BUILD UP SKILLS – Germany
Analysis of the national status quo

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0 Executive Summary

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Announced in 2007, the EU 2020 climate targets seek a 20% cut in greenhouse gas (GHG) emissions, a 20% improvement in energy efficiency and 20% share of renewables in EU energy consumption by 2020. With buildings responsible for 35-40% of total energy consumption, the building sector plays a major role in all reduction strategies. The question is to what extent the adopted policies for the energy-related refurbishment of Europe's building stock can actually be implemented, given the current size and skill levels of the building sector's labour force.

The national policies adopted in EU Member States similarly contain ambitious climate targets. Even though Germany, a country with a long history of climate protection measures - the first government regulation on thermal insulation was adopted 35 years ago and several more have followed in subsequent years -, is a front-runner in Europe with regard to setting down energy-related requirements for buildings, enormous energy-saving potential still exists. The German Federal Government is basing its policy for stimulating development and achieving its energy targets on three pillars: regulatory policy - i.e. the introduction of energy-related laws and regulations -, financial support for energy-saving measures, and instruments aimed at increasing popular acceptance for Germany's energy policy and the population's willingness to implement energy-saving measures.

Against this background, the BUILD UP SKILLS initiative within the *Intelligent Energy Europe (IEE)* programme focuses on the practical side of implementing the necessary measures in the building sector. In it, European countries are called on to establish - at national level and in national projects - the requisite framework conditions for enabling skilled blue collar workers to acquire / upgrade the skills necessary for achieving the energy efficiency targets (if not already developed) and for ensuring that there is sufficient manpower available in the building sector for implementing the necessary measures.

In this context, the German **QUALERGY 2020** project initially focuses on answering four key questions (cf. Figure 1):

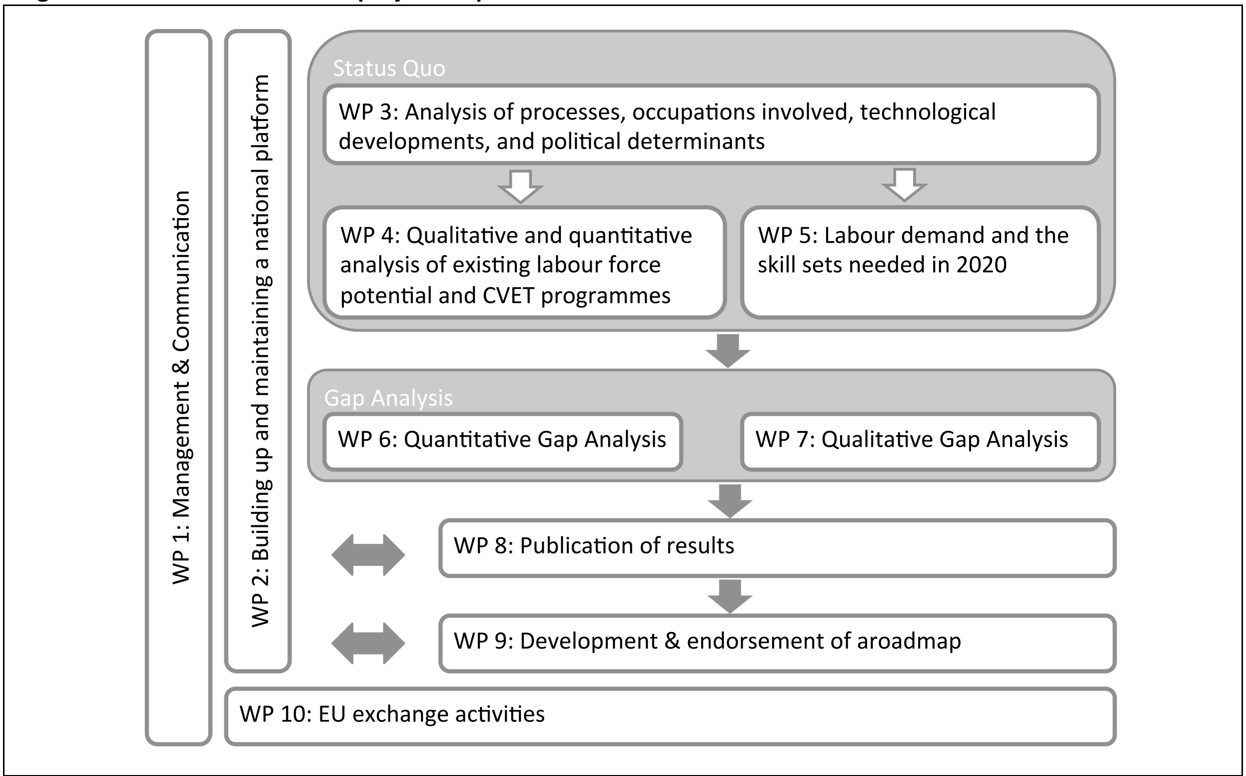
- What skill sets do blue-collar workers in the building sector need to have to implement the measures needed for achieving energy efficient targets?
- What skill sets are taught within the existing IVET and CVET system?
- In what numbers are skilled blue collar workers needed?
- How many skilled blue collar workers are already available in the building sector and how will numbers develop from now until 2020.

Through a comparison of the answers to the first two questions with the answers to the last two, the following question arises:

Which gaps exist between existing and necessary skills, and which gaps exist between existing and necessary manpower?

These analyses represent the cornerstones for a discussion with all relevant national stakeholders on the development of a roadmap for raising skill levels, which can subsequently be used for establishing the necessary framework conditions for the provision of suitably skilled blue collar workers. This roadmap should lay down the concrete measures needing to be taken to attain the necessary numbers of skilled blue collar workers.
For this purpose, the Bundesinstitut für Berufsbildung/Federal Institute for Vocational Education and Training (BIBB), the Deutsche Energie Agentur/German Energy Agency (dena), the Heinz-Piest-Institut für Handwerkstechnik (HPI) at Hannover's Leibniz University and the Zentralverband Deutsches Baugewerbe/ German Construction Industry Federation (ZDB) formed a consortium under the leadership of the Zentralverband des Deutschen Handwerks/ German Skilled Crafts Federation (ZDH) and with scientific coordination provided by Cologne University's Forschungsinstitut für Berufsbildung im Handwerk/Research Institute for Vocational Training in the Skilled Craft Sector (FBH). In the project's second phase - that of developing the roadmap in the context of the National Platform - , all relevant stakeholders will be involved.

Figure 1: QUALERGY 2020 project steps



Source: Own presentation.

This report focuses on the results of the status quo and gap analyses (shaded dark in Figure 1), i.e. providing answers to the questions listed above.

To be able to conduct the analysis, the first step involved describing the technologies relevant to achieving the energy efficiency targets in the building sector. This was initially done without regard to their respective weighting with regard to achieving the energy efficiency targets (cf. Table 1).

The technologies described act as the starting point for the two areas subsequently researched - the qualitative analysis of existing and required skills and the quantitative analysis of existing and required skilled blue collar worker numbers.

1. With regard to the qualitative analysis, first of all the occupations involved needed to be identified. As the working basis for those employed in the building sector the technologies used represent the decisive factor in the compilation of such a list (cf. Figure 2). All these apprenticed occupations were then looked at with regard to the skill sets needed in the field of energy-related refurbishment and construction.
2. With regard to the quantitative analysis, looking at the relevant technologies has a twofold importance. Firstly the list of relevant occupations compiled for the qualitative analysis is also needed for the quantitative analysis, i.e. for forecasting labour supply and demand. The occupations were listed on the basis of the 1992 occupational classification codes. Secondly the labour demand forecasts need to be correlated with the concrete amount of investment in refurbishment measures needed to achieve the energy efficient targets. This is done using the HPI-developed technology policy scenario, which itself is based on the evaluation of the technologies identified in the first step.

Table 1: Technology areas and relevant technologies (modified table from Chapters 4 and 7)

Category 1: Building envelope	**Category 2: Building infrastructure**	**Category 3: Building energy supply**
The roof: The roof construction including tiles and insulation	*Inside rooms:* walls and floors.	*Electricity:* Electricity from the sun (solar), wind, regenerative or fossil fuels (photovoltaic, wind turbines, CHP systems)
Shell: The building's load-bearing elements	*Electrics and ICT:* The electrical wiring and installation of building management systems and ICT facilities within the building.	*Heating:* Heating by means of the sun, earth, air, regenerative or fossil fuels (solar heating, CHP, geothermal or biomass systems)
Windows and doors: Windows and outside doors, including shutters and sun-shade systems.	*Heating system:* Heating and hot water systems	
Facade: The design and thermal insulation of the facade and cellar.	*Ventilation and air-conditioning (VAC):* Ventilation and cooling (air conditioning) systems.	

Vocational training for skilled blue collar workers in the building sector takes place at different levels in Germany. On the one hand the standardised 3-year apprenticeship system covers "recognised apprenticed occupations". Apprenticeships involve dual theoretical-practical vocational training. The practical side takes place within the employing company and is standardised throughout Germany on the basis of an agreement between the social partners. The theoretical side is similarly standardised, with the Conference of the Education Ministers (*Kultusministerkonferenz* or KMK) of Germany's 16 Federal States defining standard framework curricula for all IVET schools (*Berufsschulen*). In addition there are a number of "regulated" and "non-regulated" CVET opportunities available. Similarly, CVET programmes for gaining a master craftsman qualification – the level above an apprenticeship - constitute a standardised way of acquiring advanced skills in the relevant occupations.

Figure 2: Selection of the occupations analysed in the qualitative and quantitative analyses

Journeyman title	Master title	Responsibility HW	Responsibility IN	Adoption of AO	Responsibility HW	Responsibility IN	Adaption of MstrPrV	Categories GH	Categories GI	Categories EV
Plant mechanic for sanitary, heating and air conditioning systems	Master heating and plumbing technician	✓	✓	24. 06. 2003, dated on 08.07.2003	✓		17.7.2002		✓	✓
	Certified metalworking foreman					✓	12.12.1997, dated on 23.07.2010			
Construction finishing woker		✓	✓	2.6.1999, dated on 20.2.2009				✓	✓	
Building materials tester			✓	24.03.05				✓		
Building and object coater		✓		03.07.2003, zuletzt geändert am 25.07.2003				✓	✓	✓
Masonry waterproofer	Certified industrial foreman in insulation		✓	24.04.97		✓	29.06.1993, datend on 25.08.2009	✓		
Building mechanic for demolition and concrete cutting			✓	2.6.1999, dated on 20.2.2009				✓		
Concreter	Master bricklayer/concrete mason	✓	✓	2.6.1999, dated on 20.2.2009	✓		30.8.2004	✓		
Producer of pre-fabricated concrete elements	Certified industrial foreman in the manufacture of concrete elements		✓	9.9.1985		✓		✓		
Concrete bloc and terrazzo manufacturer	Master concrete block manufacturer	✓		09.09.85	✓		21.1.1993	✓		
Floor layer			✓	17.06.02					✓	
Well builder	Master well builder	✓	✓	2.6.1999, dated on 20.2.2009	✓		14.10.2005			✓
Roofer, specialised in roof, wall and waterproofing technology; specialised in reed-thatch roofing techniques	Master roofer	✓		13.5.1998	✓		23.6.2006	✓		✓
Electronics technician for building and infrastructure systems	State certified technician specialised in electro technology		✓	24.7.2007		✓	30.11.2004		✓	
Electronics technician, specialised in energy and building management systems	Master electrical engineering technician, specialised in energy and building management systems	✓		25.7.2008	✓		17.06.2002, dated on 6.3.2003		✓	✓
Screed layer	Master screed layer	✓	✓	2.6.1999, dated on 20.2.2009	✓		16.2.1995		✓	
Facade erector	Certified industrial foreman in insulation		✓	19.5.1999		✓	29.6.1993	✓		
	Certified industrial foreman in such areas as acoustics or dry wall construction					✓				
Furnace and chimney builder	Master bricklayer/concrete mason	✓	✓	2.6.1999, dated on 20.2.2009		✓	30.8.2004	✓	✓	
Tile and mosaic layer	Master tiler	✓	✓	2.6.1999, zuletzt geändert am 20.2.2009	✓		10.3.2008		✓	
Glazier, specialised in glazing; specialised in windows and glass curtain walling	Master glazier	✓		5.7.2001	✓		9.12.1975	✓		✓
Building construction worker		✓	✓	2.6.1999, dated on20.2.2009				✓		
Plumber	Master plumber	✓		10.3.1989	✓		23.05.2006, dated on 05.11.2008	✓	✓	

Painter and vanisher, specialised in design and maintenance; specialised in building and anti-corrosion protection	Master painter	✓		03.07.2003, dated on 25.07.2003	✓		13.6.2005	✓	✓	✓
Mason	Master bricklayer/concrete mason	✓	✓	2.6.1999, dated on 20.2.2009	✓		30.8.2004	✓		
Mechatronics engineer for refrigeration technology	Master refrigeration technician	✓	✓	20.7.2007	✓		27.8.1979		✓	✓
Metal worker, specialised in construction technology	Master metal builder	✓		25.7.2008	✓		22.3.2002, dated on 17.12.2002	✓	✓	✓
Stone technician	Certified industrial foreman in stoneworking		✓	9.5.2003		✓		✓	✓	
Builder of stoves and heating systems	Master stove builder	✓		6.4.2006	✓		5.3.2009		✓	✓
Parquet layer	Master parquet layer	✓		17.6.2002	✓		28.8.1974		✓	
Interior decorateur	Master interior decorator	✓		18.05.2004, dated on 09.5.2005	✓		18.6.2008		✓	
Roller shutters and sunshade mechatronic technician	Master sun-shading technician	✓		23.6.2004	✓		22.1.2007	✓		
Chimney sweep	Master chimnney sweep	✓		20.6.2012	✓		25.6.1984	✓	✓	✓
Special civil engineering works builder			✓	2.6.1999, dated on 20.2.2009						✓
Stone mason, specialised in stonemasonry	Master stone man	✓		9.5.2003	✓		11.7.2008		✓	
Stuccoist	Master plasterer	✓		2.6.1999, dated on 20.2.2009	✓		30.8.2004	✓		
Systems informatics technician	State certified technician specialised in electro technology		✓	24.7.2007		✓	30.00.2004, dated on 23.7.2010		✓	
Technical systems planner, specialised in electro technical systems; specialised in supply and equipment technology			✓	21.6.2011					✓	
Civil engineering worker		✓	✓	2.6.1999, dated on 20.2.2009						✓
Joiner	Master joiner	✓		25.1.2006	✓		13.5.2008	✓	✓	
Dry construction builder	Certified industrial foreman in such areas as acoustics or dry wall construction		✓	2.6.1999, dated on 20.2.2009		✓		✓	✓	
Thermal and noise insulation fitter	Master insulation technician	✓	✓	2.6.1999, dated on 20.2.2009	✓		3.6.1982	✓	✓	
	Certified industrial foreman in insulation					✓	29.06.1993, dated on 25.08.2009			
	Certified industrial foreman in such areas as acoustics or dry wall construction					✓				
Carpenter	Master carpenter	✓	✓	2.6.1999, dated on20.2.2009	✓		16.4.2008	✓	✓	
	Certified industrial foreman in such areas as acoustics or dry wall construction					✓				
	Certified industrial foreman in woodworking					✓				

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

In the context of the qualitative analysis, the occupations listed in Figure 2 are analysed at both apprentice and master craftsman levels with regard to the skill sets relevant to the energy-related refurbishment of old buildings or the construction of new buildings, using as a basis the existing regulatory framework standardised throughout Germany. The results are then cross-checked with experts from the industry.

The evaluation matrix (presented in a basic form in Figure 3 and broken down further in the course of the work) is used to systematically record the skill sets required, with mapping done to its two dimensions: *building work categories*[1] and *processes*: On the one hand, this covers the different areas in which building workers work, on the other hand the concrete process(es) needing to be performed.

Figure 3: 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						

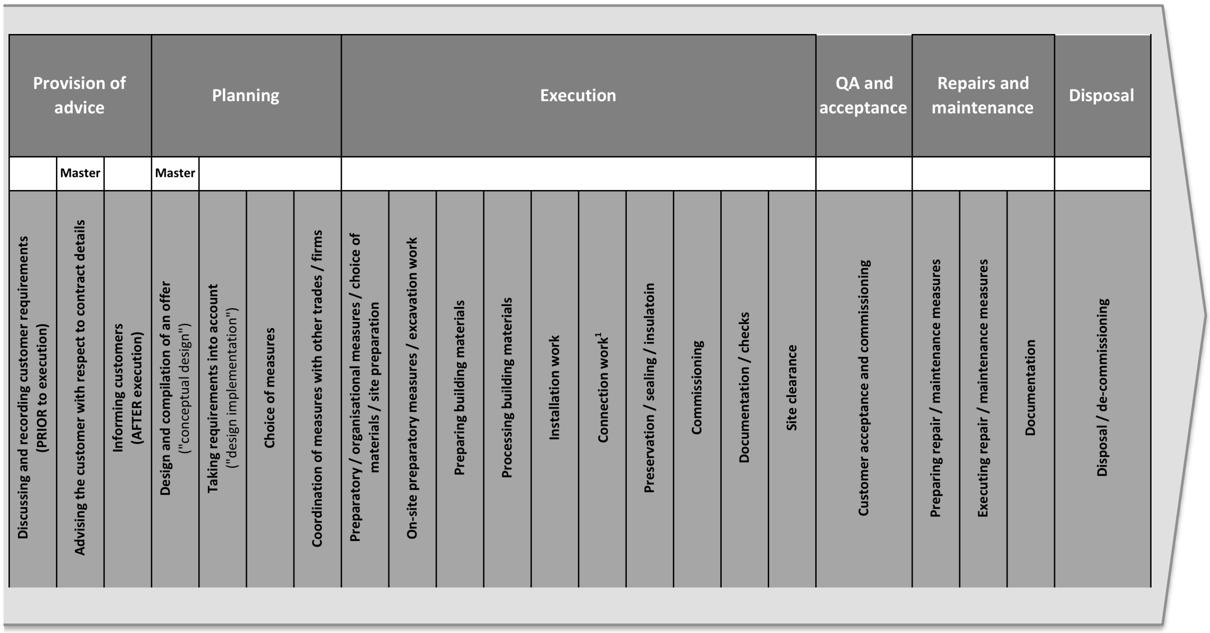
This overall process chain with its provision of advice, planning, execution, quality assurance and customer acceptance, and subsequent repair and maintenance and disposal processes is to be understood as a value chain, whereby the individual steps do not necessarily need to take place in the defined linear sequence. They can rather be seen as interlinked process categories, which may be branched to separately or repeated. Repair processes may for example trigger new advisory processes, which in turn may take place both before and after an order has been placed. Similarly, new planning processes may become necessary during the execution phase.

To ensure the visualisation of the skill sets needed and to enable a further structuring of the evaluation, the processes were broken down to a lower level, being given standardised terms applying to several or all occupations. This in turn meant that the skill sets for the

[1] The term „building work category / subcategory" is used in reference to the above categorisation of technologies. As certain of the 'technologies' are not technologies in the true sense of the word (e.g. roof, façade), the decision was taken to use the general term "building work category / subcategory".

individual occupations no longer needed to be separately defined and entered into the evaluation matrix, but could be identified through mapping them to the corresponding fields and providing a reference to the relevant regulatory framework.
The broken-down process and its associated skills also reflect the skill sets validated in the discussions with the experts (cf. Figure 4), and include, alongside the subprocesses on the journeyman level[2], the subprocesses looked at on the master craftsman level.

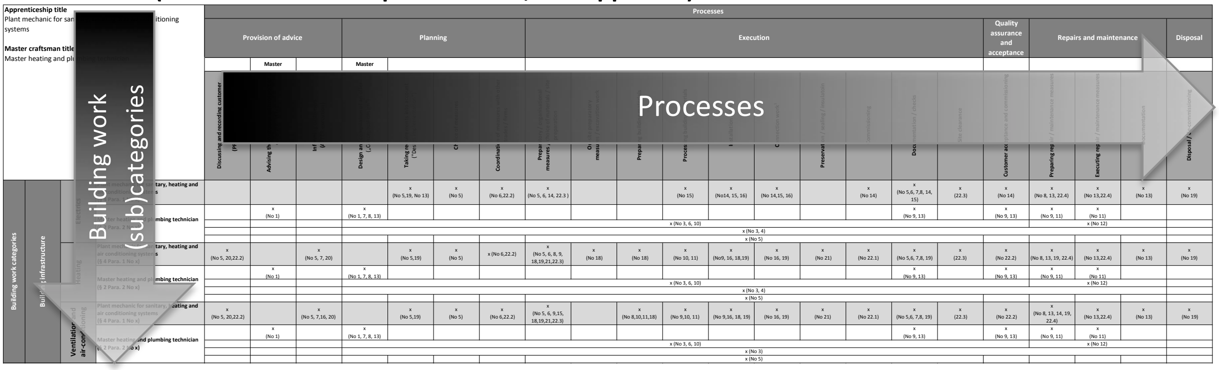
Figure 4: Skill sets at journeyman and master craftsman level



In line with this methodology, all occupations referred to above are presented with their respective skill sets at journeyman and master craftsman level.

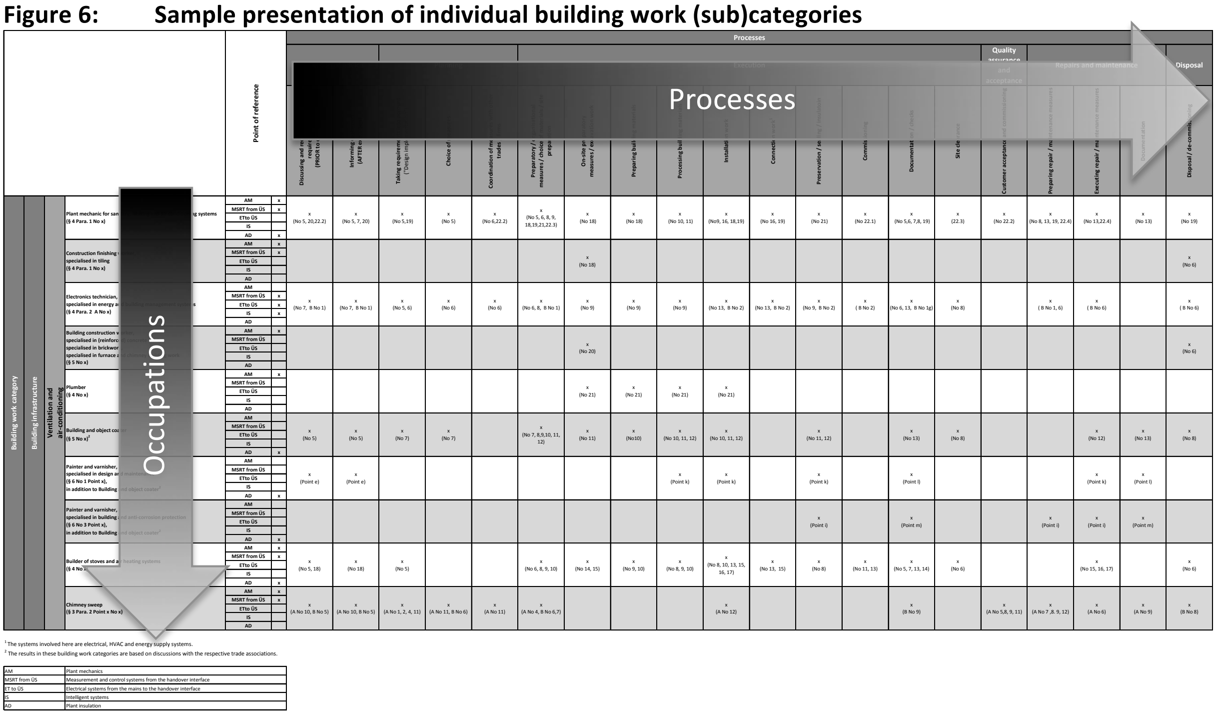
2 The term „journeyman level" refers to the point in time in a skilled worker's career when he has just successfully finished his initial vocational training.

Figure 5: Sample extract of journeyman and master craftsman skill sets demonstrating the methodology (for a more detailed presentation, see Appendix)



In answer to the research questions, skill sets are re-sorted according to the building work (sub)categories involved, i.e. listing the occupations involved in the respective technologies with their respective skill sets (cf. the example for heating technologies in Figure 6). This brings us to a further analysis, ascertaining the extent to which the necessary skill sets are available for the whole process chain and for all occupations. Moreover skill sets applying to more than one trade (overlapping skill sets) can also be identified. What is however needed here is a further breakdown of the building work categories, allowing a better distinction of the fields of action of individual trades within a category.

Figure 6: Sample presentation of individual building work (sub)categories



As an initial preview of the gap analysis (see below), this means that the process covers all trades, i.e. the required skill sets are available via the IVET and CVET system.

In addition to the desk research undertaken with regard to existing apprenticeship frameworks and master craftsman examination regulations, the evaluation of a survey of CVET providers in the field of energy efficiency / renewable energy came up with 315 different CVET offerings (apart from CVET programmes for gaining a master craftsman qualification).

A detailed description of these offerings - sorted into practical categories - highlights differences and similarities and also takes a look at how the programmes came into being. In addition quantitative evaluations provide insights into the coverage of different technologies and processes, into the development of programme participation, into the question of a standardised assessment framework and into the duration of such courses. Using the evaluation matrix shown above, this allows us to show the degree to which the individual processes and building work subcategories are covered by CVET offerings.

As seen in Table 2, the focus is on the first two processes.

Table 2: Mapping of CVET programmes to processes and building work subcategories

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

This focus is reflected in programme participation figures, whereby one finding is that - possibly as a result of the good overall economic situation in Germany in 2010 and 2011 and the associated high workload in the skilled craft companies - participation figures were down in all areas.

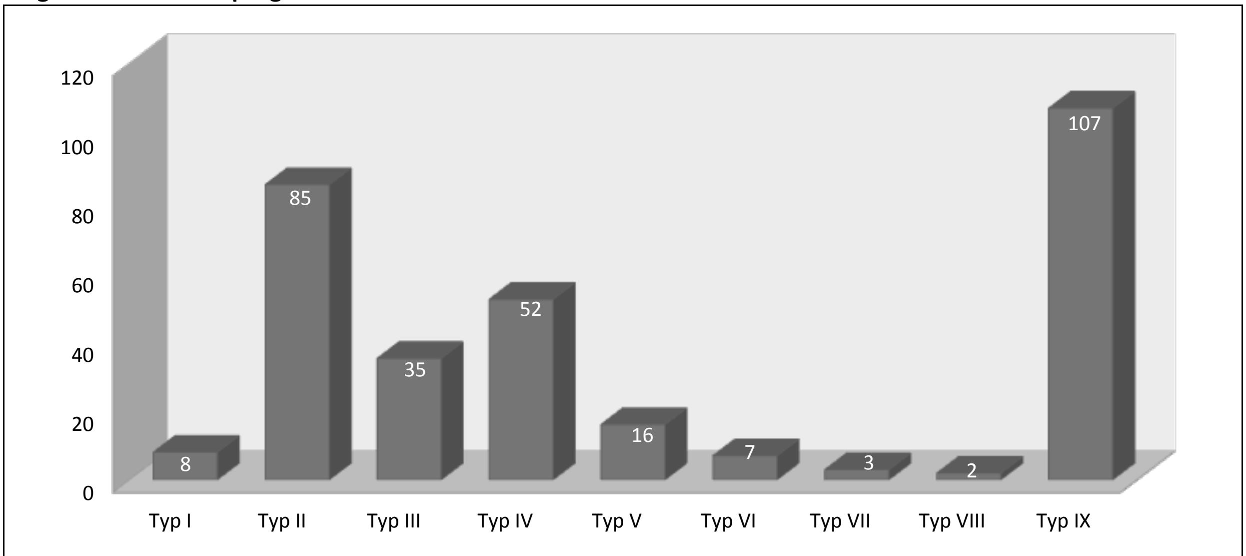
Moreover, with regard to average programme duration (in hours) different categories of CVET programmes could be ascertained (see Table 3):

Table 3: Duration-related categorisation of CVET programmes

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

This categorisation provides a first insight into programme depth. Mapping the programmes to the different categories provides the following picture:

Figure 7: CVET programme duration



On this basis and in combination with the question of which examination framework (examination regulation) is used, the following distribution is to be seen:

Table 4: CVET programmes by examination framework and duration

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

Cross-tabulation confirms the assumption that the CVET programmes examined under chamber regulations involve programmes with a duration of 200 hours or more (Type IX) in 76 of 88 cases (86.36%). By contrast, CVET programmes ending merely with a certificate of attendance last no longer than 10 hours (Type II) in 77 of 150 (51.33%) cases. CVET programmes examined yet without a state-regulated legal basis for such examinations are mainly to be found in categories II - IV.

