coordinated and provides for full national comprehensiveness.

4: Barriers preventing the early recognition of necessary skill sets and thereby hindering the adaptation of CVET programmes

From a qualitative point of view, the inadequate adaptation of CVET programmes to current developments could pose a barrier when no suitable instruments exist for recognising new skill needs at an early stage and tracking their development status.

One of the first questions in this area is whether suitable instruments exist and to what extent they can actually be used.

Looking specifically at the construction sector in this respect, high importance is attached to the InnoQua project conducted by the ZDH in conjunction with 19 skilled craft chambers. The project involved compiling and testing quality-oriented, holistic and non-proprietary concepts for developing innovative training measures in the skilled craft sector. The project objective was to develop an approach ensuring that in the future high-quality tailor-made training opportunities were available to companies and their employees in the skilled craft sector within a timeframe matching the high pace of innovation" (ZDH 2012). As part of its external support for the project, the FBH evaluated five relevant instruments/methods for the early recognition of skill needs and for monitoring technological and skill need developments, looking at the resources required, how well they suited CVET institutions, their scientific footing, their consistency and feasibility (FBH 2009, p. 88ff.):

- ADeBar, an instrument providing a long-term monitoring of developments in skill needs in the field, with the objective of recognising changes at an early stage (Fraunhofer IAO, TNS Infratest, Helmut Kuwan - Sozialwissenschaftliche Forschung und Beratung)
- Identification of trend skills as a basis for the early recognition of training needs (Institut für Strukturpolitik und Wirtschaftsförderung Halle-Leipzig e.V.)
- Early Bird (Institut für Technik und Bildung, Universität Bremen)

- A range of instruments for the long-term monitoring of company training needs using business networks (Kuratorium der Deutschen Wirtschaft für Berufsbildung (KWB), Forschungsinstitut für Berufsbildung im Handwerk an der Universität zu Köln (FBH).
- Technology monitoring in the context of the Technology Transfer Network (Heinz Piest Institute) (cf. Figure 19).

The result of this evaluation was that each of the instruments/methods had its own specific profiles requiring different things from those working with them, with different bases and differences in the extent to which their findings could be directly used. Each instrument is executable and each provides relevant findings.
They were therefore all included in the "InnoQua toolbox" (ZDH 2010, p. 11ff.).
Another interesting item is the methodology used in a further study, in which the FBH, together with the ibw in Vienna and Wilke, Maack & Partner from Hamburg, conducted a survey on future training needs up to 2020, looking in particular at micro and small skilled craft companies (cf. Buschfeld/Dilger/Heß/Schmid/Voß 2011).

The answer to the question of whether instruments allowing training needs to be recognised at an early stage exist is therefore positive. Two of these instruments (ADeBar and the HPI's Technology Monitoring) are available online and regularly used. What does however need to be asked is how the instruments can be put on a long-term footing. One specific focus here would be to provide a way of matching registered training needs with existing CVET programmes (though this would mean these being regularly recorded and updated in a database).

Conclusion:
- To a large extent, an apprenticeship provides a solid footing, providing workers with the necessary skills on the basis of minimum standards and with certain flexibility in how it takes place.
- The preconditions for ensuring that apprenticeships cover the skills necessary for the energy-related refurbishment of buildings are that apprenticeship quality is upheld and that technology transfer takes place via the inter-company training centres.
- Ways of facilitating CVET in SMEs need to be found, taking better account of the structure of such companies.
- Standardisation of CVET programme descriptions and their Germany-wide registration would help in instilling greater transparency into the CVET market.
- Ensuring that existing instruments are regularly used also contributes to CVET programmes being adapted to technological changes.

11 Conclusions

Rolf R. Rehbold

In this final chapter the core findings are consolidated and - as far as possible - conclusions drawn from the data gathered. These will in turn be used in the development of a roadmap containing recommendations for concrete measures.

1. The available data - with regard to both the existing building stock and the energy efficiency gains achievable through the use of the different technologies - may seem to be comprehensive in parts. It is nevertheless incomplete, contradictory and confusing in certain areas. This is reflected in political discussions where figures used often have no scientific basis, and resulted in one of the project's objectives: i.e. to develop a scenario on the investment needed in the building sector, backed up by plausible data. This we have achieved, even if we cannot claim that the assumptions made in the scenario on the technologies to be used represent the only possible way of achieving the energy targets. What we have described is ONE POSSIBLE way.
2. Though the calculated additional annual investment volume of EUR 23.6 billion between 2014 and 2020 does not entail - as often called for - doubling the rate of refurbishment, substantial financial effort is still needed to refurbish Germany's building stock. Tax incentives may be a suitable way of promoting investment in refurbishment measures aimed at boosting energy efficiency and the use of renewables. With regard to this point the models used illustrate the financial potential available to the State deriving from the taxes on the additional economic activity.
3. The quantitative analysis shows that the decreasing number of skilled workers in Germany due to the demographic development could lead to a problem in achieving the targets in certain relevant areas of the building sector. On account of the additionally required investment volume, the projection model foresees demand for 90,000 additional skilled workers in the selected building occupations. Comparing this figure with the labour surplus that would exist without the additional investment volume (240,000 in the BIBB DEMOS / 140,000 in the BIBB FIT model), a mathematical labour surplus would at first sight still seem to exist throughout Germany (150,000 / 50,000 dependent on the model used), were the scenario to become reality. With these figures in mind, one can easily assume that - just on account of geographical and skill-suitability matching problems and natural friction - regional shortages and shortages in certain occupations will occur. Indeed it can be expected that shortages will start appearing in the fields of "metal construction, plant construction, sheet metal construction, installation, fitters" and "electrical occupations" well before 2020.