The comparison of the required skill sets with the skill sets acquired during an initial vocational training (journeyman level) in the context of the gap analysis shows that, for all occupations together, the main skills are available. However, the following gaps have been ascertained [3] (cf. Table 5):

- In the 'provision of advice' process, skills relating to *order-related customer advice* are missing, as is also partially the case with regard to *recording customer requirements*.
- In the 'planning' process, skills in *planning and preparing an offer* are either not available at all or to an insufficient degree.
- The 'customer acceptance' process is not covered at all or only covered in a very few cases.
- In the 'repair and maintenance' process, skills for determining needs *are missing.*

Regarding these points it is necessary to mention that in Germany's craft sector *order-related customer advice* as well as *planning and preparing an offer* are processes exclusively conducted by the master craftsmen. Therefore these 'gaps' exist on the journeymen level on purpose.
In Table 5 only gaps referring to the tasks assigned to the journeymen level are listed.

[3] In the methodology used, a gap is deemed to exist when in the trades involved in a certain building work category either (1) a process is not covered, or (2) the process is not covered with regard to a specific point of reference. One example of the second aspect can be found in the field of solar heating. The "plant mechanic for sanitary, heating and air conditioning systems" is listed as having the right skill sets for all processes. However these do not always apply to all points of reference within the category. For instance, with regard to the 'customer acceptance' process, the plant mechanic is not listed as having skills for checking the attachment of the equipment to the **roof and facade points of reference**. As the other occupations also do not cover these roof and facade points of reference in the customer acceptance process, a gap exists here. Relevant occupations are those occupations mainly involved in the building work category. Attention was paid here to the points of references within a subcategory (e.g. plant mechanics, control and measurement technology, or fitting solar panels to a roof or facade), making sure that these were also covered.

Table 5: Gaps at journeyman level

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	documentation / Maintenance	5 of 14 subcategories (shell, facade, biomass systems, PV systems, wind turbines)

After analysing the skill sets taught in the CVET programmes for gaining a master craftsman qualification, we found that **these gaps were completely closed**.

A further analysis looked into other ways of gaining skills without having to take a CVET programme leading to a master craftsman qualification. To do this, we looked at available CVET offerings, mapping these to the gaps (cf. Table 6).
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.

Table 6: Gaps at journeyman level (not differentiated by sub-process) 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	×	92	×	110		×	71	×	38	
		Roof	×	164	×	178		×	117			
		Facade	×	137	×	152		×	108	×	59	
		Windows and doors	×	127	×	143		×	95			
	Energy supply	Interior walls and flooring	×	83	×	80		×	69	×	49	
		Electrics	×	122	×	133						
		Heating	×	163	×	185		×	125	×	81	
		Ventilation and air-conditioning	×	67	×	77						
	Energieversorgung	Geothermal systems	×	71	×	83		×	61	×	35	
		Biomass systems	×	41	×	51		×	35	×	22	
		Solar heating	×	104	×	122		×	84	×	52	
		Photovoltaic systems	×	118	×	136				×	66	
		CHP	×	80	×	89		×	65			
		Wind turbines	×	23	×	29		×	24	×	17	

× = Identified Gap

What can be seen here is that the gaps can in principle be closed by CVET offerings.
With regard to the question of permeability but also taking into account the concept of lifelong learning at the different skilled craft career levels (the career development concept), a further analysis looked at access requirements for CVET programmes. 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. With regard to minimum access requirements and trade-related access restrictions, each gap was analysed separately. Restricting access to CVET programmes to certain trades was more prevalent at journeyman level than at master craftsman level.

To help assess the depth of CVET programmes – and therefore their value in closing skill gaps –, programme, duration (in hours) was mapped to the number of processes and building work subcategories covered for the individual gaps (for an example see Table 7).

Table 7: The shell/advice gap as an example: 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

Looking at the tables containing all gaps, we can summarise that only a few of the relatively short CVET programmes (Types I - IV) lay claim to covering as many processes and building work subcategories as possible. Generally speaking, only 2-3 processes are covered. We conclude from this data for the Types I - IV that by focussing on a limited number of processes within the limited amount of time a sufficient depth in the contents could be achieved, but no cross-process thinking developed. To gain skills covering many processes and building work subcategories, longer CVET programmes are available - mainly Types VIII and IX.

Turning to the quantitative analysis of skilled labour requirements, the first key aspect involves coming up with a valid technological scenario for ascertaining the amount of investment (missing in the available literature and political discussion) needed for achieving the desired political energy-saving targets. This covers both the residential and the non-residential building sectors.

The initial finding here is that there is a potential of 123.2 TWh of energy savings in the residential sector (101.9 TWh of which is attributable to heating) and of 72.3 TWh for the non-residential sector (51.3 TWh of which is for heating).

Of the EU's three energy targets, the scenario focuses on energy-saving, ignoring the other two targets of reducing GHG emissions and increasing the share of renewables. This is done for the following two reasons: Firstly the targeted share of renewables within overall energy consumption for the building sector is set to be achieved without any further investment. Secondly, over-fulfilling the energy-saving target automatically results in the achievement of the GHG-reduction target.

For this purpose we start by classifying the existing building stock, assessing it with regard to the potential for improving energy efficiency.

Table 8: Building categories, assumptions regarding potential energy efficiency improvements and the resulting final energy consumption

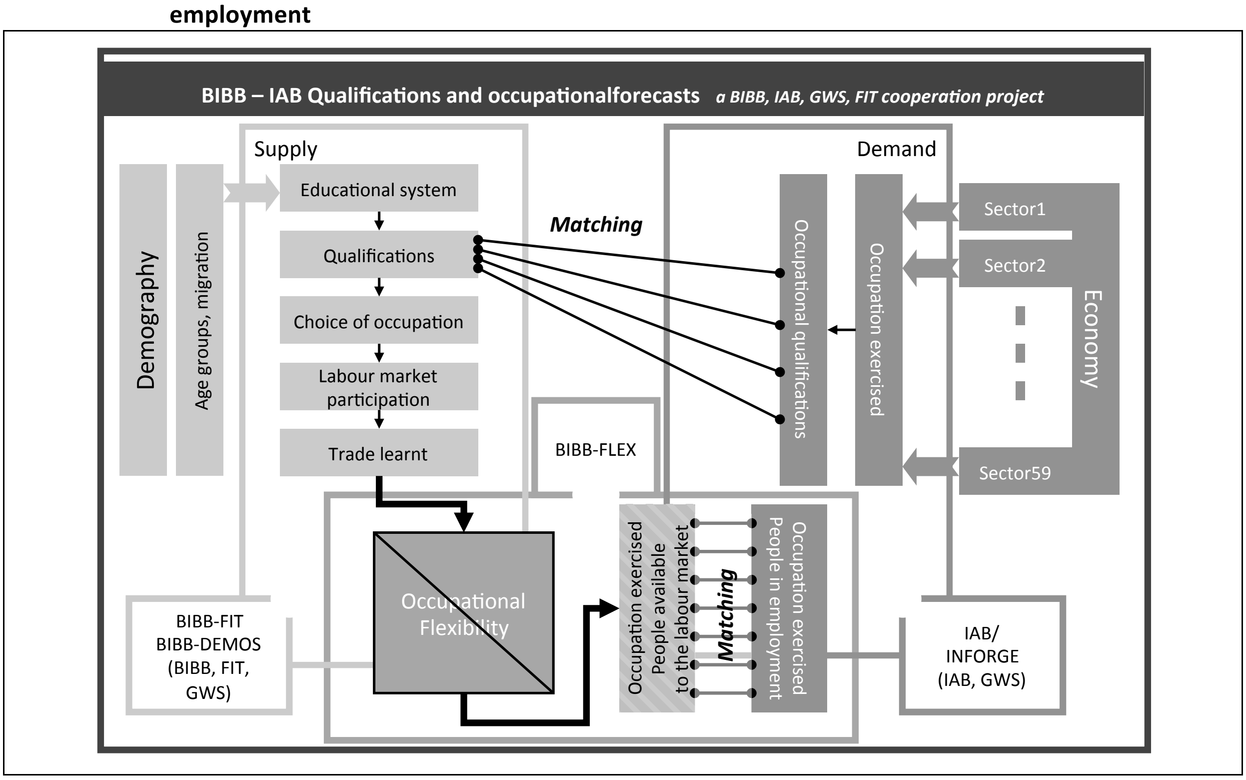
	Type of building	Energy efficiency improvement[4]	Energy consumption [TWh]
Detached/ semi-detached houses	built before 1949/uninsulated	0.806	84.7
	built before 1949/insulated	0.611	16.5
	built before 1979/uninsulated	0.806	134.9
	built before 1979/insulated	0.611	26.2
	before 1996	0.563	34.9
	before 2001	0.300	7.3
	from 2001 onwards	0.000	5.1
Small blocks of flats	built before 1949/uninsulated	0.788	44.8
	built before 1949/insulated	0.578	8.8
	built before 1979/uninsulated	0.788	71.2
	built before 1979/insulated	0.578	13.9
	before 1996	0.576	20.7
	before 2001	0.300	4.2
	from 2001 onwards	0.000	2.9
Large blocks of flats	built before 1949/uninsulated	0.781	8.9
	built before 1949/insulated	0.563	1.7
	built before 1979/uninsulated	0.781	14.2
	built before 1979/insulated	0.563	2.8
	before 1996	0.563	4.1
	before 2001	0.300	0.9
	from 2001 onwards	0.000	0.6
Non-residential buildings	before 1977	0.806	216.8
	before 1984	0.750	20.6
	before 1995	0.563	11.8
	from 1995	0.000	7.2

4 Correlations between demand and consumption parameters were not taken into account.

Under the assumption that only owners of residential buildings built before 1996 and of non-residential buildings built before 1977 will undertake refurbishment and that only 50% of houses listed as "insulated" will be refurbished, the total amount (specified in square metres of floorspace) to be refurbished was calculated for each type of building.
Using assumed refurbishment costs of 500 EUR per m2 (verified via existing studies) for residential buildings (including the modernisation of a building's technical infrastructure), the total investment volume required for the residential sector amounts to EUR 372.8 billion, or EUR 53.3 billion per year for the period 2014 - 2020. With the current annual investment volume running at EUR 42.3 billion, this means that an additional EUR 11 billion is needed annually. Turning to the non-residential sector, the assumed refurbishment cost is slightly lower at EUR 380 per m2, implying a total investment volume of EUR 195.4 billion for the 6-year period or EUR 27.8 billion annually. Of this annual sum, EUR 12.6 billion constitutes the required additional investment.

On the basis of the information on the selected occupations and the calculations for the investment needed, two scenarios were developed in the context of the quantitative analysis for measuring the supply and demand for skilled labour and extrapolating this until 2020: on the one hand the reference scenario taking into account the developments up to now without the additional investment requirements referred to above, and on the other hand a similar scenario taking these additional investment requirements (to the tune of EUR 23.6 billion annually for the period 2014 - 2020) into account.

Figure 8: Schematic diagram showing the methodology of the BIBB IAB projections for qualifications and employment



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

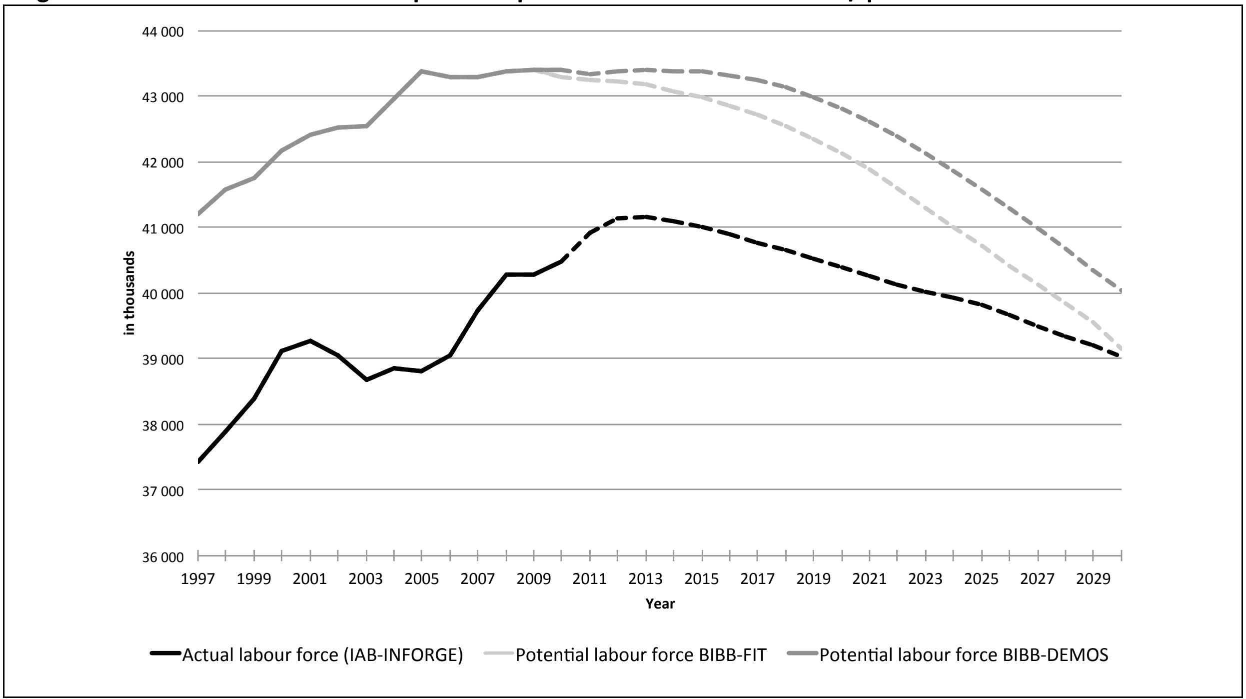
In defining the scenarios, two models are used: the BIBB-FIT transition model and the BIBB-DEMOS cohort model on the labour supply side, and the IAB/INFORGE model on the demand side. These models are also used in the so-called "QuBe project" for forecasting skill requirements in certain trades (cf. Figure 8).

Of decisive importance for the projections are the following assumptions / starting points

- Though labour supply is dependent to a certain degree on demographic factors, it is also influenced by the employment rate and educational behaviour with its focus on academic qualifications.
- Labour supply cannot be determined just on the basis of IVET qualifications. Also needing to be taken into account are switches to other occupations different to the originally trained-for occupation. This is done via flexibility matrices based on microcensus surveys.
- Labour demand is determined on the basis of a theoretical model of inputs and outputs for various production areas and product groups in the different economic sectors.
- Both the supply and demand sides are depicted using the 1992 classification of occupations, with the occupations in question being aggregated into 54 occupational fields and 14 main occupational fields.

Just taking the reference scenario into account, it can already be seen that supply is declining much faster than demand.

Figure 9: Labour market developments up to 2030: actual labour force / potential labour force

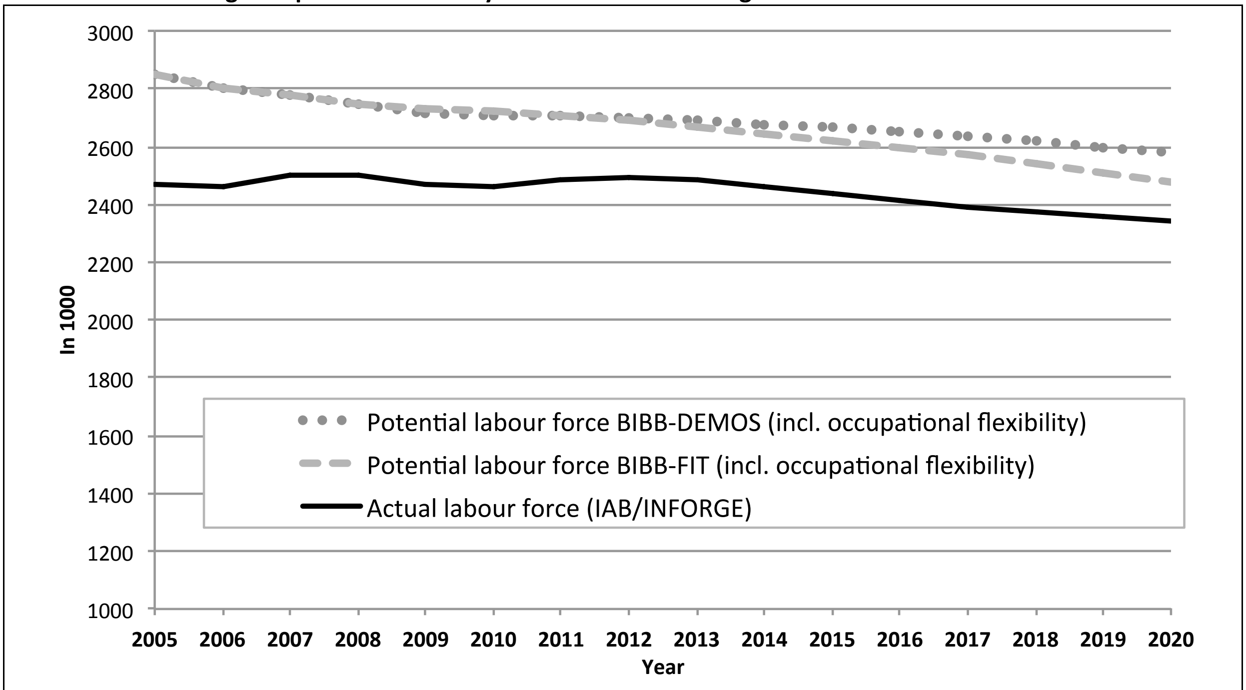


Source: Microcensus of the German Federal Statistics Agency, QuBe calculations and diagrams, 2nd wave.

Looking at the IVET level, one finding is that the supply of workers with a full IVET qualification will decline, mainly for demographic reasons, meaning that - assuming an unchanged labour demand situation - in ca. 20 years demand will outstrip supply. It can however be expected that this will actually happen a lot sooner, probably at the end of the 2010's, when Germany will see itself confronted with a rapidly increasing shortage of skilled blue collar workers, with changing occupational orientations in particular the reason for the supply and demand mismatch.

Looking specifically at the occupations dealt with in this project and taking occupational flexibility into account, the reference scenario (i.e. the projection of current developments) shows that, despite the decreasing supply of skilled blue collar workers, a supply-side surplus of 240,000 (BIBB-DEMOS model) / 140,000 (BIBB-FIT model) workers can still be expected in 2020. This means, from a purely mathematical perspective and without taking regional features and the situation in individual occupations into account, that no labour shortage can be expected before 2020. However, looking at the decade to 2030, a shortage is to be expected due to the last of the baby-boom generation leaving the labour market.

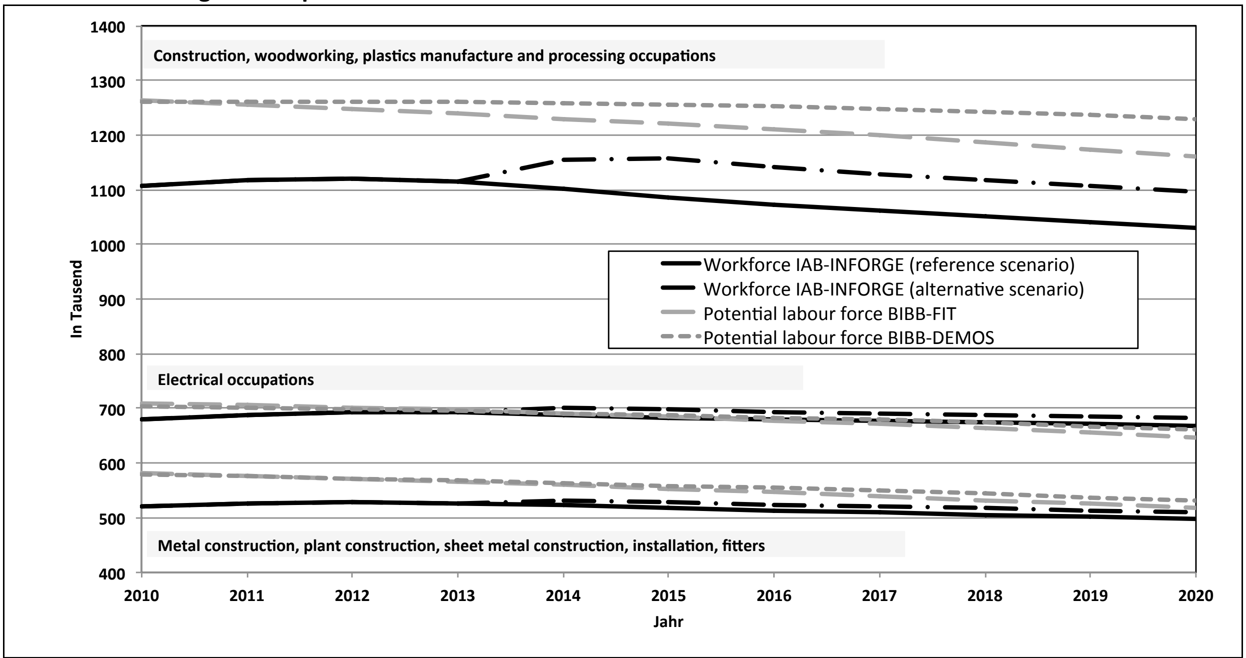
Figure 10: Labour supply and demand projection to 2020 in the selected building industry occupations, taking occupational flexibility into account and using the reference scenario



Source: QuBe project, 2nd wave.

Taking the investment amounts determined in the scenario into account and under the given funding assumptions, 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). However, this is still a mathematical figure calculated for the whole of Germany and taking all relevant occupations into account. 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 in certain occupations will occur even before 2020. Looking specifically at the three main occupational fields (cf. Figure 11), we see that in particular in 'electrical occupations' and 'metal construction, plant construction, sheet metal construction, installation, fitters' shortages can be expected before 2020. Additionally one can expect nationwide shortages in the construction related labour markets after 2021.

Figure 11: 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.

On the basis of the results presented above and a look at the barriers, the following conclusions are drawn. These will in turn be the starting point for the discussions on drawing up a skill development roadmap:

- The investment volume in energy-related refurbishment must be increased, possibly with the help of state incentives.
- The emerging quantitative shortage of skilled labour needs to be counteracted through the mobilisation of hitherto untapped potential - in particular immigrants, women and the unskilled. This will require measures raising the attractiveness of and strengthening the apprenticeship system.
- At the same time, training concepts need to be thought out, taking account of the situation of these target groups.
- Incentives for workers to remain in the occupation they originally trained for need to be provided. These will involve CVET programmes and possibilities for moving up the career ladder in the context of a systematic career development concept.
- The comprehensive master craftsman training closes the gaps existing at the end of an initial vocational training. It is to be seen as a quality assurance cornerstone, and therefore needs to be strengthened.
- Providing incentives for taking up CVET programmes against the background of micro- and small company structures is a further task needing to be tackled.

- As a way of coping with the lack of transparency in the CVET market, the standardisation of CVET programmes and their registration in a central database would seem to be suitable approaches.
- Linkage between trades could be improved through offering CVET programmes not targeting specific technologies or processes, but instead taking a broader view, looking at a building as an overall system with interlinked technologies. Thought can also be invested into anchoring such systemic thinking in apprenticeship frameworks.
- The use of systems recognising skill needs at an early stage and comparing these needs with the skills taught in existing CVET programmes is one way of ensuring that CVET programmes remain up-to-date.

1 Introduction

Katrin Rasch, Rolf R. Rehbold, Susanne Rotthege

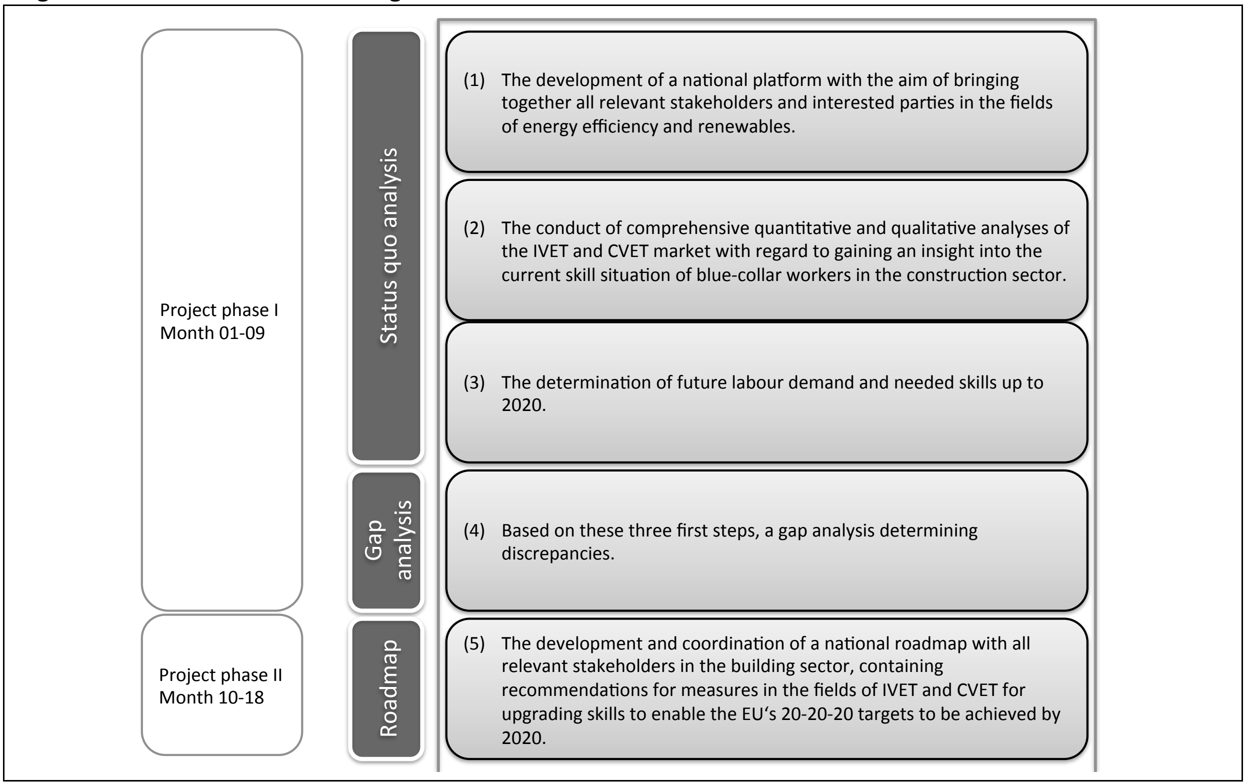
In March 2007, following a European Commission recommendation, the European Council adopted the decision to cut greenhouse gas (GHG) emissions by 20% by 2020, to improve energy efficiency by 20%, and to increase the share of renewables in EU energy consumption by 20% (the so-called 20-20-20 targets) (EU 2012). These ambitious climate and energy policy targets are Europe's initial contribution to fighting climate change and preserving resources for future generations. The intentions of the 20-20-20 targets are to combat high energy consumption, the associated high CO_2 emissions and the resulting global warming on the one hand, and to reduce dependency on fossil fuels - oil, gas and coal - on the other hand. The building sector has a key role to play here, due to the fact that buildings (residential and non-residential) are responsible for about 40% of total energy consumption and 36% of CO_2 emissions within the European Union (EU) (BMWi / BMU 2010, p. 22).

At the same time the EU 20-20-20 targets were being adopted, Germany tightened its existing climate and energy targets, adopting its Integrated Energy and Climate Programme (IECP) 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). Germany has set itself the target of reducing GHG emissions by 40% (based on 1990 levels) by 2020. This corresponds to cutting CO_2 emissions by approx. 220 million tonnes. Further reductions are targeted through increasing the share of renewables in the electricity sector (54 million tonnes), through increasing the energy efficiency of buildings (31 million tonnes) and through cutting overall energy consumption (ibid, p. 8). To achieve these targets - increasing the share of renewables in total electricity production to 25-30% (the corresponding figure in August 2007 was 13%) and to 14% in heat generation (cf. BMU 2007, p. 11) -, an amendment to the Renewable Energy Act (EEG) was planned. The CO_2 Building Refurbishment Programme saw an annual sum of ca. €700 million earmarked for 2007 and 2008 for measures increasing the energy efficiency of buildings (IEK-STE / Forschungszentrum Jülich 2001, S. 7).

Energy-related building refurbishment, the construction of new passive / low-energy houses and the increase in the share of renewables at both European and national levels are all factors giving the building sector a key role to play in achieving the 20-20-20 targets. It also means that the supply of skilled labour in this sector has to be ensured in the individual EU Member States, involving not just a quantitative (headcount) increase but also an increased offering of IVET and CVET programmes for increasing skill levels.

The *EU's Build Up Skills initiative* - part of the Intelligent Energy Europe (IEE) programme - has earmarked funds in all EU Member States for determining numbers of skilled building workers and what qualifications they have, and for defining which steps are needed to raise their numbers and skill levels. Within the German QUALERGY **2020**[5] project, the steps shown in Figure 12 for achieving the project targets set forth in the *Build Up Skills initiative* are to be carried out in the timeframe November 2011 to April 2013.

Figure 12: QUALERGY 2020 targets



Source: Own presentation.

The first half of the project will cover comprehensive analyses of the status quo, establishing the quantitative and qualitative gaps existing between the current situation and future needs regarding building workers' qualifications by July 2012. Building on the results of this gap analysis, the next step is the development and endorsement of a national (skills) roadmap for achieving the 2020 climate targets. This involves discussions with all stakeholders working in the area of IVET and CVET in the building sector.

While coordinating and conducting the quantitative and qualitative analyses is the responsibility of a team (consortium) of experts from six different institutes, the plan is for roadmap development and endorsement to involve as many interest groups as possible. To ensure the project's smooth functioning while at the same time achieving broad consensus on the roadmap, a three-level project structure was introduced for the **QUALERGY 2020** project (cf. Figure 13 for the two levels relevant for the first project phase).

[5] The full project name is:
Qualification Needs and Status Quo-Analysis of Blue-Collar Workers in the Building Sector and Endorsement of a Roadmap for Overcoming Gaps in Germany till 2020.
In Germany the short name "(European) Building Initiative" is commonly used.

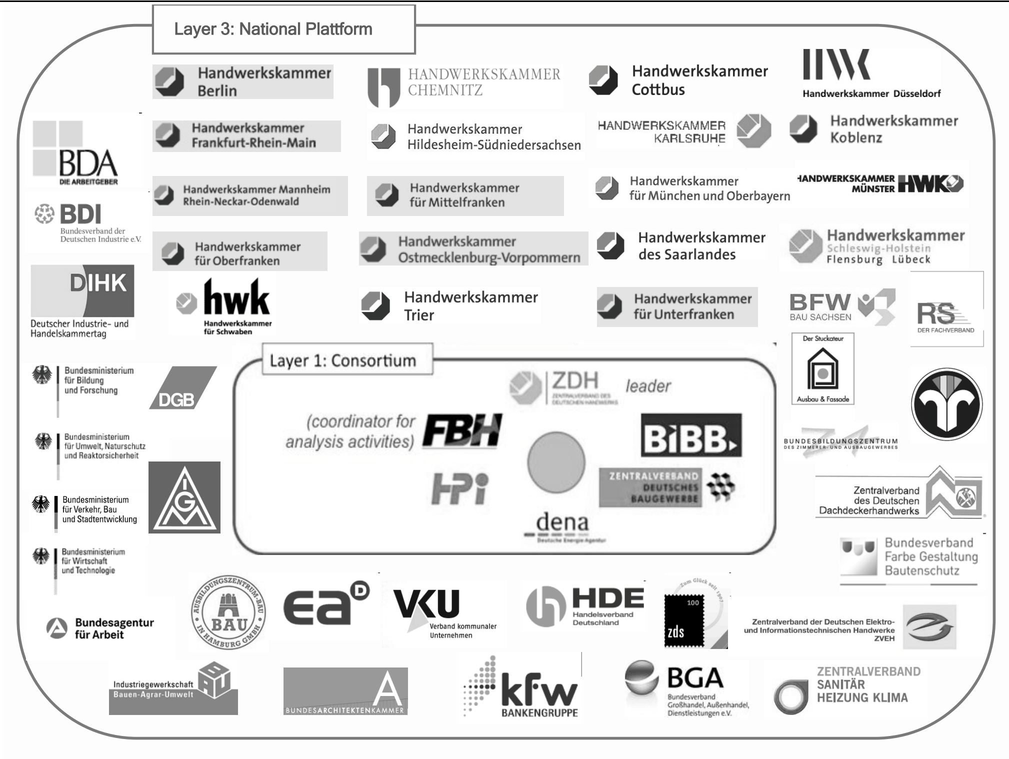
Leadership within the consortium (Level 1) is given to the German Confederation of Skilled Crafts (ZDH) as the umbrella organisation for 53 Chambers of Skilled Crafts and 36 trade federations. In its role as research coordinator, Cologne University's Research Institute for Vocational Training in the Skilled Craft Sector (FBH) has the task of coordinating and monitoring the analysis work and has a major role to play in conducting the qualitative evaluation. As a technical research facility, Hannover University's Heinz Piest Institute for Skilled Craft Technology is providing technical support in the field of new technology developments. In its role as a competence centre for renewable energy and intelligent energy systems, the German Energy Agency (dena) similarly has an important role to play. As is the case with the ZDH, , the German Construction Industry Federation (ZDB) as an umbrella organisation also maintains a series of important contacts within the German building sector, thereby complementing project work and providing valuable information. Last but not least, the Federal Institute for Vocational Education and Training (BIBB) is not only an expert in the field of German vocational education and training (VET), but is also responsible for compiling and evaluating quantitative data on Germany's VET market.

The second level consists of the Steering Board, made up of consortium members and further national platform stakeholders (Level 3). The Steering Board should not have more than 20-25 members. The Steering Board has the task of discussing suggestions and recommendations for the design of the planned roadmap, including additional aspects and finally for coming up with a template for detailing the roadmap. In association with this work, Board members have the task of discussing project findings within their respective institutions.

Moreover, the national platform stakeholders are to be included in the development and endorsement process. All involved thus have the opportunity of being regularly informed about project progress and findings, and are encouraged to actively discuss them.

Board membership has now (as of September 2012) been finalised. An overview of levels 1 (consortium) and 3 (national platform) can be found in Figure 13.

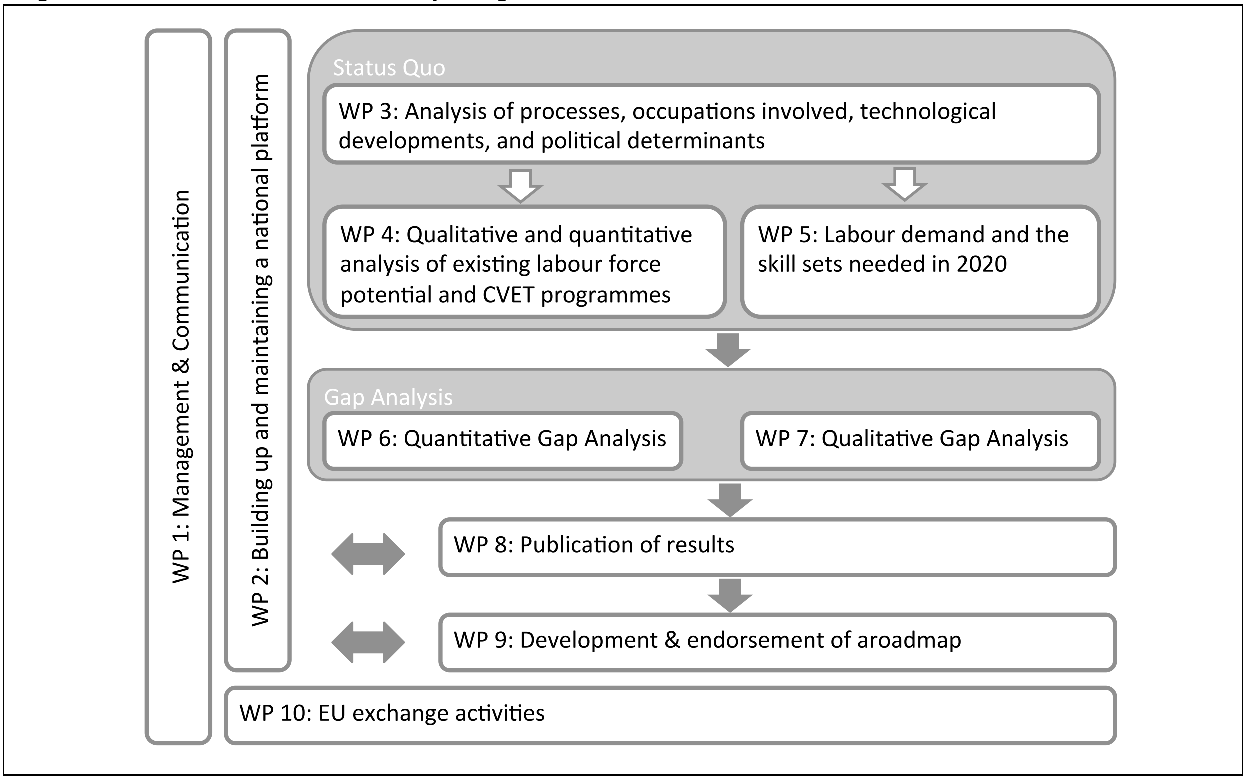
Figure 13: QUALERGY 2020: project organisation



Source: Own presentation.

To conduct the steps listed in Figure 12, the individual areas were subdivided into further steps, forming a comprehensive work programme made up of 10 work packages (WP). Figure 14 provides an overview of the WPs. This is followed by a description of planned implementation path.

Figure 14: QUALERGY 2020: Work packages



Source: Own presentation.

Whereas the horizontal WPs 3 - 10 are for the most part to be executed sequentially, the vertical WPs *Management and Communication* and *Building up and maintaining a national platform* are activities requiring permanent work.

The status quo analyses (WP 3 - 5), whose findings constitute part of this interim report, are not merely the starting point for the **QUALERGY 2020** project, but also a major challenge from a methodological and deadline perspective. The first step (in WP 3) involves selecting the building occupations relevant to the issue at hand. Selection is supported by a category system, which not only provides justification for the occupations selected but also constitutes a template for the subsequent analysis of the content of existing IVET and CVET offerings in the German VET market. On the basis of the technological and (energy) policy developments expected between now and 2020 the changes expected in all selected occupations are defined, with a scenario being developed for future developments to 2020. The next step involves a quantitative and qualitative assessment of the current situation on the VET market (WP 4). Quantification of VET offerings, requesters and providers is done both on the basis of existing statistics and via own surveys. With regard to the qualitative analysis, the apprenticeship frameworks covering each apprenticed occupation in Germany are looked at. WP 5 goes on to determine the number of skilled blue collar workers and their respective skill sets needed for achieving the 20-20-20 targets. This is done on the basis of the scenario previously defined in WP 4.

All findings of the status quo analyses are then used in the gap analyses (WP 6 and 7), where the current situation is compared with the new situation defined via the scenario. The intention of WP 8 is to document the findings of the analyses, not just in the context of the

project itself but also for the planned 9-month roadmap development and endorsement process (WP 9). With reference to the above-mentioned project organisation, the different design possibilities are to be discussed within the Steering Board before being published on the national platform.
Last but not least, WP 10 covers all discussions with other EU Member States and the EU itself, together with the planned peer review activities involving subject matter and methodology discussions between three countries.

The contents of this interim report are limited to the execution and findings of the status quo and gap analyses (mainly WP 3-7). In Chapter 2, the targets stated in Figure 12 are further detailed, and discussed with respect to the planned methodology.

2 Project objectives and methodology to be used

Katrin Rasch, Rolf R. Rehbold, Susanne Rotthege

In this chapter, the execution of the project tasks 1-4[6](cf. Figure 12 and Figure 14) is broken down into concrete steps, with details provided on the methodology used. Information is provided on the way data is collected and assessed, whereby the former includes details on the source of the data and the processes used. The methodology used is also described in the individual chapters.

The establishment of a national platform with the objective of bringing together the relevant stakeholders and interested parties in the fields of energy efficiency and renewable energy

An important role is attached to involving the relevant stakeholders in the field of VET as well as the interested parties in the field of energy efficiency and renewable energy with regard to the roadmap to be developed in the second project phase in consensus with all concerned. Due to the structure of the German VET system and the resulting responsibilities and competence areas, the respective experts and groups are not supposed to be just passive listeners but are instead expected to play an active role in the situational assessment and roadmap development. Discussions between the various stakeholders are therefore encouraged.

Even before the project actually started, such important stakeholders as public institutions (in particular ministries, energy agencies, institutes), VET institutions, the social partners (trade unions and employer associations), the building trade, the building industry, the respective trade chambers (the Chambers of Skilled Crafts (HWK), Chambers of Industry and Commerce (IHK), manufacturers and installation companies in the fields of energy efficiency and renewable energy, architects, (building) energy consultants and funding institutes were contacted and informed about the planned project. The result was that we were able to submit a *Letter of Support* signed by a total of 21 supporting institutions with the project application.[7]

With the project now underway, all platform members are kept regularly informed of the latest developments and assessment results. Alongside the European project website, the German project website www.bauinitative.de plays an important role here. Moreover, three information and discussion meetings are planned with platform members.

[6] As already stated in Chapter 1, this report only documents the results of the status quo and gap analyses. The completion of the fourth objective stated in Figure 1 is part of the second project phase, the findings of which will be included in a further report issued at the end of the project.

[7] At the point in time this interim report was submitted, the list has grown to include 54 platform participants.

Execution of comprehensive quantitative and qualitative analyses of the VET market for the purpose of establishing the skill status of blue collar building workers.

With regard to the methodology used for establishing the current skill status a distinction is made between the quantitative and qualitative analyses. Whereas the quantitative analyses relate to the (skill) situation of skilled blue collar workers and forecasts of how this will develop in the future, the qualitative analyses compare existing skill sets with required ones in IVET and CVET.

Quantitative survey of the IVET and CVET market

As a basis for the quantitative analyses, the consortium experts first used FBH analyses to discuss and determine the relevant occupations in the fields of energy-related refurbishment and the use of renewable energy in the building sector.

Building on this work, the quantitative analysis (the survey of the (skill) situation of skilled blue collar workers in the relevant occupations up to 2020) established a so-called reference scenario[8], in which the current trends were projected as they would occur without any additional investments in energy-related refurbishment and energy efficiency. As a basis for the quantitative analysis, the BIBB, together with the Institute for Employment Research (IAB), the Institute of Economic Structures Research (GWS) and the Fraunhofer Institute for Information Technology (FIT), makes use of three models providing projections on the future supply of and demand for skilled blue collar workers in the selected occupations relevant for the project (cf. BIBB 2010, no page ref.). Based on a comprehensive database containing the findings of microcensuses regularly carried out by the Federal Statistics Agency, the supply of skilled blue collar workers is projected to 2020. In the context of the subsequent gap analysis, this will then be compared with the demand for skilled workers, as established in the quantitative survey on the basis of a specified scenario.[9]

[8] This reference scenario forms the basis for the subsequent comparison with the forecasts of the additional amount of investment needed to achieve the EU 20-20-20 targets.

[9] Being directly accountable to the Federal Government, BIBB is funded directly out of the federal government budget and is subject to the legal supervision of the Federal Ministry of Education and Research (BMBF). BIBB is recognised as a centre of excellence for vocational research and for the progressive development of vocational education and training (VET) in Germany (cf. BIBB homepage). The statistical data collected and evaluated by BIBB are included in the annual VET Report. As the German Federal Employment Agency's research institution, the IAB is similarly a key player in the field of labour (market) research in Germany. The other two members of the QuBe project team are the GWS (in its capacity as an independent economic research and advisory company) and the Frauenhofer FIT.
Further information on the QuBe team can be found on http://www.bibb.de/de/55226.htm.

Qualitative view of the IVET and CVET market

Qualitative surveys are used to gain a systematic overview of skill sets provided either in the context of an apprenticeship in a building trade or through taking part in a CVET programme.

To ensure systematic coverage of both the IVET and CVET markets, a joint skill category matrix is to be developed. This should be sufficiently flexible to allow specific modifications where necessary. As a result of the consortium's meeting during the project application phase and of the discussions with several experts, it can already be stated at this early stage that this skill category matrix will contain categories relating both to typical processes and to the typical fields of work found in the construction of a new building or in the refurbishment of an existing one.

In association with this step and with an initial IVET focus, a skill analysis will then be carried out, using as a data basis the apprenticeship frameworks (cf. Chapter 6) existing for each apprenticed trade and standardised throughout Germany. Mayring's qualitative content analysis method will be used for assessment. This method allows not just the systematic categorisation of different skills, but also the bundling and/or abstraction of certain skill sets where necessary. Following the methodology proposed by Mayring (cf. Mayring 2008, p. 54), the survey is to be conducted as follows:

1. Analysis of all apprenticeship frameworks, and on this basis, the identification of the relevant skills
2. Inclusion of the identified qualifications in the previously defined skill category matrix
3. Further differentiation of the skill category matrix via the bundling of identical/similar activities in a so-called sub-category (skill abstraction).
4. Renewed categorisation of all skills in the new skill category matrix.
5. Verification of the analysis through a further FBH expert
6. Validation of the findings with representatives from the trade associations

Using this skill category matrix as a basis, the CVET market is then looked at. In doing so, account also needs to be taken of the fact that not just apprenticeships but also master craftsman programmes are governed by standardised frameworks covering the whole of Germany.[10] For all further offerings, whether subject to chamber regulations, privately certified or where a certificate of attendance is issued, a broad-based survey is to be carried out to establish the necessary data basis. To do this, a questionnaire is to be developed. In line with the skill category matrix, this will be used to record the skills taught in a specific CVET programme. It will also be used to gather qualitative information, such as attendance

[10] Whereas the skilled craft sector operates with standardised master craftsman examination regulations throughout Germany, the industrial sector has both standardised regulations and regulations issued by individual trade chambers. As the regulations in question are either identical or very similar, trade chamber regulations are also included in the analysis (cf. Chapter 6; Chapter 7.4).

figures, exam documents, programme admittance requirements and programme duration (in hours).

As with the previously described findings, the master craftsman qualification results will also be discussed with representatives from the trade associations. For the second area, telephone interviews with experts are foreseen.

Determination of future labour needs and qualifications required by 2020

In line with the introductory remarks for the second step, a separation is also to be made between the quantitative and qualitative analyses in considering the number of skilled workers and the skills needed by 2020. A further scenario is to be developed as a second basis (alongside the identification of the relevant occupations by the FBH) for the quantitative projection. This scenario will be used to validate the amount of investment needed in the building sector to achieve the EU's 20-20-20 targets from a technical perspective. Despite being assigned to WP 3 (cf. Figure 25) the methodology used by the HPI (with the support of the German Energy Agency) to develop this scenario is briefly discussed here.

Development of a technical-political scenario

Generally speaking, the design of a scenario takes place in two phases: In a first phase the technologies currently used in the fields of energy efficiency and renewable energy are determined and assessed with regard to possible developments up to 2020. In a second phase the refurbishment measures used to achieve the EU's 20-20-20 targets / Germany's more ambitious climate and energy objectives are described from a technological perspective.

The first phase is sub-divided into the four steps described below:

1. Determining the relevant technology areas and fields to be assessed:
   Selection of relevant technology areas in the construction of new buildings/refurbishment of existing buildings (cf. remarks on the qualitative assessment for the second step) and their categorisation into different technology fields
2. Ascertaining possible technologies:
   Within the identified technology areas and fields, all technologies used in the field of building refurbishment are assessed.
3. Assessing technologies:
   Using the criteria of *performance* and *potential* derived from the core question of the first phase (see above), all identified technologies are assessed with regard to their relevance for the scenario.

4. Defining the relevant technologies[11]:
   The results of steps 1-3 are merged together to define a basis for determining the technological-political scenario.

A continuous technology monitoring serves as a basis for this step. 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, are all used to gain important and up-to-date information. In addition the HPI fosters good contacts with the network of "innovation and technology officers" in the skilled craft sector. Last but not least, experts will be surveyed to gain further information important for designing the scenario.

These building blocks, together with further documentation in the form of existing statistics, data, forecasts and available scenarios, are then used for the subsequent definition of the technological-political scenario. Here as well a 3-phase structured methodology is used:

1. Task and problem analysis
2. Influence analysis and definition of the scenario
3. Assessment and interpretation

These methodological considerations clearly show that the development of the scenario constitutes a major challenge for the project team and especially for the HPI, given the plethora of different data sources, differing (expert) opinions and diverging other scenarios. At the end of the day, the hypotheses made and the values subsequently derived from these hypotheses greatly influence the calculations carried out by the QuBe team for the target year 2020.

Quantitative assessment of the number of skilled blue collar workers needed up to 2020.
The so-called IAB-INFORGE model (cf. Chapter 8.1.1 for more details) is used for the quantitative projection on the basis of the previously developed technological-political scenario. This model, based for the most part on data published by the Federal Statistics Agency, is seen as a suitable base for forecasts and scenarios. Assessment is done using scenarios - i.e. two or more alternative scenarios are used as a basis for calculations, with the results subsequently being compared. With regard to the project the forward projection calculated for achieving the second objective is used as the reference scenario, to be compared with the political scenario compiled using the IAB-INFORGE model and based on the defined scenario.

[11] As the term „technology“ in the sense of this project applies not just to technologies (e.g. solar heating, photovoltaics), but also to elements of a building where energy-related refurbishment work can take place (e.g. insulation work on a building’s roof or façade), the term “building work category / subcategory” is used hereinafter.

Qualitative assessment of the skill sets needed up to 2020

Closely linked to the analysis of existing skill sets in IVET and CVET, a process matrix is to be developed describing processes in the value chain related to the relevant technologies / building works areas. These processes are to be interpreted as the skill sets needed to carry out the processes.

Using the existing skill descriptions found in the current apprenticeship frameworks (already incorporating a number of the latest technological developments), a high-level evaluation matrix is compiled, into which the skill sets are to be entered. Following this initial assessment, an analysis of activities (verbs) is conducted for the purpose of defining a cross-occupational matrix for describing the processes. This matrix should initially contain all processes conducted at journeyman level. Ultimately - to cover the whole value chain - those processes for which a master craftsman is responsible need also to be included. To do this, the findings derived from the assessment of the master craftsman examination regulations are combined with the findings described above to form a new matrix. This new matrix is then used as a basis for interviews with experts from the trade associations, thereby achieving the required conceptual breadth and depth. The focus here is on discussing possible enhancements and additions to the overall process and - where deemed necessary - including them.

Execution of a gap analysis for determining possible discrepancies

In this last step as well, the quantitative and qualitative analyses were carried out separately.

Quantitative gap analysis

Through a comparison of the reference and alternative scenarios, both the additional demand for skilled labour in the construction sector and the effects this will have on skilled workers are to be determined. In addition information is provided on training structures available to people working in building occupations.

Qualitative gap analysis

Through comparing the skills recorded in the context of the qualitative analysis with the skill sets needed up to 2020, we are able to first identify potential gaps. These are then looked at in greater detail. Using as a base the career development concept used in the skilled craft sector, which structures a skilled worker's career into different phases, the analysis takes place in two steps: The journeyman level (i.e. the level attained immediately after finishing an apprenticeship) is first looked at, with a comparison being made between existing and required skills. This is done through the use of an evaluation matrix, with gaps being mapped to specific areas.

The analysis is then extended to cover CVET programmes targeting post-apprenticeship career phases. In this step the previously identified skill needs are reviewed, ascertaining whether they can be closed through CVET programmes either upgrading/updating skills or enabling journeymen to attain a master craftsman qualification. Taking into account the way the CVET market in Germany is structured, we look on the one hand at the standardised CVET programmes for gaining a master craftsman qualification, and on the other hand at existing CVET programmes in the fields of renewables and energy efficiency. The latter are categorised as to whether access to them is unrestricted, restricted to journeymen or restricted to master craftsmen (or a comparable level).

Alongside evaluating gaps on the basis of desk research (looking at apprenticeship frameworks and master craftsman examination regulations), further desk research looked at studies on building and quality deficits. In conjunction with discussions with experts, the aim here is to identify possible further skill requirements for people working in the construction sector.

3 Structure, development and macro-economic importance of the building sector in Germany

Peter Weiss

Despite economic and structural ups and downs in the past, the building industry remains an important sector of the German economy, making a major contribution to gross domestic product and being a major employer (cf. Hauptverband der Deutschen Bauindustrie 2011, p. 4). The companies and employees working in this sector provide planning and implementation services in the construction, modernisation and refurbishment of all kinds of buildings. This chapter looks at the structures, development and economic importance of the building sector in Germany.