4. The qualitative analysis of Germany's apprenticeship system shows that the main skill sets are basically acquired in all occupations during an apprenticeship, meaning that the system provides a firm footing for achieving the energy targets. As becomes clear when looking at the findings of the quantitative analysis, demand for skilled workers at journeyman level (ISCED 3 and 4), i.e. workers having successfully completed an apprenticeship, is rising. Strengthening the apprenticeship system would therefore contribute to achieving the targets. Solutions need to be developed for mobilising the hitherto untapped potential in this field, with measures targeting for instance immigrants, the unskilled and women. Finding ways of tapping this and other potential - for instance through measures raising the attractiveness of building occupations - will be one of the major tasks facing those developing the roadmap. The currently witnessed rise in the overall employment rate will only be a temporary factor compensating the increase in demand for skilled labour.
5. Should the sector be successful in attracting new target groups - for instance the unskilled or immigrants -, concepts will have to be developed on how to provide them with the necessary skills.
6. Parallel to the challenge of tapping unused labour potential, a further challenge involves preventing skilled workers leaving the sector. Looking at occupational flexibility patterns, i.e. whether workers remain in their originally trained-for occupations or switch to another one, one finding is that the higher the level of qualification in an occupation, the less likely a worker is to switch occupations. This in turn means that CVET programmes, not just for gaining a master craftsman qualification but also other skill upgrade programmes, provide incentives for remaining in an occupation, even if they cost time and money. What is important here is that the CVET programmes are clearly seen as part of a career development concept on the basis of lifelong learning.
7. CVET programmes for gaining a master craftsman qualification help close skill gaps, especially those associated with providing advice, planning, customer acceptance and determining repair and maintenance needs. Looked at from a quality assurance perspective, they constitute a decisive building block in the training of skilled workers.
8. The circumstance that there are 315 other CVET programmes on the market (other than the programmes for gaining a master craftsman qualification) covering all fields of energy-related building work and often with high participation rates shows that the CVET system in Germany is well-established and on a firm footing. Similarly, looking at the existing CVET programmes in combination with individual gaps, we see that there are appropriate CVET programmes available on the market. The challenge here is to make sure that these are actually taken up. The roadmap should therefore look at ways of creating incentives for workers to take up CVET programmes, taking into account the circumstances of small companies.

9. One barrier preventing more people taking up CVET programmes is the lack of a clear overview of what programmes are on offer. Standardisation is one way of overcoming this problem - as for instance currently seen in the Germany-wide recommendation for setting up a CVET programme for a "specialist in renewable energy" (*Fachkraft für Erneuerbare Energien*). Similarly a Germany-wide database containing all CVET programmes would be a great help in achieving transparency.
10. The analysis of the skill sets taught in the CVET programmes followed the already used methodology of processes within a building work subcategory. This evaluation matrix only takes limited account of interrelations between the subcategories, i.e. the sequence of processes covering different fields of work and technologies within a building (as a macro-cosmos). Though at first sight these processes would seem to be totally autonomous - their sequence affects the overall interlinkage of the processes of individual trades. The analysis of access restrictions shows that several CVET programmes are specifically tailored to a certain audience, i.e. to specific trades. This makes sense from a teaching perspective, as it allows instructors to build on the existing knowledge of participants. On the other hand, it begs the question of how skilled workers can acquire skills and knowledge covering all aspects of a building, helping them to become aware of the consequences their work can have on other processes, technologies or facets of building work for which other trades are responsible. The existing CVET programmes without any access restrictions could possibly be complemented by specific programmes catering for workers from other trades not directly associated with the technology in question, thereby allowing them to gain an insight into other areas and helping them to become aware of possible linkages with their own work. Such "systemic thinking" could possibly even become part of apprenticeship frameworks - insofar as not already included.
11. To ensure that CVET programmes keep up with the latest technological developments, it would seem a good idea to put existing instruments and methods for the early recognition of skill needs on a firm footing and to make them available online. In addition, a comparison with a database containing all existing CVET programmes could help identify areas where new offerings need to be created.