3.1 How the building industry is structured

The structure of Germany's building industry can be divided into a number of different categories: for example *by sectors* (public works, commercial buildings, housing); by *trades* (construction trades, fitting & finishing trades, ancillary building trades), or by the *type of building work* ("Hochbau", "Tiefbau", installation work). According to the 2008 version of Germany's classification of business sectors, the building trade covers all building activities belonging to the following three sections (cf. Destatis 2007):

- "Hochbau" - This term specific to the German building industry refers to all above-ground building work, i.e. the planning and construction of all buildings which are for the main part above ground (i.e. including their basements)
- "Tiefbau" - The specific German term complementing "Hochbau", "Tiefbau" refers to all infrastructure work done below the ground or at ground level, i.e. tunnels, sewers, roads and railways, etc.
- Work preparing building sites, installation work and other fitting and finishing work

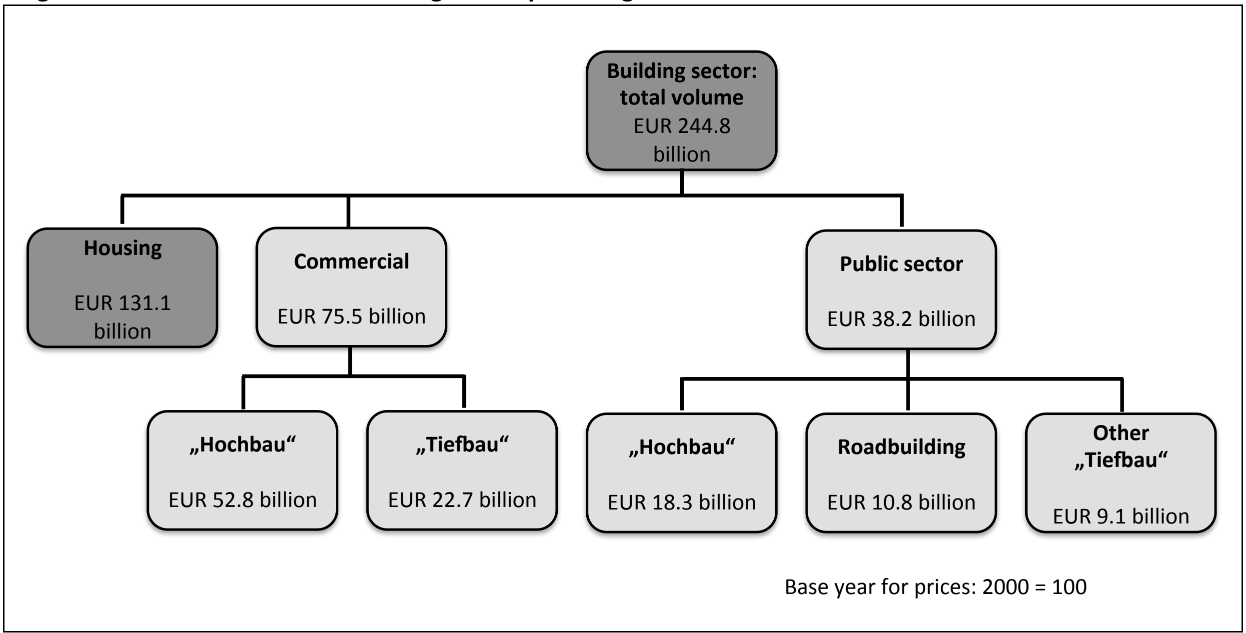
Earlier business sector classifications divided the sector into groups, as in the 1979 classification. Here the building trade was divided into the following groups (cf. for example Statistisches Bundesamt / Destatis 1992):

- *Construction trades (Bauhauptgewerbe)*: This group covered all companies responsible for actual construction work, whether in "Hochbau" or "Tiefbau".
- *Fitting & finishing trades ("Ausbaugewerbe"* or *"Baunebengewerbe")*: This group covered most trades involved in post-construction fitting/finishing work, repairs and maintenance.

In earlier classifications this group was supplemented by *ancillary building trades (Bauhilfsgewerbe),* a group covering preparatory work (e.g. erecting scaffolding). Though this division into groups is now defunct from a statistical perspective, it is still in common use and is to be found in a number of statutory regulations. For example, the government regulation on building companies and their responsibility to provide all-year-round employment (*Baubetriebe-Verordnung*) contains a definition of what constitutes a construction trade. In addition, several official statistics published in Germany differentiate between construction and fitting & finishing trades.

A third categorisation refers to the so-called 'building sectors' (*Bausparten*). Figure 15 shows the 2010 distribution of all building work by building sector.[12] Of the total EUR 244.8 billion of building work, the largest portion (EUR 131.1 billion) was attributable to housing (53.6%), followed by EUR 75.5 billion for commercial buildings (30.8%) and EUR 38.2 billion for public works (15.6%). The 2 latter building sectors are themselves subdivided into "Hochbau", "Tiefbau" (and road-building as a separate sub-division of public works).

Figure 15: Total amount of building work by building sector



Source: BBSR (2011).

Alongside such work-related categorisations of the German building industry, a further categorisation involves the type of company performing the work. Though the German building industry has quite a few medium-sized and large building companies, most of which are members of a Chamber of Industry and Commerce, the majority of companies are SMEs in the skilled craft sector and, as such, registered with a Chamber of Skilled Crafts.

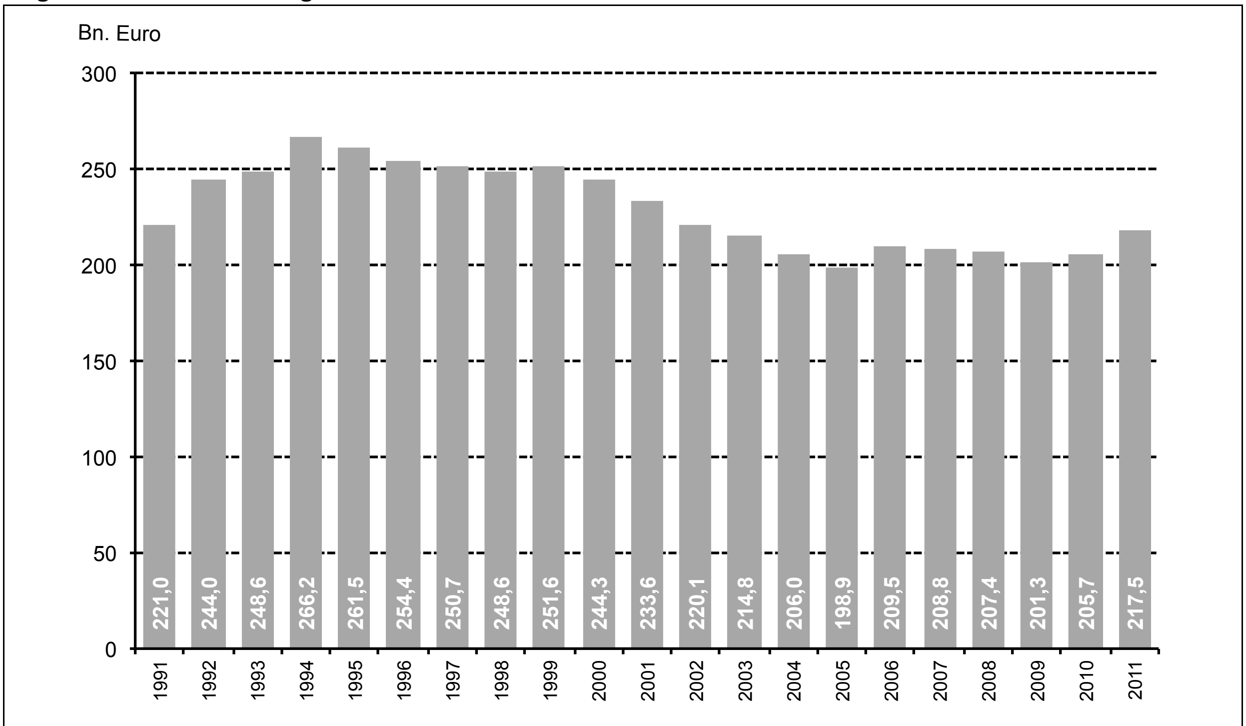
[12] The total amount of building work is higher than the total amount of building investment (described below), as the former amount is defined as the sum of all work performed for the purpose of constructing or maintaining buildings. According to the Federal Ministry of Transport, Building and Urban Development (BMVBS 2011, p. 6), the total exceeds the building investment figure calculated by the Federal Statistical Office, as the latter does not take into account consumptive (non-value-adding) building work such as normal repairs.

3.2 Industry development since 1991

Over the last two decades the German building industry has been through major adaptation, following the boom it experienced in the early 1990's, when German reunification saw the industry exploding to an extent only comparable with Germany's post-war reconstruction period. Following the 3 October 1990 reunification, the ex-GDR's infrastructure had to be quickly and comprehensively modernised, the neglected building stock in the inner cities refurbished, and private homes modernised or built from scratch. Both the building industry itself and the numerous skilled craft companies associated with this work thus made a major contribution to East German reconstruction, helping to upgrade living conditions to West German standards.

At the same time, reunification led to a strong demand surge in the building industry, characterised by double-figure increases in building investment in the 1990 - 1994 period, at the end of which the investment level reached EUR 266.2 billion (see Figure 16). This major surge in turnover went hand in hand with a major increase in employment levels. In 1995 the building industry was employing some 3.38 million workers, 427,000 more than in 1991 (cf. Destatis 2012b, p. 68).

Figure 16: Real building investment 1991-2011

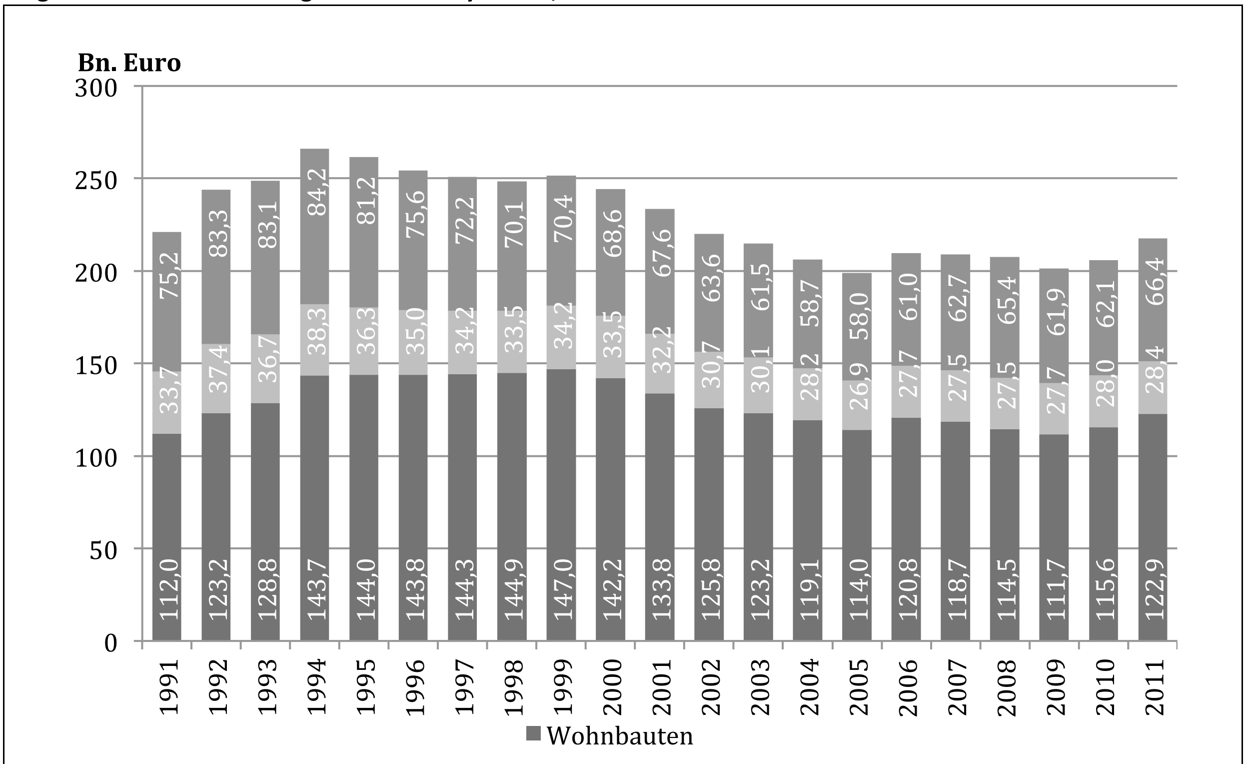


Source: Destatis (2012a), own calculations.

After just a few years in which an enormous amount of effort was put into carrying out the most urgent modernisation and refurbishment projects, the first signs of market saturation started appearing, with the market going into decline from 1995 onwards. Apart from a short-lived upturn in 1999, demand for building services decreased steadily for the next ten years, with overall building investment sinking by EUR 67.7 billion in real terms (25.4%) by 2005, the worst year (see Figure 16). This also had a major impact on employment levels in the industry, with the number of building workers dropping by 1.034 million from its reunification peak in 1995 to 2.324 million in 2006.

Sinking demand hit all sectors of the building market, though the two sectors worst hit were the housing and commercial sectors (see Figure 17). The drop in demand in the new construction field meant that the amount of real investment in new homes in 2005 ended up EUR 30 billion below the 1995 figure. Turning to the commercial sector with its overall lower volume, by 2005 demand here was EUR 26.2 billion lower than its 1994 peak. Even in the public works sector the peak levels of the early to mid-1990's remained far from being repeated in the following years. As a result of these declining investment levels, many bodies are now pointing to a refurbishment backlog in this sector.

Figure 17: Real building investment by sector, 1991 - 2011



Source: Destatis (2012a), own calculations.

As a result of this drop in demand, the building trade went through a steady restructuring process between 1995 and 2005, with building companies forced to adapt their capacities to the lower demand. Employment levels dropped sharply, with those remaining employed becoming much more productive. By 2011, the output of each person working in the building industry had increased by 19.5% in real terms compared to 1991.[13]

[13] Whereas average output per worker in 1991 was equivalent to EUR 74,941, this figure had increased to 89,580 by 2011 (own calculations).

2006 saw the 10-year downturn come to an end, with overall building investment rising sharply for the first time since 1994, even if at a much lower level. There were two reasons for this upturn. Firstly a major boost was provided by energy-related building refurbishment measures. As a result of a sharp rise in energy prices, more people started investing in energy-saving measures, supported by very low-interest loans offered in the context of the KfW building refurbishment programme. Secondly, the 3-point VAT increase announced for 1.1.2007 boosted demand in 2006, with people wanting to get their building projects completed at the lower VAT rate. This incipient recovery was however interrupted in 2008 by the world economic crisis, with investment levels in both the housing and commercial sector again on the downturn.

2010 however saw the crisis ending in Germany, with swift recovery and growth returning to the industry. And it was not just companies which, in the face of the country's good economic development and an improved market outlook, started investing in maintaining and extending their commercial premises. It was also the housing sector, which after years of downturn, finally picked up again and started growing fast. Against the background of the euro crisis, people are tending to invest their money in long-term assets instead of dubious short-term financial products, thereby favouring investments in new buildings and the refurbishment of existing ones. Historically low mortgage rates, the positive situation on the German labour market and rising incomes are providing a further boost to property investment in Germany (cf. ZDH 2012, p. 7).

Looking at the market in the spring of 2012, there is no sign as yet of this recovery in the building industry coming to an end in the near future, with the early economic indicators pointing - at least for 2012 - to growth continuing at a high rate. Taking into account the continuing uncertainty on international financial markets, the resulting trend towards property investment and the major energy-related modernisation backlog in Germany's existing building stock, the outlook is good for a "renaissance" in Germany's building industry.

3.3 The importance of the building industry

Despite the sharp downturn in real building sector investment in Germany since 1994, the building industry remains one of Germany's most important economic sectors. In 2011 for instance, 8.9% of GDP was attributable to the building industry. The sector is also a major added-value contributor: "Between 1991 and 2010, the German building industry's annual contribution to the economy's gross value added (GVA) averaged 5.1%" (Hauptverband der Deutschen Bauindustrie 2011, S. 6). Moreover, in 2011 the building industry was responsible for employing 6% of the total German workforce. This all means that the building industry and the skilled craft companies associated with it not only make a major contribution to local training and employment. With the services they provide, they often create the preconditions for economic growth. And with their know-how they are also often responsible for laying the foundations for greater sustainability and energy efficiency.

4 National policies and strategies to contribute to the EU 2020 energy targets in buildings

4.1 National policies and strategies for implementing Germany's energy efficiency objectives for buildings

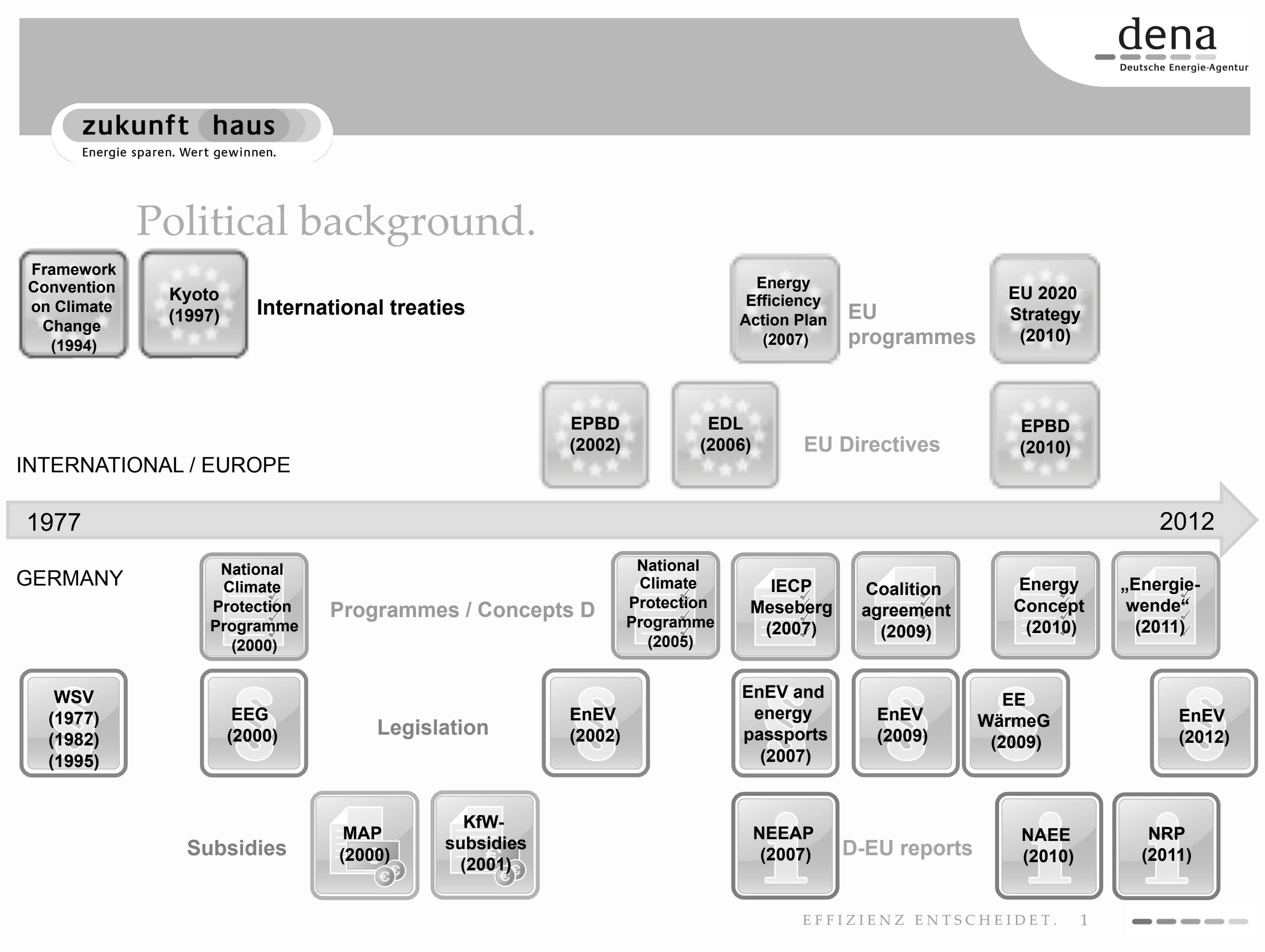
Katharina Bensmann, Henning Discher

4.1.1 Introduction

Germany is a front-runner nation with regard to climate protection, whereby energy saving and energy generation have in the past not just played an ecological role but also an economic one. Ever since the first building insulation regulation 35 years ago, Germany has been laying down requirements for the energy efficiency of buildings. The first national CO2 reduction target was set in 1995, requiring that CO2 emissions drop by 25% by 2005 against 1990 levels (BMWi 2012). Since then, regulatory requirements have been continually tightened. Nevertheless, 35-40% of Germany's final energy consumption remains attributable to buildings (Fraunhofer Institut 2011), meaning that there is still enormous potential for saving energy. This is the reason why the building sector has a dominant role to play in achieving the energy targets.

In setting its concrete energy saving targets in this field, Germany follows the direction of the EU strategies, trying wherever possible to go further than the national targets set therein. Figure 18 gives an overview of the strategies and guidelines adopted by the EU, together with the German programmes, legislation and support (in the order of their adoption).

Figure 18: European and national programmes for achieving energy saving targets



4.1.2 German climate protection strategies and programmes

The German Federal Government is constantly developing its overall strategies and concrete programmes for climate protection, with a particular focus on buildings. The resultant measures are for the most part based on three pillars: regulatory policy, state subsidies and market instruments (cf. Chapter 4.1.3). In addition, Germany's 16 Federal States (*Bundesländer*) are also active, designing their own programmes at their level. These are not explicitly looked at in this study.

4.1.2.1 National Climate Protection Programme 2000 and its 2005 update

Against the background of the United Nations Framework Convention on Climate Change (UNFCCC), which came into force in 1994, and the Kyoto Protocol ratified in 1997, Germany adopted its own National Climate Protection Programme in 2000 (BMU 2000). The main objectives of this programme are to reduce GHG emissions and to increase the share of renewables. The list of measures adopted to reduce GHG emissions includes: the adoption of the new Energy Saving Regulation (*Energieeinsparverordnung* or EnEV for short) (cf. Chapter 4.1.3.1.2), improved state-aid programmes for reducing CO2 emissions (cf. Chapter 4.1.3.2.1) and a boost to public relations and advisory services. At the same time the Federal Government introduced the Renewable Energy Act (*Erneuerbare Energien-Gesetz* or EEG for short), the successor of the 1991 Electricity Feed-In Act (*Stromeinspeisegesetz* or StrEG) (cf. Chapter 4.1.3.1.3).
2005 saw the programme subject to a review and a subsequent update (BMU 2005). Alongside the extension of the above-mentioned measures, the update includes the introduction of a "building energy passport" (*Energieausweis*) (cf. Chapter 4.1.3.3.1), the solar and biomass market incentive programmes, local advisory services (cf. Chapter 4.1.3.2.3) and a CVET and quality offensive targeting investors, planners and skilled craftsmen.

4.1.2.2 Integrated Energy and Climate Programme (IECP) 2007

With its 2007 Integrated Energy and Climate Programme (IECP) (BM / BMWi 2007) and the adoption of a concrete set of measures, the German Federal Government transposed the European EU Action Plan for Energy Efficiency (2007-12) (EU 2008). The IECP contains 29 measures aimed at achieving greater energy efficiency and generating more renewable energy (BMWi 2007a).
The programme and the associated implementation resolutions define a climate protection roadmap to 2020. The targets are: to reduce German GHG emissions by 40% (using 1990 as the base year) as Germany's contribution to the global reduction of GHG emissions (BMU 2009); to increase the share of renewables in electricity generation from the current 16% to 30%; to increase the share of renewables in heat generation from the current 9.5% to 14% (Umweltbundesamt 2011); and the development of biofuels without endangering eco-systems and food supplies (BMU 2009).

Concrete measures with regard to buildings were included in the 2009 revised version of the Energy Saving Regulation (EnEV 2009). Key elements are the 30% tightening of energy efficiency requirements for buildings, and enhancements to EnEV enforcement, with chimney sweeps being co-opted as enforcement agents and through the introduction of "specialist company declarations" (*Fachunternehmererklärungen*) Via such declarations, skilled craftsmen declare that the work performed by them complies with recognised technical provisions and EnEV requirements (cf.Chapter 4.1.3.3.1). Moreover, the building refurbishment support programmes were stepped up. In the field of renewables, the Heating with Renewable Energy Act (*Erneuerbare-Energien-Wärmegesetz* or EEWärmeG for short) was enacted and the Renewable Energy Act (EEG) revised. Last but not least, a further target in the context of the sustainability strategy has the aim of doubling energy productivity (compared with 1990) by 2020 (BMU 2009).

4.1.2.3 Germany's National Energy Efficiency Action Plan (NEEAP) (September 2007 and July 2011)

Documenting the national efforts to transpose the EU's 2006 Directive on energy end-use efficiency and energy services (2006/32/EC, EDL Directive) (EU 2006), the Federal Government presented its first NEEAP in 2007 (BMWi 2007b). Through this Directive, EU Member States undertake to reduce their final inland energy consumption by 9% over a period of 9 years (up to 2016), with the annual average final energy consumption of 9319 petajoule (PJ) for the period 2001 - 2005 being used as a base. The energy saving target (the 9% objective) for Germany is 748 PJ by 2016. Three national energy efficiency action plans (EEAPs) are to be submitted to the European Commission (in 2007, 2011 and 2014), detailing which strategies and measures are being implemented to achieve the prescribed energy savings.
In its evaluation of the measures taken to reach the 2010 interim target of 456 PJ, the Federal Government ascertained that Germany was already over-fulfilling the interim target. The evaluation results and a presentation of the current ca. 100 instruments and measures are to be found in the 2011 NEEAP. Individual measures include the tightening of energy requirements for buildings, the CO2 building refurbishment programme (cf. Chapter 4.1.3.2.1) and increased research into ways of improving energy efficiency. Preliminary calculations show that the target set for 2016 will also be over-fulfilled (BMWi 2011).

4.1.2.3.1 Germany's National Renewable Energy Action Plan (NREAP)

The National Renewable Energy Action Plan details the German contribution to achieving the EU target of covering 20% of its energy needs through renewables by 2020. The Action Plan is based on EU Directive 2009/28/EC on the promotion of the use of energy from renewable sources (EU 2009). At the same time, the Action Plan is an important document of the Federal Government, alongside its 2010 Energy Concept (cf. Chapter 4.1.2.4), for the national promotion of renewable energy. In it, existing and planned measures, instruments and policies for achieving the EU's targets are described. The key elements for increasing the supply of renewable energy, including the Renewable Energy Act (EEG), the Market Incentive Programme (MAP), the Heating with Renewable Energy Act (EEWärmeG), the KfW support programmes and the Energy Saving Regulation (EnEV), have already been introduced. For the most part they have also already undergone initial evaluation and been correspondingly revised. These instruments have already helped in greatly increasing the share of renewable energy. A major focus is put on the use of renewable energy in buildings. Work is currently underway on reviewing the rental situation and whether investment costs can be proportionally covered by rent increases. This would greatly boost the use of renewable energy (BMU 2010).

4.1.2.4 The Federal Government's 2010 Energy Concept and the 2011 "Energiewende" (Transformation of the Energy Sytem)

In 2010 the Federal Government formulated a long-term strategy based on climate and energy targets reaching up to 2050. The 2010 Energy Concept covers nine fields of action, one of which focuses on "energy upgrades for buildings and energy-efficient new buildings". The Federal Government's target for 2050 is to have a building stock which is almost climate-neutral. To achieve this target, the heating requirement is to be reduced by 20% by 2020, with primary energy demand dropping by an order of magnitude of 80% by 2050. The annual refurbishment rate is to be stepped up from 1% to 2% by 2020. The comprehensive package of measures includes a wide-ranging building modernisation offensive. To establish a long-term refurbishment strategy with reliable framework conditions, the Energy Concept foresees the compilation of a refurbishment roadmap for Germany's total building stock covering the period 2020-2050 (BMWi / BMU 2010).

The Fukushima nuclear meltdown in March 2011 led to a reassessment of the role played by nuclear energy in the 2010 Energy Concept, with the result that Germany's seven oldest nuclear power stations and one additional one were permanently shut down. It was also decided that the remaining nine nuclear power stations would be progressively phased out, the last one in 2022. This "*Energiewende*", the transformation of Germany’s energy system, has wide-reaching consequences, especially in the area of energy supply. Alongside the measures needed to compensate for the no longer available nuclear energy, the requirement to upgrade the grid and ensure grid stability, the *Energiewende* means that the speed needed to achieve the targets set in Germany's climate policy needs to be stepped up. These consequences led to a wide-ranging package of new legislative measures being adopted in the summer of 2011 The so-called Energy Package contains seven acts and one regulation, including a revision of the Renewable Energy Act (EEG), the Energy Industry Act (*Energiewirtschaftsgesetz* or EnWGÄndG for short) and the Act establishing an "Energy and Climate Fund" (*Gesetz zur Errichtung eines Sondervermögens „Energie- und Klimafonds“* or EKFG-ÄndG for short), a new act on fiscal support for energy-related housing refurbishment measures and a new act for an accelerated upgrade of Germany's power grid (NABEG) (BMWi 2011a).