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14 Glossary

Ancillary building trades — Group covering preparatory work (e.g. erecting scaffolding).

Berufliche Handlungskompetenz — Skill sets that describe the "occupational skills, knowledge and capabilities needed to exercise a skilled occupational activity in an ever-changing working environment" (BBiG §1). It is 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"

Berufsprinzip — The *Berufsprinzip* forms the basis for the standardised implementation of the apprenticeship system throughout Germany. As the counterpart to modularisation, 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).

Construction trades — This group covers all companies responsible for actual construction work, whether in "Hochbau" or "Tiefbau".

Dual system of vocational education and training — Vocational education training which mainly takes place in the (vocational) school and the company.

Fitting & finishing trade — This group covers most trades involved in post-construction fitting/finishing work, repairs and maintenance.

German Chamber of Industry and Commerce — The Association of German Chambers of Industry and Commerce (DIHK) is the umbrella organisa- tion of 80 Chambers. All companies registered in Germany, with the exception of handicraft businesses, the liberal professions and farms, are required by law to join a Chamber. Thus, the DIHK speaks for more than 3.6 million enterprises. They include not only big companies but also retailers and innkeepers. It does not represent any specific corporate group but all commercial enterprises in Germany (DIHK).

Integrated Energy and Climate Programme (IECP) — The programme was adopted in Meseberg in August 2007. Listing 29 key targets and defining a concrete set of measures for achieving them, the IECP is regarded as a trendsetting policy throughout the world (cf. BMU 2007, p. 1).

Inter-company apprentice teaching programme (Überbetriebliche Lehrlingsunterweisung or ÜLU) — 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.

International Standard Classification of Education (ISCED) — International Standard Classification of Education. ISCED level 3b covers educational programmes designed to provide direct access to ISCED 5B (vocational higher education). These include the basic training year / first year of an apprenticeship (Berufsgrundbildungsjahr), IVET colleges (Berufsschulen and Berufsfachschulen) and 1-year IVET courses in the healthcare

	sector. ISCED 4 contains educational programmes designed to provide access to ISCED 5a (first stage tertiary-level university education) or 5b or to prepare students for direct access to the labour market (such as the German vocational colleges "Berufs-/Technische Oberschulen" or 1-year "Fachoberschulen". ISCED levels 0 - 3a cover non-vocational primary and secondary education. See also Bott, et al. (2010: 72ff.).
Occupation in Crafts	Occupations which are regulated by §25 ff. in the Crafts Code and which are assigned to the crafts sector.
Occupation in the industry and trade secotr	Occupations which are regulated by §25 paragraph 1 in conjunction with paragraph 2 sentence 1.and which are assigned to the industry and trade sector.
Policy Scenario	Policy scenarios integrating measures to be analysed, in this case the additional energy-related refurbishment of buildings.
Reference Scenario	The reference scenario describes a development ignoring the measures to be analysed (in this case the QuBe projection). The other scenarios are policy scenarios integrating these measures (in this case the additional energy-related refurbishment of buildings).
Status Quo Scenario	c.f. reference scenario.
Technology Monitoring	Technology monitoring covers expert meetings, desk research, patent rights, together with a monitoring of the research and development (R&D) activities of research institutions and companies and the application of new technologies on the part of users, to gain important and up-to-date information.
Vocational Training Act	Legislation relating to the vocational training sector.

15 Appendix

The Appendix can be found in a separated file.

BACK COVER

BUILD UP Skills

The EU Sustainable Building Workforce Initiative in the field of energy efficiency and renewable energy

BUILD UP Skills is a strategic initiative under the Intelligent Energy Europe (IEE) programme to boost continuing or further education and training of craftsmen and other on-site construction workers and systems installers in the building sector. The final aim is to increase the number of qualified workers across Europe to deliver renovations offering a high energy performance as well as new, nearly zero-energy buildings. The initiative addresses skills in relation to energy efficiency and renewable energy in all types of buildings.

BUILD UP Skills has two phases:

I. First, the objective is to set up national qualification platforms and roadmaps to successfully train the building workforce in order to meet the targets for 2020 and beyond.

II. Based on these roadmaps, the second step is to facilitate the introduction of new and/or the upgrading of existing qualification and training schemes.

Throughout the whole duration of the initiative, regular exchange activities are organised at EU level to underline the European dimension of this important initiative and to foster the learning among countries.

The BUILD UP Skills Initiative contributes to the objectives of two flagship initiatives of the Commission's 'Europe 2020' strategy — 'Resource-efficient Europe' and 'An Agenda for new skills and jobs'. It is part of the Commission's Energy Efficiency Action Plan 2011. It will also enhance interactions with the existing structures and funding instruments like the European Social Fund (ESF) and the Lifelong Learning Programme and will be based on the European Qualification Framework (EQF) and its learning outcome approach.