In February 2012 the two responsible ministries, the Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) and the Ministry of Economics and Technology (BMWI), took initial stock of the resolutions for transforming Germany's energy system, presenting an outlook and important milestones. Given that energy efficiency standards for buildings are to be ambitiously increased, the following milestones are defined: increased financial support for energy-related refurbishment measures (cf. Chapter 4.1.3.2.1), the revision of the EnEV (cf. Chapter 4.1.3.1.2) and the compilation of the above-mentioned refurbishment roadmap in the form of a long-term refurbishment concept. The intention of the refurbishment roadmap is to chart the path towards reducing primary energy needs by 80% by 2050 and to act as a guideline for home-owners and investors (German Federal Government 2012).

4.1.2.5 National Reform Programme 2011

Parallel to the 2010 Energy Concept, the National Reform Programme (BMWi 2011b) serves as a strategic instrument for the European Member States. National Reform Programmes are key reporting instruments in the context of the so-called Europe 2020 strategy, and are used by Member States for presenting their national contributions towards achieving the European growth and employment objectives.
In the German report, the national policy measures taken to translate the objectives formulated at EU level are described.

4.1.3 Key instruments for increasing energy efficiency and the share of renewables

As a way of achieving a long-term improvement in the energy efficiency of buildings and their use of renewables, statutory provisions and reliable support measures for energy-efficient construction forms are essential. Also needed in the fight to step up the refurbishment rate are suitable instruments for removing the specific market constraints that currently exist.

4.1.3.1 Regulatory policy

A regulatory policy specifically targeting energy efficiency and the use of renewables provides reliable framework conditions for the market. Over the last few years, a number of new laws have been adopted. Laws already in existence are being constantly evaluated and revised to take into account the latest requirement and circumstances.

4.1.3.1.1 Energy Saving Act / Energieeinsparungsgesetz (EnEG)

The “Act on Saving Energy in Buildings” (EnEG) was initially adopted in 1977 in reaction to the oil crisis and rising energy prices in the mid-1970's. The Act authorises the Federal Government to issue government regulations aimed at reducing the energy consumption of buildings, with a focus on insulating outside walls and installing energy-efficient heating systems. The new Act acted as a base for the first Building Insulation Regulation

(*Wärmeschutzverordnung* or WSchVO), which came into force in the same year. In 2002 it was replaced by the Energy Saving Regulation (*Energieeinsparverordnung* or EnEV) The first version of the EU Directive on the energy performance of buildings (EBPD) (EU 2010) came into force in 2002, establishing for the first time an EU-wide regulatory framework for improving the energy efficiency of buildings. In Germany, this Directive was transposed via the revised Energy Saving Act (EnEG 2005) (German Federal Government 1976) and the revised EnEV (EnEV 2007) based thereon (cf. Chapter 4.1.3.1.2).

4.1.3.1.2 Energy Saving Regulation / Energieeinsparverordnung (EnEV)

The first EnEV came into force in February 2002. In it, structural and technical requirements for existing and new buildings were for the first time jointly defined. The EnEV replaced the Building Insulation Regulation (cf. Chapter 4.1.1) and the Heating System Regulation with its specific requirements for heating systems. The 2007 revision of the EnEV saw the additional EPBD requirements being included, a minor tightening of energy efficiency requirements and the recast of several aspects, including the introduction of the Building Energy Passport (*Energieausweis*).
The latest revision of the EnEV in 2009 (German Federal Government 2009) saw the energy efficiency requirements for buildings being tightened by 30% on average vis-à-vis the EnEV 2007. In addition, the owners of buildings were obliged to replace old boilers and to insulate pipes and roofs. The government is currently working on a further revision of the EnEV. The focus here is to transpose the contents of the 2010 EU Directive of the energy performance of buildings (EPBD) into national legislation and to give the targets set forth in the Federal Government's 2010 Energy Concept a statutory footing. One area needing major amendment as a result of the EBPD is the energy passport. To boost its effectiveness, energy efficiency performance indicators are to be included in property sale / rental documents. In addition a random inspection system for energy passports and inspection reports for air-conditioning systems are to be introduced. A further important point contained in the EPBD is the introduction of nearly-zero-energy standards for new homes built from 2019 (2021) onwards. This standard is however not yet defined in all Member States. In Germany, a number of pilot projects are currently underway in this area.

4.1.3.1.3 Renewable Energy Act / Erneuerbare-Energien-Gesetz (EEG)

The EEG came into force on 1 April 2000, replacing the Electricity Feed-In Act (*Stromeinspeisegesetz* or StrEG). Since then, it has been revised a number of times. It constitutes the core instrument for promoting the use of renewable energy sources in generating electricity. Its provisions ensure that home-owners generating renewable energy are given priority feed-in access to the national grid. The EEG provides for a set KW/h reimbursement rate for renewable electricity, guaranteed for 20 years. The rate is dependent on the technology used and the geographical location of the generation facilities. The 2009 amendment to the EEG included the introduction of a sliding-scale reimbursement scheme for photovoltaic (PV) systems (§ 20 Abs. 2a EEG), with the guaranteed reimbursement being reduced in proportion to the increase in the number of PV systems. In doing so, the legislator is preventing electricity costs rising too sharply (German Federal Government 2012).

The EEG (and the previous StrEG) have played a major role in the steady increase of the share of renewables in electricity generation. 2011 saw a sharp increase in the demand for PV systems, with the result that 20% of electricity generation in the second half of 2011 was covered by renewables. Market observers see the reasons behind this increase in the sharp rise in electricity prices and the falling price of PV systems. Reimbursement levels have just recently been further reduced: "Taking the sharp increase in the installed capacity over the last two years into account, the purpose of the latest reimbursement rate adjustment is to keep the current EEG reallocation charge for electricity customers at a stable level and to maintain the high level of acceptance of the population for photovoltaic and renewable energy sources in general. The objective is for photovoltaic systems to become profitable within the next few years, without needing any further subsidies" (BMWi Philipp Rösler / BMU Norbert Röttgen 2012). The contribution made by renewables to reducing Germany's CO_2 emissions was equivalent to 120 million tonnes of CO_2 in 2010 (BMU 2011a).

4.1.3.1.4 Heating with Renewable Energy Act / Erneuerbare-Energien-Wärmegesetz (EEWärmeG)

As of the beginning of 2009, the EEWärmeG introduced the obligation for renewable energy to be used for heating new houses throughout Germany. All buildings (whether residential or non-residential) constructed from 2009 onwards need to have a certain proportion of their heating requirements covered by renewable energy, for instance biomass, solar energy or heat pumps). The amended EEWärmeG came into force on 1 May 2011, introducing the requirement that public buildings were to play an exemplary role in the use of renewables. For instance, when existing public buildings are subjected to "major refurbishment" (German Federal Government 2008), a certain percentage of heating requirements are to be covered by renewables.

The next amendment to the EEWärmeG is planned for 2013. The government is currently working on an EEWärmeG progress report, which will contain recommendations for the planned amendment.

4.1.3.2 State subsidies

State subsidies for energy-efficient buildings are a core aspect of the Federal Government's Energy Concept. Alongside the currently available subsidies, the tax deduction of energy-efficient measures is under discussion.

4.1.3.2.1 KfW CO2 Building Refurbishment Programme

2001 saw the introduction of the CO2 Building Refurbishment Programme as part of the National Climate Protection Programme. Its goal is a significant reduction in the CO2 emissions of buildings (BMVBS 2012a). To achieve this reduction, Germany's main bank for providing subsidies, the KfW, is subsidising building measures aimed at improving energy efficiency and helping protect the climate. Energy-efficiency refurbishment and the construction of new energy-efficient buildings are subsidised. The higher a building's energy efficiency classification, the higher the subsidy is. The subsidy can take the form either of a low-interest loan or a non-repayable grant. The positive effects of the programme on energy efficiency and reducing CO2 emissions were proved in a wide-ranging impact assessment (Bremer Energie Institut 2011). As a consequence, the annual amount available for subsidies in the context of the energy package (cf. Chapter 4.1.2.4) was increased to EUR 1.5 billion in early 2012 and will remain at this level until 2014.

4.1.3.2.2 Market Incentive Programme

The Market Incentive Programme (MAP) introduced in 2000 is the Federal Government's core instrument for promoting the use of renewables in heating (BMU 2011b). With this programme, the government supports home-owners wanting to use renewables in their homes. Subsidies for the installation or extension of biomass systems, solar-powered heating systems and heat pumps are provided in the form either of an investment grant (via the Federal Office of Economics and Export Control (BAFA) or as a loan with a repayment grant from the KfW.

4.1.3.2.3 Promoting advisory services

Property owners, tenants or lease-holders are given the opportunity of taking advantage of a BAFA-sponsored on-site advisory visit by an energy efficiency expert. This is intended as a first step in a refurbishment project. The expert has the task of identifying a house's weak points - either in the building's envelope or in its heating / building management system - and of providing tips on remedial measures. The application for a subsidy is submitted by the expert. The BAFA grant is then deducted from the amount the expert invoices the home-owner with (BAFA 2012). An initial advisory session can also be conducted by an energy expert from a consumer advice centre. These are similarly sponsored by the BMWI and conducted against payment of a small fee (vzb 2012).

4.1.3.3 Market instruments

There is a whole range of market instruments available in Germany. As with the regulatory provisions and subsidy policy, these are intended as a contribution towards achieving the energy and climate policy targets. Their purpose is to spotlight the subject of energy efficiency in the market, to firmly anchor it in the building and skilled craft sectors, and to help remove existing obstacles. A selection of measures is presented below.

4.1.3.3.1 Energy Passport

The energy passport is an important element of the EnEV (cf. Chapter 4.1.3.1.2). In it, a building's energy performance is documented in facts and figures and depicted on a colour scale ranging from green to red. A major element of any energy passport are the modernisation recommendations for reducing a building's energy consumption. The energy passport is seen as a way of introducing greater transparency into the property market and of providing an incentive for home-owners to invest in improving the energy efficiency of their property. At the same time the passport also targets tenants, allowing them to assess the energy-related quality of a house or apartment and thereby to make a rough estimate of heating costs. There are two different types of energy passport: passports issued on the basis of estimated energy needs and passports issued on the basis of a building's recorded energy consumption. The former involves the building being inspected with regard to its energy efficiency quality, on the basis of which theoretical consumption is then estimated. The latter involves recording actual consumption. Dependent on the type of building, these two ways have different consequences. Estimated consumption can for instance be higher than actual consumption. On the other hand, actual consumption is dependent on user behaviour. This in turn can have a negative effect on any statement on a house's energy efficiency quality. The Federal Government has opted to allow both kinds of energy passport.

4.1.3.3.2 Information and motivation: national information programmes

Information campaigns, consumer brochures and guidelines play an important role in Germany's implementation strategy, and the offerings are tailored to the different knowledge levels and needs of the respective target groups. Whereas the information campaign for the KfW's CO2 Building Refurbishment Programme or the German Energy Agency's "future house / zukunft-haus" campaign target the population as a whole, a large number of publications and advisory service offerings are specifically tailored for experts, going into the details of such topics as energy contracting.

4.1.3.3.3 Market transparency and quality assurance: further instruments

As a way of creating market transparency, Germany uses a wide range of instruments, a number of which are presented below.

Written specialist company declarations were introduced as part of the EnEV 2009 as a way of assuring quality on the building site. In the declaration, the company performing the work guarantees that the equipment installed or upgraded complies with EnEV requirements.

With the quality of issued energy passports varying greatly, the German Energy Agency (dena) has introduced a quality seal for energy passports. As a reliable quality assurance instrument, an energy passport with dena quality seal contains not just a high-quality assessment of a building's energy consumption, but also a whole range of valuable additional information (cf. Chapter 4.1.3.3.1).

Dena also runs an expert database, allowing consumers to find suitable architects, construction engineers or skilled craftsmen operating locally. The experts listed here are checked by dena with regard to their qualifications. Search parameters available to consumers looking for an expert include distance, specific qualifications or services. The expert database is also linked up to dena's "energy-efficient house" database, giving experts the opportunity of presenting reference buildings, in whose construction or refurbishment they were involved.

At the same time, dena is also responsible for a new list of experts (introduced in 2011) for federal subsidy programmes (German Federal Government 2012), in which experts can have themselves registered as advisors for the BAFA's on-site advice programme, as well as planners and site managers for KfW energy efficient houses (categories 40 and 55). A listing in the register of energy efficiency experts for federal subsidy programmes is currently done on a voluntary basis (cf. Chapter 4.1.3.3.5).

In addition the Federal Agency for Energy Efficiency (*Bundesstelle für Energieeffizienz* or BfEE for short) has set up a list of providers of energy services, energy audits and energy efficiency measures (BfEE 2012).

4.1.3.3.4 Research / pilot projects

To tap the enormous potential for improving the energy efficiency of buildings, innovation is essential for the markets. There are numerous examples of past and current research projects in Germany, a few of which are presented below:

Complementing the 2010 Energy Concept, the Federal Government's "Research programme for an environmentally sound, reliable and affordable energy supply" focuses on promoting energy-related R&D, with the programme covering the fields of energy efficiency, renewable energy, energy storage and grids. Two of its main objectives are to improve cooperation between business, academia and politics in the research and development of innovative energy technologies, and to further develop international research work (BMWi 2011c).

The Federal Government's research initiative "Zukunft Bau / Future Construction" focuses on researching energy efficiency and the use of renewable energy in buildings, developing new concepts and prototypes for energy saving construction, further developing new materials and construction techniques, and fostering sustainable construction. In the context of the research programme, innovative concepts are developed, transferred to the business world and there brought to market (BMVBS 2012b).

Dena's pilot programme "*Auf dem Weg zum EffizienzhausPlus* / On the way towards the zero-energy house" is using selected pilot projects to show ways of refurbishing houses to achieve a high level of energy efficiency. The buildings in question over-fulfil the energy efficiency requirements set by the EnEV for comparable buildings by on average 50%, making them into transferable and economically viable best practice examples. One of the aims of the pilot programme is to further develop such policy instruments as the EnEV and KfW subsidy rules (dena 2011)

4.1.3.3.5 Upgrading skills

One of the first and most important steps when planning the refurbishment of an existing building or the construction of a new one is to engage the services of skilled specialists.

The introduction of the EnEV 2007 meant that those issuing energy passports had to have a qualification complying with §21 EnEV. However as yet there is neither an official authorisation procedure nor an official list of people entitled to issue such passports. As a way of improving the quality of on-site advisory sessions (cf. BAFA 2012) and the planning and site management services required by the KfW when building / refurbishing ultra-low-energy houses, a CVET catalogue for federal subsidy programmes was established in 2011 in conjunction with the compilation of the register of energy efficiency experts (cf. Chapter 4.1.3.3.3). Standardised skill criteria, proof of regular CVET course attendance and random inspections of results are seen as a way of assuring quality and providing a guarantee that the experts listed have the necessary state-of-the-art skills.

Alongside the statutory requirements, there are several regional networks and energy agencies, chambers and associations offering their members information via their websites, in newsletters and in specific CVET courses.

4.2 IVET and CVET strategies

Jorg-Günther Grunwald

Upgrading skills for the energy-related refurbishment of buildings or the installation of renewable energy systems is taking place in Germany within the bounds of the existing VET system. A special strategy specifically targeting this field is – at least today – not (yet) seen as necessary, as both the Federal Government and the social partners and trade associations are unanimous in their opinion that the current IVET and CVET set-up in Germany is so flexible that changes in technical, social and working standards can be accommodated as required, enabling the right amount of skilled blue collar workers to be available at the right time (BMBF 2007).

4.2.1 Systemic principles

VET in Germany is based on the Vocational Training Act (*Berufsbildungsgesetz* or BBiG), recast in 2005. The BBiG distinguishes between pre-VET education (*Berufsausbildungs-vorbereitung*), initial vocational and educational training (*Berufsausbildung* - hereinafter referred to as IVET), continuing vocational and educational training (*berufliche Fortbildung* - hereinafter referred to as CVET) and occupational retraining (*berufliche Umschulung*). With respect to the concrete energy policy issues this report focuses on, the following discussion focuses mainly on IVET and CVET. At this stage it is worth pointing out that there is a further code applying specifically to the skilled crafts sector - the "Skilled Crafts Code" (*Handwerksordnung* or HwO for short). This basically repeats the main VET principles of the BBiG, often with identical wording.

IVET has the objective of teaching the occupational skills, knowledge and capabilities needed for the exercise of a skilled occupation. It is conducted within a regulated VET system and enables participants to gain the necessary professional experience (§1.3 BBiG). The Federal Government issues official "apprenticeship frameworks" (*Ausbildungsordnungen*) for officially recognised apprenticed occupations (*Ausbildungsberufe*), in which the minimum requirements for exercising the occupation are specified. The actual training takes place mainly in the framework of what is called the "dual system" (hereinafter referred to as the “apprenticeship system”), an apprenticeship combining theoretical training in a VET college and on-the-job training and practice in a company (see Chapter 6.2). The fact that the initiative for creating new apprenticed occupations or modernising existing ones always comes from industry can be seen as a guarantee that the IVET regulations and requirements always reflect current needs, thereby ensuring a steady supply of skilled labour to the companies. When a company is not in a position to offer adequate on-the-job training itself, parts of the training can take place (in accordance with §5 BBiG / §26 HwO) in suitable institutions outside the company providing the apprenticeship. These institutions are referred to as inter-company VET institutions (*überbetriebliche Ausbildungsstätten* or ÜBA or, in the skilled crafts sector, inter-company apprentice instruction (*überbetriebliche Lehrlingsunterweisung* or ÜLU) (cf. Chapter 7.5.1.3).

CVET has the objective of maintaining and updating the skills acquired in the initial (IVET) training (skill update training or *Anpassungsfortbildung*) or to expand existing skill sets and help participants move up the career ladder (*Aufstiegsfortbildung* or career training). Here as well, the regulatory initiative lies with industry, whereby the legislator distinguishes between two forms of statutory frameworks: on the one hand there are the CVET programmes regulated at Federal level. These apply to the whole of Germany and are issued in the form of government decrees (*Rechtsverordnungen*) by the Federal ministry responsible. On the other hand there are CVET programmes subject to regional legislation. Insofar as the Federal Government makes no use of its legislative prerogative, these are regulated by the responsible chambers - for the most part by the Chambers of Industry and Commerce, and by the Skilled Craft Chambers (cf. Chapter 4.2.5.3.2). The latter set-up is especially suited for providing relatively quick answers to emerging CVET requirements in the region concerned.

In addition to the CVET opportunities available within these statutory frameworks, there is also a whole range of non-regulated CVET offers available on the market. These are offered by various training providers or by manufacturers giving specific training courses for their own products. These opportunities are generally very effective in upgrading skills needed for working with new and innovatory technologies, and are often precursors to official (and thus non-proprietary) CVET measures within the regulatory frameworks.

Germany's VET system with the apprenticeship system as its main pillar is enjoying increasing attention internationally and has recently assumed a leading and guiding role in the cooperation with other EU Member States. The new EU VET targets for 2020, primarily focused on reforms in national systems, are based on the dual principle, on close interaction between schools and industry, on the relevance of IVET for the labour market and on the introduction of apprenticeship systems. The reasons are to be found not just in the apprenticeship system's relative stability in the global economic and financial crisis, but also in its effectiveness in keeping youth unemployment down[14], the high skill levels and from an overall perspective the relatively easy transition from VET to the labour market. Several EU Member States, including Sweden and Hungary, have introduced reforms paving the way towards an apprenticeship system. In a recent international comparison (OECD 2011) the OECD, in the past mainly focused on tertiary education, highlighted the efficiency and performance of the apprenticeship system.
A further advantage of the apprenticeship system lies with the fact that IVET is geared to company requirements and to enabling technological changes to be quickly integrated into IVET programmes. This advantage was highlighted in a European comparison conducted by

[14] EUROSTAT figures for December 2011 show that Germany had the lowest rate (7.8%) of under-25 unemployment in the whole of Europe (compared to EU27: 22.1%, Eurozone: 21.3%; highest rates: Spain 48.7%, Greece 47.2%) (BMBF 2012a, S. 2).

BIBB in 2001, using the IVET programmes in the building industry as an example. The survey was carried out in six EU Member States[15] as part of the EU's Leonardo action programme together with other research institutes (Grünewald / Moraal 2001) The conclusion here is that changes in the building sector, especially in the field of energy-related building refurbishment and the use of renewable energy sources, can be integrated into this system without problem.

4.2.2 Current developments on the apprenticeship market

As confirmed in the Federal Government's latest VET report (BMBF 2012a), the above-average economic growth in 2011, the decrease in the number of IVET applicants due to Germany's demographics and the successful joint efforts of the Federal Government, the Länder and industry have all helped improve IVET opportunities for young people seeking an apprenticeship in Germany. Companies are now beginning to experience difficulties finding enough apprentices, especially in the SME sector. Between 1 October 2010 and 30 September 2011 (the 2011 "IVET year"), 570,140 new apprenticeship contracts were concluded in Germany[16]. This constitutes an increase of 1.8% (2010: 559,960). The increase in company apprenticeships was a lot higher (+4% compared to 2010). In the overall balance this is however not visible due to the intentional decline in non-company apprenticeships[17] which took place at the same time. At the end of the 2011 IVET year, the number of vacant apprenticeships had risen by 51.4% to 29,689, considerably more than the number of applicants not able to find an apprenticeship (2011: 11,550, 2010: 12,255)[18].

4.2.3 VET policy challenges

Despite Germany's just discussed solid VET foundations and the relatively favourable development of the market for apprenticeships in Germany, there is still work needing to be done. The decrease in the number of school-leavers due to the worsening demographic situation in Germany is already beginning to cast a shadow over the supply of skilled labour in parts of the economy. The Federal Government is forecasting economic growth to weaken significantly in 2012, and a large number of young people, despite the relatively good situation on the apprenticeship market, are still experiencing problems gaining an apprenticeship and therefore need support. The Federal Government is therefore continuing with its strategy of promoting the apprenticeship system as an important instrument in

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15 The countries compared were Finland, Germany, Italy, Spain, Great Britain and the Netherlands.

16 BIBB records on an annual basis the number of new apprenticeship contracts concluded between 1 October of the previous year and the 30 September deadline of the survey year and which are still running on 30.09. This survey is conducted in collaboration with the institutions responsible for IVET (Flemming / Granath 2011).

17 Non-company apprenticeships involve teaching the required contents of the apprenticeship framework outside the established IVET system in "other VET institutions" (*sonstige Berufsbildungseinrichtungen*) (BBiG §2.1.3). The latter include training centres (*Berufsbildungszentren*) and support institutions (*Berufsförderungswerke* or *Berufsbildungswerke*, where handicapped people in particular can gain training.

18 Further details on the IVET balance can be found in Chapter A1 or the BiBB VET report (BIBB 2012a, p. 11 ff.).

ensuring the future supply of skilled labour. This in turn means that the apprenticeship system needs to stay in tune with the latest technological changes and undergo structural reform in order to maintain its long-term prospects (BMBF 2012a, p. 3).

Beyond its apprenticeship system and the way this is structured, Germany is confronted with a whole range of challenges needing to be overcome:

- The need for higher skill levels to 2020 as a result of changing requirements: CEDEFOP is forecasting a disproportionate increase in high-skilled employment opportunities (up to 34% against 26% in 2007) and a corresponding decline in low-skilled employment opportunities (down from 27% to 18%) (CEDEFOP 2009);
- The transition from an industrial to a knowledge society with a corresponding shift in focus away from manufacturing and towards services and new sectors without an adequate IVET culture;
- Changes in the vocational (and academic) education focus, with the demographic development leading to a decline in IVET and increased importance for CVET;
- The development of a common European work and education area with indirect structural consequences for the national VET system.

The demographic development in particular, currently reducing pressure on the apprenticeship market, will in the future become a major challenge for vocational training and its whole infrastructure, putting a question-mark over whether enough skilled labour will be available in Germany. Between now and 2030 the 17-25 age bracket is forecast to decline by 20% (Pfeifer / Kaiser 2009), with this development accompanied by changing education decisions of young people. The trend towards higher school-leaving qualifications is continuing, and with it the increased attractiveness of a university education, leading to increased competition between the apprenticeship system and universities.

As a way of strengthening the apprenticeship system and improving transitions, the Federal Government has over the past few years already introduced a number of specific Federal initiatives and programmes. In addition, it has - with the announcement of its 10% target for investment in education and research - raised the stakes, investing an additional €12 billion in these core policy areas in its current term of office (BMBF 2012a, p. 4). In this connection, the budget available for VET was greatly increased, with a specific focus being put on improving transitions between secondary schools and IVET ("Threshold 1" / "*Schwelle 1*") and between IVET and the labour market ("Threshold 2" / "*Schwelle 2*"), as well as the permeability between educational systems (school, IVET, university). Apart from raising the education budget, a focus is being put on qualitative and structural improvements to the educational system.

4.2.4 VET policy priorities

According to the 2012 VET Report, Germany's 2011 policy priorities focused on the following five areas (BMBF 2012a, p. 4ff.):

- the reduction of the “transitional area” and its closer interaction with the apprenticeship system (Chapter 4.2.4.1),
- increasing the attractiveness of the apprenticeship system (Chapter 4.2.4.2),
- quality assurance, differentiation and greater flexibility in the field of VET (Chapter 4.2.4.3),
- CVET (Chapter 4.2.4.4), and
- VET internationalisation (Chapter 4.2.4.5).

Against the background of the outstanding importance of the European Educational Area, a special focus is put on the development of the German Qualification Framework (Chapter 4.2.4.6).

4.2.4.1 Reduction of the “transitional area”; closer interaction of the transitional area with the apprenticeship system

The "National Pact for IVET and ensuring the supply of skilled labour" (BMBF 2010) was signed by the Federal Government and the employers in 2004 and has since been renewed several times. Along with its quantitative IVET targets, a further objective is to improve the transition between IVET and the labour market. With this in mind, new measures such as the "Educational Chains" (see below) and an increased focus on pre-IVET have been introduced. These measures are set to remain a focus in the coming years.

The "Educational Chains to Successful IVET Completion" (*Bildungsketten bis zum Ausbildungsabschluss*) initiative involves comprehensive measures aimed at ensuring that young people with low school-leaving qualifications successfully complete their IVET. To achieve this, a structured and consistent support policy is being introduced by the Federal Government and the Länder. Concrete instruments include analyses of a person’s potential, job guidance, and support in first entering the labour market. These instruments have been greatly enhanced, now providing systematic and long-term support for young people beginning with their last -1 class at school and continuing into an apprenticeship.

In 2011, the BIBB Steering Committee compiled a set of guidelines for improving the transition between school and work, stressing the importance of individual support, including the use of "IVET modules" (*Ausbildungsbausteine*), and putting the focus on normal apprenticeships. The possibilities for analysing the developments in the transitional area have been further improved by the integrated IVET reporting subsidised by the BMBF. Current BIBB scenario estimates point to the transitional area losing ground, even though it can be expected to continue existing, albeit at a lower level. This is the reason for the need to improve the efficiency of the support instruments involved.

4.2.4.2 Increasing the attractiveness of the apprenticeship system

Along with boosting the apprenticeship system's integrating role, a further main objective is to open up the apprenticeship system for top-of-the-class school leavers through innovatory measures and enhanced attractiveness.

The Federal Government would like to see high-quality IVET offerings and skilled staff being available both in the field of VET and in the universities. Germany is currently seeing increased competition between VET and universities, as reflected by the fact that 2011 saw a new record being achieved, with 55% of the age cohort starting university studies[19] (2005: 37%). The new post-Bologna university education structure with its initial focus on bachelor courses giving students a solid practical background is now widely implemented in German universities, meaning that the apprenticeship system, previously responsible for taking up some two-thirds of school-leavers and where previously some 20% of apprenticeships were awarded to youngsters with *Abitur*, now needs to enhance its competitiveness. The system must be in a position to come up with attractive on-top offerings capable of swaying young people faced with the key decision of whether to go to university towards an apprenticeship. Possible approaches here include closer IVET / CVET interaction and use of the hitherto little used legal options offered by the BBiG to create and foster the uptake of standardised additional qualifications alongside the existing system of regional and sectoral qualifications.

As a way of enhancing the attractiveness of vocational training, the BMBF, in conjunction with the Federal Ministry of Economics and Technology (BMWi) and with the support of the National Pact partners, has launched a Germany-wide campaign under the slogan "*Berufliche Bildung – Praktisch unschlagbar*" (Vocational training - practically unbeatable). The campaign uses a wide range of instruments, Germany-wide info tours, advertising, social media (one of the best ways to reach young people), specific information campaigns targeting attractive occupations and Federal support offerings. These target in particular young people doing well at school, opening their eyes to the opportunities offered in IVET and CVET.

The campaign will reach its peak in July 2013 in Leipzig with the "WorldSkills" an IVET world championship in which the best apprentices in 49 different occupations from 60 countries throughout the world will be taking part. This will be accompanied by a large number of national and international meetings and conferences highlighting the attractiveness, excellence and performance of vocational training.

[19] A major reason for the 10% upsurge in 2011 (compared with the 2010 45% figure) is the switch from 13-year to 12-year *Abitur* programmes in many *Länder*, incurring the one-off effect of having two age cohorts leaving school with their *Abitur* qualification in just one year).

Improving permeability between vocational training and university education is a further field of action for improving the attractiveness of vocational training, with the KMK (*Kultusministerkonferenz*) resolution on allowing IVET graduates to go on to university offering a good starting point. The BMBF has been promoting an increase in the number of grants available for young people to go on to university as well as supporting specific on-the-job university programmes for IVET graduates without an *Abitur* and initiatives for recognising IVET qualifications when young people want to go to university.

4.2.4.3 Quality assurance, differentiation and greater flexibility in vocational training

Quality assurance, differentiation and greater flexibility in vocational training constitute a further field of action, with the focus here on issues involving VET design and structure. Greater flexibility in the sequencing of learning units, for instance in the form of learning modules, is seen as a way of taking different requirements regarding both the supply of and demand for apprenticeships (individual applicant profiles) better into account. In this field, the BMBF has been promoting initiatives aimed at ensuring the quality of the apprenticeship system, upgrading the skills of training staff, systematically consolidating similar occupations into occupational groups and making it easier for people to switch to the apprenticeship system from other areas, with their previous skills and knowledge being taking into account. The latter applies in particular to immigrants to Germany. The Act on the Recognition of Foreign Qualifications (*Gesetz zur Anerkennung ausländischer Qualifikationen)* came into effect of 1 April 2012. It is now in the implementation phase, with the respective advisory and assessment structures currently being established.

Alongside the modernisation of the IVET and CVET frameworks (see Chapters 4.2.5.3.1 and 4.2.5.3.2), the focus is on developing a concept of skill-based descriptions of apprenticeship frameworks - a major measure in implementing the German Qualification Framework with its focus on learning outcomes (Chapter 4.2.4.6) - and on introducing measures aimed at the early recognition of skill needs (Chapter 4.2.5.3.3).

4.2.4.4 Continuing vocational education and training (CVET)

A longer working life (in the context of raising the retirement age to 67 in Germany), skills and knowledge becoming obsolete quicker, and Germany' internationally unimpressive CVET track record despite the looming shortage of skilled labour in the country are the starting points for a new CVET initiative. The planning of a BMBF campaign aimed at boosting CVET started in 2011. This campaign is now being implemented in conjunction with the above-mentioned "*Berufliche Bildung – Praktisch unschlagbar*" campaign. Aimed at boosting CVET, the campaign consists of events covering CVET policy, online advice, publications and information specifically targeting certain groups.

As a way of promoting individual CVET, the BMBF has extended its successful VET bonus ("*Bildungsprämie*") programme for a further two years. The aim here is to raise the participation rate of people who are currently excluded from CVET on financial grounds.

In 2011, the Federal Government also adopted its "*Konzept zur Fachkräftesicherung in Deutschland*", a concept for ensuring the supply of skilled labour in Germany. Though this focuses primarily on mobilising domestic potential, it also contains measures for promoting the immigration of skilled workers from abroad. The Federal Government's skilled labour concept describes concrete measures - either new ones or enhancements of existing ones - for boosting and maintaining employment, a better work-life balance, better integration and the immigration of skilled workers.

4.2.4.5 VET internationalisation

The German VET system needs to maintain its attractiveness and competitiveness at an international level.

The international - and in particular European - trend towards focusing on VET learning outcomes [20]instead of controlling and monitoring input is in many respects beneficial for the apprenticeship system, as it helps align the skill requirements of the labour market and allows skills to be compared independently of VET institutions and types of diplomas officially documenting these results. This potentially allows qualifications acquired in Germany in a non-academic environment to be compared and possibly put on a par with ones acquired in an academic environment in other countries. The main EU-Level initiatives, drawn up with BMBF help in 2011 and flanked by national measures, include:

- the European Qualifications Framework (EQF) and its counterpart, the German Qualifications Framework (DQR) - see Chapter 4.2.4.6,
- the European Credit system for Vocational Education and Training (ECVET) and its German counterpart, as well as the initiative for promoting modular IVET courses,
- the new EU initiative, ESCO, with its aim of compiling a common European taxonomy for occupations, skills and qualifications, thereby establishing a common language between the labour market and the educational world,
- the EU EQAVET initiative for VET quality assurance and its German counterpart DEQA-VET,
- the EU focus on learning outcomes and the BMBF's national research initiative (launched in 2011) on measuring VET results from a learning outcome perspective,
- the enhancement of transnational apprentice mobility and support for establishing the required advisory structures in the chambers,

[20] The focus on learning outcomes is to be understood as the definition of which outcomes (skills) need to be acquired in any one VET programme, enabling a successful graduate to make immediate use of such on the labour market. This system is complemented by input factors, which define the time and processes needed to achieve a certain skill level.

- the enhancement of the infrastructure for occupational competitiveness in Germany and the preparations for WorldSkills, due to take place in 2013 in Leipzig (cf. Chapter 4.2.4.2.).

4.2.4.6 The development of the German Qualification Framework

As a way of increasing the transparency of qualifications within Europe, the European Commission, in the wake of an EU-wide consultation in 2008, recommended the adoption of a *European Qualifications Framework for Lifelong Learning (EQF).* The EQF is designed as a reference framework not tied to any one educational area and which allows qualifications to be mapped to eight levels based on learning outcomes. One of the main purposes of the framework is to act as a translation device, making national qualifications more readable across Europe, promoting workers' and learners' mobility between countries and facilitating their lifelong learning. The European Commission's goal is to have all VET attestations, certificates and EUROPASS documents containing an indication of the EQF level by 2012.

The introduction of the EQF in individual Member States requires the corresponding development of so-called National Qualification Frameworks. This saw the Federal Government and the *Länder* reaching agreement in 2007 on cooperating to build a *German Qualification Framework (DQR) for lifelong learning* covering all educational areas. National qualifications, whether acquired in secondary schools, IVET / CVET or in tertiary education, are to be assigned to reference levels, allowing learning outcomes. wherever acquired (i.e. at school, at university or on the job) to be assessed in accordance with common standards.

The DQR has both an international and national objective. From an international perspective, qualifications acquired in Germany should be readable throughout Europe, thereby making them more comparable with similar qualifications from other EU Member States. This is being done via the linkage between the DQR and the EQF. In doing so, the German Qualification Framework takes account of the specific features of the German educational system, i.e. the apprenticeship system with its focus on practical skills, enabling an appropriate assessment of German qualifications and their comparability throughout Europe. On the other hand, the German Qualification Framework is also a way of improving permeability between the previously totally separate fields of school, vocational and academic education, with a special focus here in the links between vocational and academic education.

A draft framework was first compiled by a working group made up of representatives from the Federal Government, the *Länder*, universities, social partners and other experts from all fields of education. After reaching agreement on such controversial issues as the relationship between apprenticed occupations and the *Abitur*, political agreement was finally reached on 31 January 2012 at a top-level meeting (BMBF / KMK et al 2012). The result of this meeting was that, in an initial phase, only qualifications of relevance to the labour market should be assigned to the DQR, with school-leaving qualifications initially not covered. The following qualification assignments to DQR levels have been made:

- IVET preparation measures: DQR Levels 1 & 2,
- 2-year apprenticeships under the HwO / BBiG: Level 3,
- 3 & 3.5 year apprenticeships under the HwO / BBiG: Level 4,
- Qualifications at the first upgrade level (e.g. service technicians, IT specialists): Level 5.
- Qualifications at the second upgrade level (e.g. master craftsmen and technicians graduating from polytechnics), as well as bachelor graduates: Level 6.
- Qualifications at the third upgrade level (e.g. strategic IT professionals) together with master graduates: Level 7.
- Level 8 is reserved for PhDs, meaning that there is no corresponding VET level.

This initial phase is to be evaluated over a 5-year period. On the basis of skill-based apprenticeship frameworks and outcome-based standards for school-leaving certificates, and for the purpose of finding a common denominator between academic and vocational education, all assignments are to be reviewed before final agreement is reached.

Though a compromise, two of the main goals of the DQR are achieved. Firstly the master craftsman qualification is now on a par with a bachelor qualification in the DQR. Secondly the *Abitur* is not ranked higher than an IVET qualification under the HwO or BBiG. This means that vocational and academic qualifications are now on a par with each other.

The EQF and DQR are core instruments in achieving greater transparency and permeability between the different educational systems existing within Europe. The outcome-based approach means that the focus is no longer on where the qualifications were achieved and how long it took to acquire them, but is now on what a person is capable of doing and what he knows - a major pre-requisite for putting vocational, school and university education on a par with each other.

4.2.5 VET policy measures and programmes

The Federal Government's current VET measures and programmes are presented in the 2012 VET Report (BMBF 2012a, p. 51 ff). In the following section, the main activities are therefore merely outlined and in certain cases accompanied by indications of which objective they help to achieve.

4.2.5.1 Improvements in IVET conditions

The Federal Government is continuing its work on the measures introduced over the last few years to strengthen the apprenticeship system, provide guidance in choosing an occupation, ensure that young people have the necessary maturity to embark on an apprenticeship, facilitate the transition from school to an apprenticeship and to ensure the quality of IVET qualifications and the continuing supply of skilled labour.

In cooperation with the trade associations, the Federal Government reached agreement on the above-mentioned "*National Pact for IVET and ensuring the supply of skilled labour*" in June 2004. This Pact foresees a greater commitment to the apprenticeship system on the part of companies as well as increasing efforts on the part of the public sector (BMBF 2010). Now extended until 2014, the aim of the Pact is to ensure an adequate supply of IVET and qualification programmes for all young people ready and willing to do an apprenticeship. The Pact applies to all young people, whether high-fliers or low-performers at school and is seen by the Federal Government as the only way of ensuring the continuing supply of skilled labour.

Core measures contained in the Pact include the BMBF's initiative for educational chains (*"Abschluss und Anschluss - Bildungsketten bis zum Ausbildungsabschluss*") with its bundle of measures aimed at qualitatively improving the transition between school and an apprenticeship, as well as industry's commitment to provide 10,000 places for low-performers to upgrade their qualifications so that they can start an apprenticeship (the "*EQ Plus*" programme).

The Pact also gives priority to attracting more high-fliers to apprenticeships as a way of ensuring the continuing supply of skilled labour. This saw the Federal Ministry for Education and Research (BMBF) and the Federal Ministry of Economics and Technology (BMWi) launching their joint initiative "*Berufliche Bildung - praktisch unschlagbar*" (VET - practically unbeatable) in November 2011. The aim of this programme is to highlight the attractiveness of an apprenticeship and the wide range of CVET opportunities available.

Further concrete measures and programmes in this field target improving career guidance for young people, ensuring they are mature enough to start an apprenticeship, optimising the transition between an apprenticeship and the labour market and giving an overall boost to the apprenticeship system through tailor-made structural programmes and the specific promotion of inter-company training centres (Chapter 4.2.4.2).

4.2.5.2 Improved employability through CVET

The Federal Government is similarly continuing its work on the measures introduced over the last few years to improve employability through promoting CVET and lifelong learning and to enhance permeability within the educational system. Though CVET decisions in Germany are the responsibility of the social partners, the state (e.g. Federal ministries, the Länder) can also help, providing incentives and regulatory frameworks

- to increase CVET participation,
- to get companies to invest more in CVET,
- to improve the CVET participation of such specific groups as the low-skilled, women, older workers, immigrants, etc.

Important measures and programmes in this field include the promotion of career-upgrading CVET programmes (i.e. master craftsman courses or other courses providing similar high-skilled qualifications, support for workers wanting to upgrade their skills via the award of a bonus voucher, increased advisory services for companies, apprentices and newcomers to the labour market on mobility opportunities abroad and ways of improving the IVET and employment chances of disadvantaged people through transnational exchange programmes. Moreover the Federal Government is promoting permeability within the educational system through such measures as identifying and testing possible credit systems facilitating entry into an apprenticeship or the transition to a university study programme, or successful participation in a study programme while working at the same time.

4.2.5.3 The future prospects of VET in Germany

In order for VET in Germany to be in a position to meet up to future challenges, state-recognised IVET and CVET occupations are being reviewed and recast by the Federal Government in conjunction with the social partners, bringing them into line with future needs and skill requirements. In doing so, core developments need to be identified as early as possible in order to be able to react appropriately.

4.2.5.3.1 Re-organising apprenticed occupations

In a world where the technologies used, overall working conditions and requirements are constantly changing, the VET system cannot stand still. The system needs to be continually kept up-to--date with these changes, especially through adjustments to its regulatory frameworks. It is therefore necessary to continually review existing apprenticeship frameworks with regard to whether they are up-to-date and, where necessary, to make the necessary adjustments to the changed requirements, to create new occupations for new needs, and where necessary to abandon old occupations no longer needed. Generally speaking, the Federal Government follows the recommendations of the social partners in this field, with the latter being responsible for stating their regulatory requirements (cf. Chapter 6.3). 2011 for instance saw the apprenticeship frameworks for 15 occupations being modernised and one new occupation being created. In 2012, five frameworks have so far been modernised. This means that the number of framework updates since 2000 now totals 152, with a further 51 new occupations having been created.[21]

The apprentice frameworks for the occupations selected for this survey (cf. Chapter 7.1) – as is the case with most other occupations - were adopted at different points in time. A check therefore needs to be made whether they need updating. For instance the frameworks for the two apprenticed occupations "chimney sweep" and "technical system planner" have just been updated, and now cover energy-efficiency aspects. The apprenticeship framework for plumbers, which dates back to 1989, is currently in the process of being updated by BIBB, in

[21] The BIBB maintains an annually revised list containing all recognised apprenticed occupations (BIBB 2011b).

conjunction with experts from the social partners (Jones 2012); it is expected that the corresponding government decree will come into force in 2013. Turning to the occupations of the "wood technician" and the "engineering draughtsman", BIBB is currently conducting scientific studies, ascertaining whether the associated frameworks are in need of revision (Seyfried / Azeez 2012; Dorsch-Schweizer 2012).

4.2.5.3.2 Re-organising CVET programmes

The standardised system of CVET career upgrade programmes set forth in the BBiG/HwO is similarly subject to permanent revision and extension in line with needs[22]. The CVET occupations selected in this survey (see Chapter 7.1), as is the case with the selected apprenticed occupations, were regulated at different points in time. There is therefore a need to check, in the course of the survey, whether they need updating or recasting. Initiating such measures is within the responsibility of the respective trade associations. Implementation is either in the hands of the Federal Government (for federally regulated CVET frameworks) or in those of the chambers for the other CVET programmes.

To the extent that the competent Federal Ministry does not make use of its prerogative under §53.1 BBiG or §42.1 HwO to regulate CVET measures through government decrees, the chambers responsible (the Chambers of Industry and Commerce or the Skilled Craft Chambers) are entitled under §54 BBiG / §42a HwO to adopt regulations governing CVET examinations in line with their regional needs. In Appendix A, an overview of the adopted CVET regulations covering the building and energy fields can be found. The sheer size of this overview confirms the effectiveness of this instrument, enabling the chambers to react quickly to regional CVET needs and new technologies.

One current example of this is the development of a new CVET programme under §42a HwO in the field of renewable energy. Though a study commissioned by the BMU has shown that craft fitters in Germany have the requisite skills to carry out work on renewable energy equipment (cf. Chapter 7.5.1.2), this does not necessarily apply to older journeymen who did their apprenticeships a long time ago. To plug this gap, a working group consisting of experts from the relevant trade associations and chambers was established at the ZDH for the purpose of compiling a new CVET programme under §42a HwO in the field of renewable energy. This CVET examination regulation is intended to cover work on renewable energy facilities in different fields. The CVET regulation, expected to come into force in 2012/2013, will play a major role in achieving the EU's and Federal Government's energy saving targets.

[22] Whereby a distinction needs to be made between: federally regulated CVET frameworks (*Fortbildungsordnungen*) coming under §53 BBiG (applies to all sectors other than the skilled craft sector) and its counterpart §42 HwO (for the skilled craft sector), federal master examination frameworks (*Meisterprüfungsverordnungen*) under §45 HwO for crafts subject to admission requirements and §51a HwO for crafts or quasi-crafts without such requirements (solely for the skilled craft sector) and the CVET examination regulations of the chambers under §54 BBiG (all sectors other than the skilled craft sector) and §42a HwO (for the skilled craft sector).

4.2.5.3.3 The early recognition of training needs

Successful action needs to be based on reliable data. This is the reason why measures for the early recognition of training needs represent a crucial factor in VET policymaking. These include the development of instruments for ascertaining current and future labour demand by sector, occupation and region (the "job monitor"), the conduct of model calculations to forecast labour market developments between now and 2025 (BIBB 2010; see also Chapters 7.2 and 8.1) and supporting pilot programmes. Of specific relevance to the topic of this survey is the programme "Beruflichen Bildung für eine nachhaltige Entwicklung" (VET at the service of sustainability), under which BIBB has been commissioned by the BMBF to support individual and networked programmes in the electrical and metalworking sectors focusing on renewable energy, construction and housing (BIBB 2012b). In addition, BIBB is conducting research into the training needs of individual occupations and groups of occupations with the aim of preparing recasting measures in the field of IVET and CVET. One example of this is the already mentioned study of the "wood technician" occupation (see Chapter 4.2.5.3.1).

4.3 Analysis of technological developments and scenario design up to 2020

4.3.1 Analysis of technological developments in the buildung work categories relevant for energy-related buildung refurbishment measures and for “renewables”

Christian Heinecke, Andreas Marek, Christian Welzbacher

The aim of this chapter is to first provide basic information on which technologies are currently being used in the fields of energy-related building refurbishment and renewables and which developments are on the horizon between now and 2020. This information is used in a second step - the development of a scenario. This scenario is to be seen as a hypothetical - from a technological point of view - yet validated (in discussions with experts) description defining which combinations of refurbishment measures seem viable in order to achieve Germany's energy-saving policy targets (cf. Chapter 4.1). This scenario becomes the basis used in estimating the additional annual investment volume needed to refurbish Germany's building stock in order to achieve Germany's climate targets by 2020.

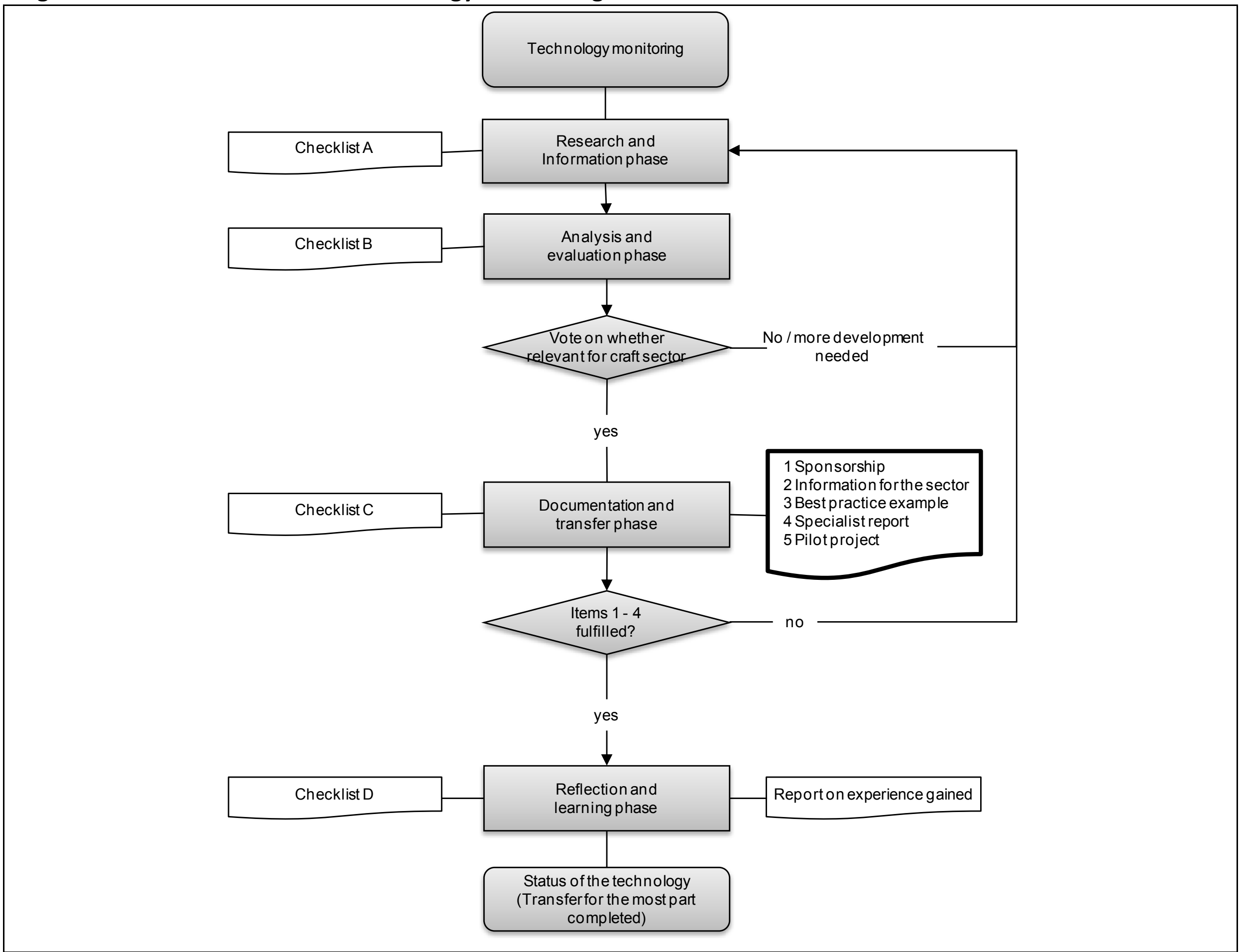
As a way of substantiating the assumptions used in the scenario, we start by looking at the technological developments. The intention here is to ascertain which technological developments will have achieved maturity and become established on the market by 2020, thereby playing a major role in reducing building energy consumption. This technology monitoring is seen in particular as a way of identifying the relevant technologies.

4.3.1.1 Methodology

As the German Skilled Craft Institute's research centre (DHI) with a focus on technological innovation, the Heinz-Piest Institute for Craft Technology (HPI) at Hannover's Leibniz University is responsible for monitoring innovation and technology transfer in the skilled craft sector.

This technology monitoring involves keeping track of technological developments. An overview of the monitoring process, constituting a basis for assessing technological developments in the context of this project, is to be found in Figure 19.

Figure 19: Overview of HPI technology monitoring



Source: Fülbier and Pirk 2010, p. 40.

For this monitoring to be effective, different sources need to be tapped over a long period. These include:

- Expert meetings and conferences
- Desk research
- Patent research
- Monitoring the activities of research institutes
- Monitoring the R&D activities of companies
- Monitoring the application of new technologies by users.

For its technology monitoring, the HPI also leverages its close links with the BIT Network, a network of "innovation and technology officers" (BIT officers) in the skilled craft sector. There are currently 72 highly skilled engineers and scientists working as BIT officers in skilled craft chambers, VET centres and regional craft guilds. With each of them responsible for monitoring one specific technology field, they help document the potential of new technologies. BIT officers come together in specific thematic working groups, which meet once a year to discuss latest developments. The assessment of the work of these working groups constitutes an important element in the compilation of this report.

As a way of taking sufficient account of these latest technologies and their future market importance from a user perspective, over 80 skilled craft companies from the trades concerned were interviewed. One of the findings was that user assessments were generally in line with what the experts were saying.

The documentation of the results of this process is done in four steps:
1. determining the technological fields
2. ascertaining possible technologies
3. evaluating the technologies
4. determining the relevant technologies

4.3.1.2 Technology fields in the building trade

The project focus is on looking at the technologies and processes used in the building sector. To allow a systematic approach, a building is divided into categories of building work where different technologies are used, and, within these categories, into sub-categories. Table 9 shows the scheme used, together with a short explanation defining the respective terms.

Table 9: Relevant building work categories

Category 1: **Building envelope**	**Category 2:** **Building infrastructure**	**Category 3:** **Building energy supply**
Roof: The roof construction including tiles and insulation	*Interior finishing:* The design of inside walls and floors	*Electricity:* Electricity generated from the sun, wind, regenerative or fossil fuels or from an energy supplier
Shell: A building's whole shell, including supporting walls and ceilings and outside stairs.	*Electrics and ICT:* The electrical wiring and installation of building management systems and ICT facilities.	*Heating:* Heating from the sun, earth, air, regenerative or fossil fuels or from an energy supplier.
Windows and doors All windows and outside doors, including their shutters/shading systems.	*Heating system:* Distributing and controlling heat within a building	*Electrics and ICT:* Technology for connecting up the energy supply and ICT.
Facade: The design and insulation of the facade and cellar.	*Air conditioning* Ventilation and cooling (air conditioning) systems.	
	Plumbing: The (hot) water distribution system	

4.3.1.3 Ascertaining and describing the technologies in question

4.3.1.3.1 A building's envelope

The construction of a building's envelope is one of the main factors influencing its energy values / heat loss. In our study, three different aspects were assessed: the roof; windows & doors; and the facade and cellar. In doing so, figures from different sources were used (incl. Adolf et al. 2011; Beltrán et al. 2010; Fördergesellschaft Holzbau und Ausbau mbH 2012), whereby a certain fluctuation needs to be taken into account with regard to heat loss figures.

1. The roof:
   Up to 40% of heat is lost through the roof. To insulate a roof, a number of different forms of insulation and materials - in particular mineral wool and rigid foam - are used. The forms of insulation and the insulation systems already available on the market will continue to be used throughout the projection period, and can be expected to continue dominating the mass market.

2. Windows and doors:
   Alongside the actual outside doors and windows, this subcategory also includes shutter and sunshade systems. Up to 20% of heat can be lost through windows. Alongside the well-established double-glazing, various technologies are now available in this sector. High levels of insulation are achieved for instance through the use of vacuum insulated glass (VIG) in triple glazing. This has the further advantage of reducing the overall thickness and weight of the window, thereby opening up new possibilities for use and design. No further energy-saving effect is assumed for our study. The use of shutter / sunshade systems may have energy-saving relevance, especially when combined with modern electronic control systems. We do not however expect these technological developments to have any great impact on the market between now and 2020.

3. Facade and cellar:
   Up to 40% of heat is lost through the outside walls. Transmission heat loss can be reduced through the application of various insulation measures applied either to the inside or outside of walls. For new buildings, walls can be made of modern composite materials, thereby greatly helping reduce transmission heat loss (DIN EN ISO 6946 1996). Other than the various insulation methods already well-established in the market, no major new methods are expected before 2020. In the long term, systems using vacuum-insulated panels could represent an alternative. Looking at cellars, the statements made with reference to item 1 similarly apply here, though cellar heat loss is not so high (max. 10%).

Alongside the performance of these technologies, we also need to look at the extent to which they can be applied to the building stock, i.e. to what extent their application is considered necessary.

Studies of the German Energy Agency (dena 2011) and the Window and Facade/ Plate Glass Trade Associations (2011) show that the outside envelopes of some 80% of Germany's building stock are not insulated and that 25 million window units (WU)[23] only have single glazing.

Looking specifically at windows, the Window and Facade/ Plate Glass Trade Associations have available detailed figures on individual window types (cf. Table10).

Table10: The window stock in Germany

Type	Window units (million.)	Surface area [million m²]
Type 1: Single-glazed windows	25	42.25
Type 2: Double-glazed windows	52	87.88
Type 3: Windows with uncoated insulating glass	235	397.15
Type 4: Windows with double-glazed heat insulating glass	257	434.33
Type 5: Windows with triple-glazed heat insulating glass	12	20.28
Total	581	**981.89**

Source: Window and Facade/ Plate Glass Trade Associations 2011, p. 3.

According to Diefenbach et al. (2010, p. 70 ff.), the following annual modernisation rates[24] are to be assumed for insulating buildings built before 1978 against heat loss (outside walls / roof / top floor / floors / cellar ceilings) (Table 11):

[23] One window unit = 1.3 m x 1.3 m = 1.69 m².

[24] The energy-related refurbishment rate states the percentage of the building stock being subjected to energy-related refurbishment each year. When using the refurbishment rate, care should always be taken to check what it is being referred to. Generally speaking, a refurbishment rate does not always reflect an upgrade in energy efficiency.

Table 11: Modernisation rates for older buildings (pre-1978)

All buildings

	Outside walls	Roof & top floor	Floors and cellar ceiling
2000 - 2004	1.01% (+/- 0.09%)	2.18% (+/- 0.17%)	0.49% (+/- 0.06%)
2005 - 2008	0.83% (+/- 0.09%)	1.50% (+/- 0.10%)	0.31% (+/- 0.05%)

Detached and semi-detached houses

	Outside walls	Roof & top floor	Floors and cellar ceiling
2000 - 2004	0.88% (+/- 0.09%)	2.07% (+/- 0.14%)	0.43% (+/- 0.06%)
2005 - 2008	0.83% (+/- 0.10%)	1.49% (+/- 0.12%)	0.31% (+/- 0.05%)

Apartment buildings

	Outside walls	Roof & top floor	Floors and cellar ceiling
2000 - 2004	1.52% (+/- 0.27%)	2.65% (+/- 0.59%)	0.72% (+/- 0.16%)
2005 - 2008	0.83% (+/- 0.17%)	1.54% (+/- 0.24%)	0.34% (+/- 0.09%)

Source: Diefenbach et al. 2010, p. 70 ff.

Looking at the 2005-2008 refurbishment figures for older (pre-1978) buildings, we can see that, if the current refurbishment rate is maintained, it will take another 66 years for energy-saving measures to be applied to all roofs / top floors, and 120 years for outside walls. This is way behind what is possible and necessary for achieving the short- and long-term climate protection targets (e.g. reducing GHG emissions by 80% between now and 2050 (BMU 2010).

In this context, a survey of households as to their energy-saving modernisation plans for the next five years revealed that the refurbishment rates presented in Table 12 are to be expected (all buildings/pre-1978 buildings), whereby the figures for the measures planned are higher than the number of modernisation projects actually carried out in the past. This could possibly point to a greater awareness of homeowners to energy issues. But it could similarly merely reflect the gap between planned and actual implementation.

Table 12: Expected refurbishment rates

	All buildings	Pre-1978 buildings
Insulation of outside walls	1.50 %/a (+/- 0.11%/a)	1.93 %/a (+/- 0.13%/a)
Insulation of roof/top floor	1.69%/a (+/- 0.09%/a)	2.19 %/a (+/- 0.12%/a)
Installation of new windows / glazing	1.50 %/a (+/- 0.09%/a)	1.90%/a (+/- 0.13%/a)
Installation of a new heating system	2.04 %/a (+/- 0.15%/a)	2.09 %/a (+/- 0.15%/a)

Source: Diefenbach et al. 2010 p. 70 ff.

According to a survey carried out by Friedrich (2012), 23% of households see roof insulation as the most effective way of preventing heat loss, followed by the insulation of outside walls (22%) and installing a new heating system (19%).

4.3.1.3.2 A building's infrastructure

In many areas involving a building's infrastructure, innovative technological developments are on the horizon. These include "phase change materials" (PCM for short) which can store latent heat and can be used in building products and panels, as well as in wallpaints. With their special heat storage qualities, these materials compensate for lacking thermal storage.

New technologies can also be expected in the fields of electrics, electrical installations and building management systems in the coming years. One example is the introduction of smart meters able to chart energy consumption, thereby helping to avoid peak loads and encouraging consumers to take advantage of off-peak periods. Building management systems, ranging from surveillance to control and optimisation systems, offer users the opportunity of automatically controlling (interlinked) building processes via pre-defined parameters and simplifying their operation and control.

As there are as yet no reliable figures on the effect they can have on final energy needs in homes, they will not be further considered.

4.3.1.3.3 A building's energy supply

Turning to a building's energy supply, with the focus principally on electricity, heating, hot water and air conditioning, the following section explains the relevant technologies.
Looking at electricity generation, the main technologies are photovoltaic (PV) systems and wind turbines. A PV system uses solar cells to convert sunshine into electricity. PV systems are for the most part installed on a building's roof. Also possible are PV systems attached to a mast with a sun-tracking device. As regards energy generation using wind turbines the focus in this study is on small-scale turbines. Simplified approval procedures are opening up new application fields for this technology in domestic electricity generation. Wind turbines are currently on the market with a performance ranging from 0.4 to 30 kW.

In the context of domestic heating, a further energy generation technology is a mini combined heat and power (CHP) system. The range of conventional CHP systems has been extended and now includes low-performance systems suitable for use in houses or blocks of apartments. They use combustion engines (Stirling motors and free-piston steam engines) to generate heat via the combustion of oil or gas from fossil or renewable sources. This in turn can be used to generate electricity.

A further technology for generating energy involves the use of geothermal systems, which makes use of the warmth stored in the Earth's crust. Deep wells are drilled into the ground, in which geothermal probes are installed. These extract the energy stored in the ground. Most probes consist of a bundle of pipes filled with a heat-conducting fluid (normally water mixed with glycol) circulated via a pump. The Earth's warmth can either be used for heating / cooling purposes via a heat pump or for generating electricity or for feeding into a CHP system. Through the future use of carbon dioxide (CO_2) instead of a fluid, the circulation pump would no longer be needed. This would in turn mean that heat could be very effectively transported through the geothermal probe, thus boosting the performance of heat pumps by 12 - 15% compared with water-filled systems.

Apart from their use in extracting heat from the earth, heat pumps can be used to extract heat from the air for heating a house.

Solar heating is the term used for converting solar energy into useable thermal energy via solar panels. This is done by heating fluids inside the panels. The heat gained from such solar panels is stored in a hot water tank or fed into the building's heating system.

As a result of the very low heating needs of the low-energy houses now being built in Germany, conventional central heating systems are generally not used. For such reduced heating needs a down-sized oil heating system which can be installed in a house's ventilation system has been developed (Verband für Energiehandel Südwest-Mitte e.V. 2007).

As a way of optimising conventional central heating systems, condensing boilers are increasingly being used for water-based heating systems. Such boilers are very efficient, using practically all of the input energy. Through the additional use of waste heat in the flue gases to pre-heat the cold water entering the boiler, efficiency can be raised by 6-11%. Condensing boilers are available for pellets, gas and oil.

District heating (*Fernwärme*) is the term used for the supply of warmth and hot water from an external provider. The thermal energy is transported through a system of well-insulated pipes. District heating can be used for heating whole towns or city districts. Where individual buildings, parts of buildings or small housing estates have their own heat generation facilities, the term ‘local heating’ (*Nahwärme*) is used.

The technologies referred to above can be used individually or in combination with each other, whereby a system using different sources of heating is referred to as a hybrid system. The hybrid system seen most frequently is a combination of solar heating with a condensing boiler.

According to Diefenbach et al. (2010) it can be assumed that only 12% of heating systems use state-of-the-art technology. Oil is used as a fuel in nearly 34% of buildings, with 23.8% of the boilers used here older than 20 years - i.e. on average at the end of their lifespan. A similar picture exists for gas-fired boilers, used to heat 52% of buildings. Here, 17% of boilers are at the end of their lifespan. With regard to the modernisation of heating systems, the annual replacement rate was 2.8%/a (+/- 0.1%/a.) in the 2005-2009 period.

With regard to overall energy consumption, the share of ventilation and air-conditioning (VAC) systems only plays a very minor role (<1%).

In 77% of all residential buildings, hot water is generated in connection with the heating system. Where it is separate, electrical tankless heaters are the main way of heating water (12.1%). Only 10% of residential buildings have solar heating. In 2009, solar heating systems were being installed at a rate of 1.21%/a (+/-0.18%/a). Looking only at new buildings built from 2005 onwards, over 30% of them have solar heating or PV systems.

Table 13 provides an overview of the shares of the different types of heating by age of building, underlining the dominance of central heating.

Table 13: Types of heating

	Pre-1978 buildings	1979-2004 buildings	Post-2004 buildings
District heating	3.9% (+/- 0.6%)	4.0% (+/- 0.6%)	3.6% (+/- 1.0%)
Central heating	79.9% (+/- 1.0%)	92.4% (+/- 1.2%)	92.2% (+/- 2.9%)
Apartment heating	6.3% (+/- 0.6%)	1.5% (+/- 0.3%)	1.6% (+/- 0.7%)
Heating of individual rooms	9.9% (+/- 0.7%)	2.1% (+/- 0.4%)	2.5% (+/- 1.2%)

Source: Diefenbach et al. 2010, p. 82.

In contrast to the Diefenbach findings (Diefenbach et al. 2010) on solar heating and PV systems for 2009, more recent surveys carried out by the AGEB (2012) show that the use of renewables for generating warmth will stagnate in 2012.

4.3.1.4 The selection of the technologies to be considered

The technologies to be considered were selected on the basis of their relevance to the overall project objective, the assessment of technological developments up to 2020 and their marketability, and their effects on reducing building energy consumption. The following selection criteria were used:

- energy-saving / energy generation potential,
- the potential for applying these technologies to the building stock.

Also needing to be taken into account was whether - from the perspective of the suppliers of each technology - the technologies could be marketed throughout Germany. This aspect entailed the use of further selection criteria:

- Development status: the product should already be available or be imminently available on the market.
- Market penetration: the product should be expected to penetrate the market in the medium term. One of the criteria here is that adequate substitution potential exists vis-à-vis established technologies.
- Market volumes: market volumes should be high enough for the trades involved to actually work with the technology to a significant degree, i.e. sufficient exploitation potential needs to exist.
- Competitiveness: the use of the technology needs to go hand in hand with competitive advantages.

The technologies to be looked at in the areas of a building's envelope, infrastructure and energy supply were selected by HPI on the basis of the criteria listed above. A summary presentation of the selection is to be found below.

4.3.1.5 Relevant technologies

A major proportion of building energy savings is achieved through refurbishing existing buildings. One of the main aspects here involves insulating roofs, outside walls and cellar ceilings, as well as reducing heat loss through windows and doors.

Apart from its envelope, a building's energy supply - i.e. the supply of energy for heating / hot water and electrical appliances - is of importance with regard to overall energy consumption. Through the use of renewables for generating electricity and heat, major reductions in the consumption of fossil fuels can be achieved. Electricity generation is accomplished mainly through the use of PV systems and wind turbines. Heat can come from geothermal systems, especially ones using CO_2 earth probes, solar heating (also in combination with fossil fuels and heat pumps), as well as through the use of renewable sources such as pellets in combination with condensing boilers. Heating is also done via the optimised combustion of fossil fuels using condensing boilers, low-temperature boilers, combined heat and power (CHP) systems, district heating and, where only minimal heating requirements exist, via oil-fired mini-heating systems (Verband für Energiehandel Südwest-Mitte e.V. 2007).

To further exploit the energy-saving potential in buildings, rooms need to be appropriately designed and building management systems linked together. The lack of energy storage, in particular in buildings needing refurbishment, can for example be compensated through the use of phase change materials (PCM). The supply of hot water and the distribution of hot air can be designed in an energy-saving manner. Similarly, building management systems can be linked together to save further energy.

The technologies shown in Table 14 are considered relevant for developing the scenario. They are shown in connection with the respective building categories.

Table 14: Overview of technologies relevant for the development of a scenario (by category)

Category 1: **Building envelope**	**Category 2:** **Building infrastructure**	**Category 3:** **Building energy supply**
Roof: ▪ Above-rafter insulation ▪ Between-rafter insulation ▪ Under-rafter insulation ▪ Loft insulation	*Inside rooms:* ▪ Use of phase change materials (PCM)	*Electricity:* ▪ Micro-CHP systems ▪ PV systems ▪ (Mini) wind turbines
Shell: In most cases, energy-related refurbishment does not entail any changes to existing outside walls and ceiling.	*Electrics and ICT:* ▪ Electrical installation, building management systems ▪ Smart metering ▪ Building management systems	*Heating:* ▪ Geothermal systems ▪ CO_2 earth probes ▪ Solar heating ▪ Micro-CHP systems ▪ Mini oil-fired heating systems ▪ Condensing boilers ▪ District heating ▪ Hybrid heating systems ▪ Low-temperature boilers ▪ Heat pumps
Windows and doors: ▪ Triple-glazed high-insulating windows ▪ High-insulating windows with vacuum-insulated glass ▪ Shutters	*Heating technology:* ▪ Point-of-use hot water generation ▪ Point-of-use pumps for regulating room temperature ▪ High-efficiency circulating pumps	
Facade and cellar insulation ▪ Cavity wall insulation ▪ Cellar insulation ▪ Cellar ceiling insulation ▪ Vacuum-insulated panels ▪ Composite insulation systems ▪ Inside insulation ▪ Heat insulation plaster ▪ Membrane facade	*Ventilation and air conditioning (VAC) technology:* ▪ VAC control sensors ▪ Ventilation with heat recovery ▪ Low-energy VAC systems	
Outdoor facilities The design of outdoor facilities has no energy impact.	*Plumbing:* No technologies with energy-saving relevance.	

The technologies selected as being relevant all have go-to-market status, the potential to penetrate the market, can be expected to achieve high market volumes and are competitive (and therefore have major substitution potential).

Technologies not considered as relevant for the survey period up to 2020 are seen to not fulfil the listed criteria. They are listed in Table 15 below.

Table 15: Overview of technologies not considered relevant for the survey period up to 2020.

Category 1: Building envelope	**Category 2: Building infrastructure**	**Category 3: Building energy supply**
Roof:	*Inside rooms:* ▪ Loam plaster ▪ Insulating wallpaper	*Electricity:* ▪ Hydropower ▪ Batteries for storing electricity ▪ Hydrogen production and storage
Shell ▪ Timber-frame constructions	*Electrics and ICT*	*Heating:* ▪ Heat storage in the ground ▪ Seasonal hot water storage ▪ Ground-air heat exchanger systems
Windows and doors: ▪ Switchable solar control glass	*Heating technology:* ▪ Waste-water heat recovery	
Facade and cellar insulation: ▪ Insulation plaster	*VAC:*	
Outdoor facilities ▪ Use of rainwater	*Plumbing:* ▪ Use of rainwater	

Timber-frame constructions (Category 1) are not considered relevant in a refurbishment context, as generally speaking existing walls are not replaced by this method. In the case of switchable solar control glass, current and foreseeable price levels are not considered low enough for penetrating the market and making any major contribution to saving energy (EnOB 2009). By contrast, the use of insulation plaster or wallpaper does not involve any high cost and makes sense where building regulations prevent outside insulation. However, their contribution to bringing down energy costs is considered low due to their lower insulation properties (Krus et al. 2005).
The use of rainwater for watering the garden means that less tap water is needed. There is however no direct connection here to saving energy.

Loam plaster (Category 2) is not seen as having any great energy-saving relevance. Although such plaster is often considered advantageous for a room's micro climate through the way it regulates humidity, its actual effect on heating energy consumption is very low.
Similarly, waste-water heat recovery, for instance from shower or bath water, does not have sufficient energy density in normal residential units to generate enough wide-scale energy-saving potential. The use of such a technology only makes sense when there is a constant supply of hot waste water. Its contribution to energy-saving in the residential building stock is therefore considered to be negligible (Brandstetter 2009; König 2009). The in-house use of

rainwater in areas where drinking water quality is not required can help save energy. In relation to total energy consumption, it is however again negligible.

Though the use of batteries for storing energy (Category 3) is set to play an increasing role in the use of electricity generated on-site via PV systems and wind turbines, its contribution is not seen as sufficient to warrant its inclusion in our survey due to its adverse cost-benefit ratio. A further possibility for storing surplus energy from renewable sources is to convert it into hydrogen, store it in a fuel cell and use the latter for generating electricity. Again, this technology is not seen as making any significant contribution to saving energy in the next few years (Höpfner and Pehnt 2009). The use of hydropower, in particular when generated using mini-hydroelectric plants, is set to play an increasing role in electricity generation, especially as energy costs get more expensive. Nevertheless it is not seen as having any significant effect on overall energy savings (Kaufmann 2009).

The energy-saving potential of storing heat in the ground or of storing hot water on a seasonal basis is difficult to contemplate due to existing planning restrictions. They are therefore not considered relevant.

Last but not least, no major technological advances are expected in the period covered by the survey. However what can be expected is that existing technologies will be further developed and optimised. This basically means that there will be no major qualitative change in skill needs. Taking a long-term perspective, certain technologies need to be monitored in order to be able to react quickly to changing skill requirements.

4.3.2 Development of a technological / political scenario

The overall objective of the work package was to develop a technological and political scenario on which the future calculations can be based. To do this, the existing data was first assessed. On this basis a road was then defined for achieving the required targets. This entailed the use of a clearly structured phase model involving the following phases:

- Phase 1: analysis of the tasks and problems
- Phase 2: analysis of the influencing factors and determination of the scenario
- Phase 3: assessment and interpretation

4.3.2.1 Phase 1: analysis of the tasks and problems

The European Union is set on achieving its 20/20/20 targets. These involve cutting GHG emissions by 20%, boosting the share of renewables in power generation to 20% and cutting energy consumption by 20% by 2020. The German Federal Government has gone one step further, announcing in 2010 the ambitious goal (BMU 2010, p.3 ff.) of becoming one of the most energy-efficient and eco-friendliest economies in the world, while at the same time ensuring that energy prices remain at competitive levels and maintaining German prosperity. This involves meeting certain targets by 2020 and further ones (in steps) by 2050. GHG emissions (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O, aka "laughing gas"), hydrofluorocarbons (HFC), perfluorcarbons (PFC) and sulphur hexafluoride (SF_6)) are to be reduced by 40% by 2020 and by 80-95% by 2050 (using 1990 as the base year). The share of renewables in gross final energy consumption is set to reach 18% by 2020, rising to 60% by 2050. The productivity of energy use is also to be improved, with primary energy consumption declining by 20% by 2020 (using 2008 as the base year) (BMU 2010, p. 3 ff.).

Energy saving measures

According to the BMWi (2011) energy data, the energy-saving target in the field of primary energy involves reducing overall consumption from its 2008 level of 14,000 Petajoule (PJ)[25] to 11,200 PJ.

After subtracting consumption and losses within the energy sector, statistical variances and non-energy-related consumption, end energy consumption is around 9,100 PJ.

For buildings alone, final energy consumption in 2008 accounted for 3,517 PJ. Under the assumption that energy consumption is to be cut by the same proportion in all energy fields, this means that buildings will need to consume 700 PJ less. Mapping final energy consumption to the individual "consumers" within a building (heating, hot water, ventilation and air-conditioning (VAC) and lighting), the following amounts (see Table 16) need to be saved by each 'consumer" area:

[25] In line with the international unit measurement system *Système Internationale d'unités*, energy is measured in joules. Dependent on the field of application, other units may also be used. In the field of buildings, a kilowatt hour (kWh) is a frequently used unit. 1 joule (J) = 2.78×10^{-7} kilowatt hours (kWh). This means that 1 PJ = 0,278 terawatt hours (TWh).

Table 16: Final energy consumption reduction targets

Residential buildings				
Area	Share of energy consumption	Share of final energy consumption[26]	Target (-20%)	Amount to be saved
Heating	82.68 %	1,832.5 PJ	1466.0 PJ	101.9 TWh
Hot water	15.33 %	339.8 PJ	271.9 PJ	18.9 TWh
VAC	0.00 %	0.0 PJ	0.0 PJ	0.0 TWh
Lighting	1.99 %	44.0 PJ	35.2 PJ	2.4 TWh
Total	100 %	2,216.4 PJ	1,773.1 PJ	123.2 TWh
Non-residential buildings				
Area	Share of energy consumption	Share of final energy consumption 26	Target (-20%)	Amount to be saved
Heating	70.90 %	922.2 PJ	737.7 PJ	51.3 TWh
Hot water	6.74 %	87.7 PJ	70.2 PJ	4.9 TWh
VAC	3.87 %	50.3 PJ	40.3 PJ	2.8 TWh
Lighting	18.49 %	240.4 PJ	192.3 PJ	13.4 TWh
Total	100 %	1,300.6 PJ	1,040.5 PJ	72.3 TWh

Source: BMWi 2011, own calculations.

Renewable energy

The 2010 share of renewables in total final energy consumption was 11.3%. Looking at electricity generation, the 20% target has already almost been reached (17.1%). In 2010, 10.2% of heating was produced from renewables (BMU 2011, p. 6 ff). Making a projection on the basis of average annual growth of the last five years (0.84% p.a. in absolute terms), this percentage would reach 18.6% by 2020. The Arbeitsgemeinschaft Energiebilanzen (AGEB 2012) however uses the assumption that "a renewable energy share in the region of 16%" of gross final energy consumption (p. 36) could already be achieved in 2011. Given the right overall conditions, the Federal Renewable Energy Association (BEE) even sees renewables achieving a share of 25% in heating consumption by 2020 (BEE 2009, p. 3).

GHG emissions

GHG emission levels are listed at 1,215 million t CO_2 equivalents for the base year 1990. By 2008, this figure had already dropped to 988 million t, i.e. a reduction of 20%. Looked however just at primary energy consumption in Germany, we see that this has only gone down 10% in the period between 1990 and 2009, whereas emissions have decreased by 22% (BMWi 2011). Without any further efficiency gains or increase in the share of renewables,

[26] The shares of final energy consumptions were calculated on the basis of the 2008 figures.

the achievement of the 20% energy-saving target would in itself lead to a 35% reduction (based on 1990) of energy-related GHG emissions. Further 60.8 million t CO_2 equivalents would still need to be saved in order to achieve the 40% target by 2020.
Mapping this reduction to buildings, two steps are seen as necessary. From an overall perspective, the share of energy supply in overall GHG emissions can be assumed to be around 78%. Energy consumption can be broken down into the following applications:

- Heating ca. 24% (60.8 million t x 0.78 x 0.24 = 11.4 million t CO_2 equivalents
- Hot water ca. 4% (60.8 million t x 0.78 x 0.04 = 1.9 million t CO_2 equivalents
- VAC ca. 0.5% (60.8 million t x 0.78 x 0.005 = 0.2 million t CO_2 equivalents
- Lighting ca. 2.6% (60.8 million t x 0.78 x 0.026 = 1.2 million t CO_2 equivalents

Heating takes up a major share and would need to be cut by a further 11.4 million t CO_2 equivalents to achieve the target. The current avoidance share of heat generation amounts to 39.6 million t (BMU 2011, p. 7) and would need to be increased by 14.7 million t to a total of 54.3 million t. This corresponds to expanding the avoidance share by 37.1%. Current BMU data (2011) show that a 5% increase in renewables corresponds to ca. 19.4 million t CO_2 equivalents. As the share of renewables is set to increase much more (see above), the targeted 40% avoidance of GHG emissions in buildings is attainable. According to BEE figures, renewables are expected to help avoid 57.0 million t CO_2 equivalents in the heating sector by 2020 (2009, p. 14).

The result of Phase 1

As already discussed, current projections show the reduction of energy consumption as being the main challenge on the way to achieving the climate protection targets. For this reason, the following forecast looks only at this item. If the targeted reduction in energy consumption can be achieved, it can then be assumed that, given the continuance of current conditions, the two other targets (20% share of renewables and 20% reduction in GHG emissions) will also be achieved.

4.3.2.2 Phase 2: analysis of the influencing factors and determination of the scenario

Quantitative data

Our survey requires that the targets quantified in Phase 1 are to be broken down for the whole building stock. To do this, we first used desk research to define the stock of buildings involved. Along with the type of building, the condition of a building also plays a major role. Looking first at residential buildings, a series of reliable data exists. Using as a base the 2006 microcensus of the Federal Statistical Office, the 2011 Building Report of the Germany Energy Agency (dena) and the building stock data compiled by the Institut Wohnen und Umwelt GmbH (IWU) / *Institute for Housing and the Environment* in conjunction with the Bremen Energy institute, reliable assumptions were made. Germany has a total of ca. 40 million residential units in ca. 18 million buildings. There are different estimates of total floorspace, ranging from 2.7 to 3.4 billion m^2. This corresponds to an average size of 67 - 85 m^2 per unit. 70% of residential buildings were built before 1978 (dena 2011; Diefenbach et al. 2010; Statistisches Bundesamt 2008).

Surveys conducted by Diefenbach and Enseling (2007) show that some 2.3 million m^2 of floorspace is added each year in the form of new housing, while 0.5 million m^2 is lost through demolition. This corresponds to a mere 0.05% growth. A further source refers to the new construction of residential units, showing a new construction rate of 0.45% (dena 2011, S. 5). Generally speaking, the sensitivity of the housing stock vis-à-vis new construction can be ranked as minor. What can however be assumed is that the trend in new construction is towards larger residential units, i.e. new units will generally be larger than the average stated above. As the effect of new construction is minimal, it is not taken into any further account. Demographic (i.e. the decrease in Germany's population) and socio-cultural (i.e. the increase in single households) developments are similarly not taken into account.

The data needed to determine the stock of non-residential buildings is insufficient. In 2011 the Federal Ministry for Transport, Building and Urban Development (BMVBS) published the following figures on non-residential buildings (BMVBS 2011, p. 114 f.):

- Educational buildings
  - 36,000 schools
  - 9,000 VET centres
  - 400 higher education institutions
- Office buildings
  - 189,000 buildings
  - 276 million m² floorspace
- Factories and workshops
  - 355,000 buildings
  - 417 million - 549 million m² floorspace
- Shops and warehouses
  - 634,000 buildings
  - 623 million - 714 million m² floorspace
- Sports centres
  - 35,000 buildings
- Culture centres
  - 19,000 buildings
- Hotels and restaurants/pubs
  - 49,000 buildings
  - 40 - 45 million m² floorspace
- Healthcare buildings (hospitals, clinics, etc.), indoor swimming pools
  - No data available

Floorspace details differ, with totals ranging from 2.2 billion m² in 2.5 million buildings to 3.913 billion m² in 3.7 million buildings (BMVBS 2011, p. 101ff.); or between 2.3 billion m² and 2.7 billion m² (Hörner 2011) in 6.8 million workplaces in manufacturing, retail and services (GHD).

Looking at measures in the scenario and their effectiveness with regard to achieving the climate protection targets, it would seem necessary to classify the measures by building type. In this respect, there are two main dimensions for which data - at least partially - exist. One dimension is the age of the building. Specific building features resulting from the building regulations applying at the time of construction (for instance the Building Insulation Regulation) characterise buildings of certain age categories. A second dimension is the type of usage, from which certain energy-related aspects can be derived. Table 17 shows the total floorspace of different types of building by age.

Table 17: Building stock floorspace as of December 1991 in Germany [million m^2]

Type of usage	before 1870	before 1918	before 1948	before 1965	before 1978	before 1990	Shares
Detached houses	104.91	167.84	158.58	275.29	252.29	195.50	47 %
Terraced houses	12.64	20.22	49.78	87.10	108.32	55.97	13 %
Small blocks of flats	74.26	118.82	124.39	259.68	194.29	115.60	28 %
Large blocks of flats	16.83	26.93	11.96	47.09	92.32	45.31	11 %
High-rise blocks of flats				10.14	35.99	5.62	1 %
Total residential buildings	**208.64**	**333.81**	**344.71**	**679.30**	**683.21**	**418.00**	**100 %**
Office buildings	20.47	51.19	30.76	43.83	36.03	35.42	12 %
Institutional buildings	25.56	63.91	38.29	54.55	25.55	11.34	4 %
Hotels and restaurants	4.41	11.05	6.63	9.43	7.22	6.29	2 %
Shops and warehouses	61.11	152.77	91.65	130.61	99.93	87.28	29 %
Factories and workshops	53.83	134.58	80.75	115.07	88.02	76.78	26 %
Agri. buildings	52.47	131.12	78.69	111.81	53.24	44.85	15 %
Other non-res.	65.50	163.73	98.07	137.32	85.87	36.32	12 %
Total non-res.	**283.35**	**708.35**	**424.84**	**602.62**	**395.86**	**298.28**	**100 %**
Total floorspace	**491.99**	**1042.16**	**769.55**	**1281.92**	**1079.07**	**716.28**	**5380.97**

Source: Kohler et al. 1999, p. 24.

The figures contained in the BMVBS publication (BMVBS 2011) are further broken down into heated and non-heated non-residential buildings in the sense of the Energy Saving Regulation (EnEV). According to this, there are in Germany between 1,258 and 1,887 million heated non-residential buildings in the sense of the EnEV (p. 102ff.). For instance, such buildings as stables, churches and warehouses do not come under the EnEV. They are however taken into account in the energy data compiled by the BMWi and used in the context of this scenario. For this reason, the remaining study works with the whole stock of non-residential buildings. Moreover data and assumptions pertaining to residential sector are, where necessary, applied to the non-residential sector, thus enabling us to at least make an approximation.

Qualitative data

Alongside the absolute number of buildings, their current condition is a further important determinant. This can be described using a whole range of different parameters. For the purpose of developing an understandable model, simplifications are however needed.
For the remaining survey, residential and non-residential buildings are viewed separately and further subdivided. Looking first at residential buildings, three subcategories are used: detached / semi-detached houses, small blocks of flats (up to 12 flats) and large blocks of flats (>12 flats). These subcategories are further divided into five age categories (built before 1949, before 1979, before 1996, before 2001 and from 2001 onwards).
Turning to non-residential buildings, there is not much data available. For the scenario, four age categories (built before 1977, before 1984, before 1995 and from 1995 onwards) were formed. Total floorspace is mapped to the individual usage and age categories, with calculations based on the dena figures (2011). The distribution of non-residential buildings by age is done on the basis of the stock of residential buildings.

In the remaining survey the gains in energy efficiency through refurbishment are to be ascertained in relation to the buildings. Energy performance indicators with their wide range of parameters offer a possible approach here. The available literature distinguishes between consumption indicators (*Verbrauchskennzahlen*) and demand indicators (*Bedarfskennzahlen*), whereby the absolute size of these figures varies. Dena (2012) assumes for instance a final energy demand of 239 kWh/m²a for detached houses that have not yet undergone energy-related refurbishment. Following comprehensive refurbishment (to efficiency level 55), this should drop to 48 kWh/m²a (dena 2012, p. 29). In their article, Schröder et al. (2011) point out that energy demand indicators are often too high, not reflecting actual consumption. Their survey revealed average energy consumption of 150 kWh/m²a for detached and semi-detached houses (Schröder et al. 2011, p. 33). For blocks of flats *Institute for Economic Research* (IWH) reckons with an average of 131.1 kWh/m²a (Michelsen et al. 2011, p. 296), though with strong regional fluctuations. At the end of the day, the absolute figures are of no relevance for the design of the scenario. Of greater importance is the percentage tightening of the standard, as this is what triggers modernisation measures applying to the different types of building. Table 18 therefore shows the possible energy efficiency improvements on which the scenario is based. These values are based on estimates of the Heinz-Piest Institute arrived at after analysing various sources (BMVBS 2011; Schröder et al. 2011; dena 2011; FGK 2011; dena 2010; Diefenbach et al. 2010; Wolff 2007; GDI 2006) and carrying out their own calculations. The effectiveness of a modernisation measure refers to the potential percentage energy savings through achieving efficiency level 40 (the KfW scale) with a heating requirement of 35 kWh/m²a (Diefenbach 2012).

These calculations and a building's actual condition also allow us to come to conclusions on the respective shares of the individual types of building in overall energy consumption. These are in turn used to map assumed energy consumption to overall heating requirements. However only a certain percentage of this consumption (60%) is assigned to heat loss via the building's envelope, whereby this percentage is dependent on the building's actual condition. The assumed average is based on our own calculations (in turn based on the FGK figures (2011).

Using the efficiency factor, a building's post-refurbishment energy consumption is then calculated and extrapolated to gain the maximum saving when all buildings are refurbished. Using the savings required to achieve the energy-saving target, the percentage of buildings needing to be refurbished is then calculated.

Table 18: Building categories, assumptions regarding potential energy efficiency improvements and the resulting pre-refurbishment final energy consumption

Type of building	Energy consumption [TWh]	Energy efficiency improvement [27]
Detached / semi-detached houses		
before 1949, not refurbished	84.7	0.806
before 1949, partially refurbished	16.5	0.611
before 1979, not refurbished	134.9	0.806
before 1979, partially refurbished	26.2	0.611
before 1996	34.9	0.563
before 2001	7.3	0.300
from 2001 onwards	5.1	0.000
Small blocks of flats		
before 1949, not refurbished	44.8	0.788
before 1949, partially refurbished	8.8	0.578
before 1979, not refurbished	71.2	0.788
before 1979, partially refurbished	13.9	0.578
before 1996	20.7	0.576
before 2001	4.2	0.300
from 2001 onwards	2.9	0.000
Large blocks of flats		
before 1949, not refurbished	8.9	0.781
before 1949, partially refurbished	1.7	0.563
before 1979, not refurbished	14.2	0.781
before 1979, partially refurbished	2.8	0.563
before 1996	4.1	0.563
before 2001	0.9	0.300
from 2001 onwards	0.6	0.000
Non-residential buildings		
before 1977	216.8	0.806
before 1984	20.6	0.750
before 1995	11.8	0.563
from 1995 onwards	7.2	0.000

Source: Own calculations taking BMVBS figures into account (BMVBS 2011); Schröder et al. 2011; FGK 2011; dena 2010; dena 2011; Diefenbach et al. 2010; Wolff 2007; GDI 2006 and BMWi 2011.

A total 3.4 billion m² floorspace in residential buildings and 2.5 billion m² in non-residential buildings is assumed. The floorspace presented in Table 11 is calculated on the basis of the described types of buildings.

[27] Efficiency is expressed as the relation between actual energy consumption and the 2020 target consumption of 35 kWh/a*m² (Diefenbach 2012). Correlations between demand and consumption parameters were not taken into account.

For our scenario, we initially assume that only people owning homes built before 1996 (or non-residential buildings built before 1977) will undertake refurbishment measures. The remaining buildings will not make any additional contribution to achieving the targets. A further assumption is that only half of already insulated houses will undergo further energy-related modernisation. The savings to be provided by these types of buildings is to be achieved via the refurbishment of additional non-insulated types of buildings. The following Table 19 shows the amount of floorspace needing to be refurbished.

Table 19: Floorspace share of each type of building

Type of building	Energy consumption [TWh]	Energy efficiency improvement [28]
Detached / semi-detached houses		
before 1949, not refurbished	84.7	0.806
before 1949, partially refurbished	16.5	0.611
before 1979, not refurbished	134.9	0.806
before 1979, partially refurbished	26.2	0.611
before 1996	34.9	0.563
before 2001	7.3	0.300
from 2001 onwards	5.1	0.000
Small blocks of flats		
before 1949, not refurbished	44.8	0.788
before 1949, partially refurbished	8.8	0.578
before 1979, not refurbished	71.2	0.788
before 1979, partially refurbished	13.9	0.578
before 1996	20.7	0.576
before 2001	4.2	0.300
from 2001 onwards	2.9	0.000
Large blocks of flats		
before 1949, not refurbished	8.9	0.781
before 1949, partially refurbished	1.7	0.563
before 1979, not refurbished	14.2	0.781
before 1979, partially refurbished	2.8	0.563
before 1996	4.1	0.563
before 2001	0.9	0.300
from 2001 onwards	0.6	0.000
Non-residential buildings		
before 1977	216.8	0.806
before 1984	20.6	0.750
before 1995	11.8	0.563
from 1995 onwards	7.2	0.000

Source: dena 2011, own calculations.

Compiling the data for the systems used in the context of energy-related refurbishment is quite difficult, as the different systems are in many cases not separately surveyed. The data available (cf. also Chap 4.3.1.3.3) is not compatible with the refurbishment data. A simplified model is therefore used to estimate refurbishment requirements.

[28] Efficiency is expressed as the relation between actual energy consumption and the 2020 target consumption of 35 kWh/a*m² (Diefenbach 2012). Correlations between demand and consumption parameters were not taken into account.

According to the *Federal Trade Association Germany House, Energy and Environmental Technology* (BDH), it can be assumed that 17.8 million heating systems and 1.5 million solar heating systems are installed in Germany. These figures are based on surveys conducted by the Chimney Sweep Trade Association for 2010, which arrived at a figure of 13.7 million systems, and BDH estimates (Breidenbach 2011).

77 - 88% of these systems need to be modernised, as they are considered to be inefficient or no longer state-of-the-art (Breidenbach 2011; Diefenbach 2011, p. 87 ff.). If we assume that ca. 30% of the final energy consumption is used by these systems, they will have to contribute ca. 30.6 million kWh of savings to bring energy consumption down by 20%. Internal dena calculations point to an average of 4,500 kWh being able to be saved per year and system through modernisation. On this basis, the maximum amount of potentially saveable energy would be ca. 67.6 million kWh. To achieve the target, 6.8 million systems would need to be modernised. This figure is however only approximate. Dependent on the base used, it represents somewhat more than a third of existing systems. In relation to the age structure and technical condition of the systems, the number of systems needing to replaced does however seem realistic.
With regard to the type of heating system, reference could be made to the market shares seen over the last few years (cf. Breidenbach 2011). As this market is however greatly influenced by available state subsidies, we will not take the figures into account. Generally speaking, it can however be said that the market will continue to be dominated by oil- and gas-fired systems.

4.3.2.3 Phase 3: assessment and interpretation

For the following steps, the findings arrived at in Chapter 4.3.2.2 need to be put in relation to the costs. The focus here is on two main aspects: the size of the buildings needing to be modernised and the type of heating system to be replaced. As the available data only allows an in-depth analysis of individual measures on the basis of actual buildings, we again have to revert to an estimate.
One possible approach involves using refurbishment cost per m². In the literature already referred to, a discussion can be found on ways of delimiting additional costs related to energy efficiency improvements. But these are for the most part the additional costs of energy-related modernisation compared with a modernisation without a primary focus on improving energy efficiency. For our calculations, this is however irrelevant, as we need to estimate the total on-top cost. We therefore assume the following m² costs: 500,- EUR/m² for residential buildings and 380,- EUR/m² for non-residential buildings. This assumption for residential buildings is similar to the full costs used by dena (cf. dena 2011, p. 36; dena 2012, pS. 35 f). As regards non-residential buildings, we refer to Hebel et al. (2011, p. 27 f.).

These costs reflect comprehensive modernisation including the heating system. On ascertaining the floorspace to be refurbished, only the heat loss of the building's envelope was taken into account. We therefore need to consider whether these cost assumptions need to be corrected. When the floorspace needing to be refurbished is put in relation to the buildings, the figure of 30% of buildings needing refurbishment is about the same as the percentage of systems needing to be replaced. As a result of the assumptions and simplifications made, it can be assumed that our cost figures do not need correcting.

Using these figures, we arrive at a total investment volume for residential buildings of 372.7 billion EUR up to 2020. This is the amount needed to achieve the climate protection targets. Broken down over 7 years, this implies 53.2 billion EUR per annum. Taking into account the 2011 model calculations of the *German Institute for Economic Research* (DIW), 42.3 billion EUR is already being invested in energy-related measures. This therefore points to an additional requirement of about 10.9 billion EUR per annum (Gornig et al. 2011, p. 42).

Turning to non-residential buildings (for which we only have rudimentary data), a total of 195.4 billion EUR has been calculated, i.e. 27.9 billion EUR per annum for the 7-year period 2014-2020. Taking into account the DIW figures of 15.2 billion EUR for 2010, this results in an on-top requirement of 12.7 billion EUR a year (Gornig et al. 2011, p. 42).

In line with Wolff (2009), the investment requirement can be broken down into heating systems (25%), windows (30%), insulating outside walls (20 %), insulating cellar ceilings/cellars (12.5%) and insulating top floors/roofs (12.5 %). The figures arrived at using this breakdown can be used as a base for further estimates. It should always be borne in mind that the results are in many cases approximations due to the often rudimentary and indeed sometimes contradictory state of the data available. Nevertheless they constitute an adequate basis for the project.

4.3.2.4 Conclusions

The aim was to design a scenario on which the further steps of the project could be based. In contrast to our initial assumption, our study of the available literature has shown that the existing data is for most part incompatible, with different definitions of terms and problems in different boundaries meaning that the existing figures could not, as originally planned, be linked up with each other. This was especially the case with non-residential buildings, where the existing figures were by no means comprehensive. There is an urgent need here for further research.

This all means that the scenario, though covering all main aspects, is defined on a conservative basis. It is based on a distinction between residential and non-residential buildings and different age categories. Quantification of the targets to be achieved, together with assumptions on efficiency improvements, enables us to estimate the total refurbishment requirement in m^2 floorspace terms. The results show that the targets set for the building sector are by no means unattainable, though the task of reducing energy consumption is very ambitious. Compared to the energy-saving target, the targets for the use of renewables and the reduction of GHG emissions are relatively easy to achieve. At the end of the day, what remains is a major investment effort, whereby past experience shows that state subsidies can play a major role in triggering measures. Whether and in which manner the state will support the private sector is not part of this study. What does however need to be taken into account is that many public buildings are in need of refurbishment and that this alone requires a major investment effort. Even so, what is also clear is that the major share of the 23.6 billion EUR per annum needed to achieve the targets will have to be borne by the owners of the buildings.

5 Statistics on building and energy sectors

5.1 Data on the selected building occupations

Tobias Maier

5.1.1 The buildung industry and selected building occupations

In its National Accounts, the Federal Statistical Office (FSO) lists the building (construction) industry as employing 2.428 million people in 2011. Given a total employed population of 41.1 million people, this corresponds to 6%.[29]. Total employment figures in the selected building occupations are not however fully equivalent to the total number of people employed in the building industry overall, as not all the latter work in the selected occupations. At the same time, certain occupations listed as belonging to other economic sectors (such as manufacturing) have been identified as occupations relevant to the energy-related refurbishment of buildings (cf. Chapter 7.1). The National Accounts unfortunately contain no data on occupations in certain sectors, meaning that in this area we have to make use of the FSO's microcensus, an annually conducted representative survey of 1% of Germany's population, covering some 830,000 people in around 370,000 private households and community dwellings. Questions asked relate to family and partnerships, the labour market and employment, occupations and education. Despite the random selection mechanism and despite the high participation rate (participation is mandatory) of 97%, the microcensus's extrapolated values are not fully consistent with the figures contained in the National Accounts. For instance, the National Accounts give a figure of 2.343 million people working in the building industry in 2008, whereas the microcensus-based figure is 2.547 million.[30]

Table 20 shows a matrix mapping occupational categories[31] to economic sectors. The occupations listed in Chapter 7.1 as being relevant for the energy-related refurbishment of buildings are classified according to the sectors, using the second level (2-digit) of the 2003 economic sector classification system (Destatis 2003). This matrix shows that, on the basis of 2008 microcensus figures, 1.384 million people working in the selected building occupations actually work in the building sector. This means that the occupations selected as building occupations are also occur in other sectors: 6.1% of all employed in these occupations are found

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29 Table 2.2.5 of the FSO's "Fachserie 18, Reihe 1.4, Statistisches Bundesamt 2011".

30 This means that the microcensus tends to over-estimate building industry employment figures, while at the same time underestimating total employment (2008: microcensus total employment: 39.343 million; National Accounts total employment: 40.345 million). See also: Köhne-Finster & Lingnau, 2008.

31 In its Classification of Occupations (Destatis 1992), the Federal Statistical Office established a hierarchy for classifying occupations. At the top level we find 6 "occupational areas" (Berufsbereiche), for instance "manufacturing" or "services. On the lower levels there are first 33 "occupational sectors" (Berufsanschnitte), then 88 "occupational groups" (Berufsgruppen), then 369 3-digit "occupational categories" (Berufsordnungen". The lowest level (4-digit) covers 2,287 actual occupations.

in the "manufacture of fabricated metal products" sector and 5% in the "manufacture of machinery" sector. The main 'culprits' here are "construction mechanics and associated metal-builders" / "*Konstruktionsmechaniker (Ausrüstungstechnik) und zugehörige Metallbauer*", "Other metal-building and associated occupations" / "*Sonstige Metallbau- und verwandte Berufe*", "Refrigeration engineers and technicians" / "*Kälteanlagenbauer, Kälteanlageninstallateure*" and "Foremen" / "*Industrie-, Werkmeister*".

Table 20: People working in the selected building occupations (by economic sector)

Occupatinal categories (*Berufsordnungen*) associated with building occupations		Economic branches (WZ classification 2003)															
		28 Manufacture of fabricated metal products		29 Manufacture of machinery		34 Manufacture of motor vehicles, trailers and semi-trailers		36 Manufacture of furniture, jewellery, musical instruments, sports goods, games and toys and other products		45 Construction Sector		74 Legal activies		Other economic branches		Total	
		In 1000	In %	In 1000	In %	In 1000	In %	In 1000	In %	In 1000	In %	In 1000	In %	In 1000	In %	In 1000	In %
101	Stone preparers	0,3	1,7%	0,0	0,0%	0,0	0,0%	0,5	2,5%	1,6	8,2%	0,0	0,0%	17,1	87,7%	19,5	100%
112	Shaped brick, concrete block makers	0,2	2,8%	0,0	0,0%	0,0	0,0%	0,0	0,0%	2,7	39,2%	0,0	0,0%	4,0	58,0%	7,0	100%
254	Construction mechanics (plant equipment) and associated metal workers	115,9	37,6%	40,4	13,1%	19,2	6,2%	1,9	0,6%	28,5	9,2%	13,1	4,2%	89,1	28,9%	308,1	100%
259	Other metalworking and related occupations	5,9	29,0%	2,4	12,1%	1,7	8,5%	0,2	0,8%	5,1	25,1%	0,3	1,7%	4,6	22,8%	20,2	100%
261	Plumbers	0,1	0,5%	0,2	1,0%	1,1	4,6%	0,0	0,0%	20,3	87,7%	0,3	1,5%	1,1	4,8%	23,1	100%
264	Plant mechanics (energy systems)	1,0	5,5%	1,2	6,1%	0,6	3,3%	0,0	0,0%	6,4	33,7%	1,6	8,4%	8,2	43,0%	19,1	100%
266	Refrigeration system builders and fitters	0,0	0,0%	7,5	58,5%	0,0	0,0%	0,0	0,0%	2,8	21,8%	1,1	8,7%	1,4	11,0%	12,9	100%
267	Gas and water fitters	0,6	0,6%	0,5	0,5%	0,5	0,6%	0,0	0,0%	79,0	83,4%	2,6	2,8%	11,5	12,1%	94,8	100%
268	Central heating and air-conditioning builders	1,3	1,1%	0,4	0,4%	0,0	0,0%	0,0	0,0%	99,8	89,3%	4,2	3,8%	6,0	5,3%	111,7	100%
310	Electricians	7,4	2,1%	21,5	6,1%	11,8	3,3%	0,7	0,2%	160,3	45,2%	15,8	4,5%	137,3	38,7%	355,0	100%
311	Energy system electricians	3,0	2,8%	10,5	10,1%	8,1	7,8%	0,7	0,7%	9,7	9,3%	2,4	2,3%	70,0	67,0%	104,5	100%
316	Electro-mechanical technicians, industrial electronic technicians	5,6	3,1%	21,0	11,5%	17,9	9,8%	1,3	0,7%	15,8	8,6%	4,5	2,5%	117,2	63,9%	183,3	100%
317	ICT electronic technicians	0,7	1,9%	0,3	0,8%	1,0	2,6%	0,0	0,0%	1,2	2,9%	2,6	6,5%	33,6	85,3%	39,4	100%
440	Other construction occupations	0,3	0,5%	0,2	0,3%	0,6	1,1%	0,0	0,0%	53,2	93,9%	0,7	1,2%	1,7	3,0%	56,6	100%
441	Masons, furnace and chimney builders	0,8	0,4%	0,5	0,2%	0,3	0,1%	0,0	0,0%	180,2	92,1%	1,9	1,0%	12,0	6,1%	195,6	100%
442/ 443	(Reinforced) concrete masons	2,4	4,3%	0,3	0,5%	0,2	0,3%	0,0	0,0%	44,8	80,8%	0,4	0,8%	7,4	13,3%	55,4	100%
460	Scaffolders	0,2	0,4%	0,0	0,0%	0,0	0,0%	0,0	0,0%	34,3	94,8%	0,2	0,5%	1,6	4,3%	36,2	100%
466	Civil engineering occupations, demolition and blasting experts (not mining)	0,2	0,6%	0,5	2,0%	0,0	0,0%	0,0	0,0%	19,6	76,7%	0,2	0,8%	5,1	19,9%	25,6	100%
480	Other civil engineering occupations	0,1	1,5%	0,0	0,0%	0,0	0,0%	0,0	0,0%	7,9	92,2%	0,0	0,0%	0,5	6,3%	8,6	100%
481	Finishing occupations	0,0	0,0%	0,0	0,0%	0,2	0,7%	0,0	0,0%	30,1	95,3%	0,2	0,7%	1,0	3,2%	31,6	100%
482	Stuccoists	0,2	0,3%	0,4	0,6%	0,2	0,4%	0,0	0,0%	55,6	92,3%	0,3	0,5%	3,5	5,9%	60,3	100%
483	Insulation and sealing specialists	0,0	0,0%	0,0	0,0%	0,0	0,0%	0,0	0,0%	63,6	93,0%	0,3	0,5%	4,5	6,6%	68,4	100%
484	Tilers	0,0	0,0%	0,2	1,9%	0,0	0,0%	0,0	0,0%	7,7	88,2%	0,0	0,0%	0,9	9,8%	8,7	100%
485	Tiled stove and air heating builders	0,4	1,5%	0,0	0,0%	0,2	0,8%	0,0	0,0%	18,5	68,9%	0,4	1,4%	7,3	27,4%	26,8	100%
486	Glaziers	0,0	0,0%	0,0	0,0%	0,0	0,0%	0,0	0,0%	10,8	97,8%	0,0	0,0%	0,2	2,2%	11,1	100%
487	Screed and terrazzo layers	0,4	0,4%	0,0	0,0%	0,2	0,2%	0,6	0,6%	78,4	87,2%	1,2	1,3%	9,1	10,2%	89,9	100%
488	Carpenters	0,4	0,4%	0,0	0,0%	0,0	0,0%	0,0	0,0%	84,5	97,7%	0,6	0,7%	1,0	1,1%	86,5	100%
491	Roofers	0,0	0,0%	0,0	0,0%	0,0	0,0%	1,6	2,8%	41,0	71,1%	3,5	6,0%	11,6	20,1%	57,7	100%
501	Interior decorators, parquet layers	0,5	0,2%	0,3	0,1%	3,2	1,1%	113,4	40,2%	85,4	30,3%	4,7	1,6%	74,6	26,4%	282,1	100%
505	Joiners	0,1	0,5%	0,0	0,0%	0,0	0,0%	8,9	32,2%	4,1	14,7%	0,9	3,3%	13,6	49,3%	27,7	100%
511	Wood mechanics	0,9	0,6%	1,4	1,0%	0,4	0,3%	0,5	0,3%	117,4	84,4%	4,2	3,0%	14,4	10,4%	139,1	100%
651	Painters and varnishers (finishing sector)	18,0	12,7%	16,7	11,8%	19,7	13,9%	1,0	0,7%	4,9	3,5%	1,2	0,9%	80,3	56,6%	141,8	100%
633	Chemical lab technicians	0,9	1,2%	1,2	1,5%	0,7	0,9%	0,5	0,6%	1,2	1,6%	5,9	7,6%	67,0	86,6%	77,4	100%
641	Draughtsmen	6,3	8,9%	17,1	24,2%	4,5	6,3%	0,4	0,6%	7,6	10,7%	17,5	24,7%	17,4	24,6%	70,7	100%
804	Chimney sweeps	0,0	0,0%	0,0	0,0%	0,0	0,0%	0,0	0,0%	0,1	0,8%	15,6	93,2%	1,0	6,0%	16,7	100%
	Total	174,2	6,1%	144,7	5,0%	92,4	3,2%	132,1	4,6%	1384,1	48,2%	108,5	3,8%	836,9	29,1%	2872,9	100%

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

The findings of Table 20 are however to be used with care, as the selected occupational categories are not fully identical with the building occupations used in Chapter 7.1). Within the above-mentioned occupational categories, the building occupations selected only play a minor role with regard to employment figures. An exact mapping to the selected building occupations at the 4-digit level of the 1992 occupational classification system (KldB 1992) (Destatis 1992) is not possible due to the fact that the microcensus in many cases does not come up with sufficient response figures. The mapping of building occupations to economic sectors, as done in Table 20, must therefore be seen as an approximation, giving a rough idea of how the selected apprentice / master occupations are to be found not just in the building sector, but also in other sectors.

Table 20 states that a total of 2.873 million people work in the selected building occupations. Taking into account the fact that the microcensus overestimates the number of people working in the building sector compared to the National Accounts yet underestimates the total working population, any future calculations should take both sources into account. For this reason, the microcensus figures were subjected to an iterative marginal value adjustment process (*Randsummenanpassungsverfahren* or RAS), with their figures being corrected upwards in relation to the employment figures stated for the 59 economic sectors listed in the National Accounts. In doing so, the parameters age, gender, level of education and originally learnt occupation relating to the population as a whole were kept constant (see also Bott, Helmrich, Schade, & Weller, 2010: S. 66). As a result of these new calculations, the number of people working in the selected building occupations in 2008 goes down by ca. 175,000 from 2.873 to 2.697 million. As regards 2011, assuming the same distribution of occupations to sectors as in 2008, we estimate a total of ca. 2.678 million people to have been working in the selected building occupations.

Following the non-structural adjustment of the microcensus figures to the National Accounts figures, the qualification and age structure of the ca. 2.697 million people working in the selected building occupations in 2008 can now be determined using the microcensus figures, as the determinant ratios of workers between categories was maintained despite the adjustment.

5.1.2 Number of people working in the selected building occupations

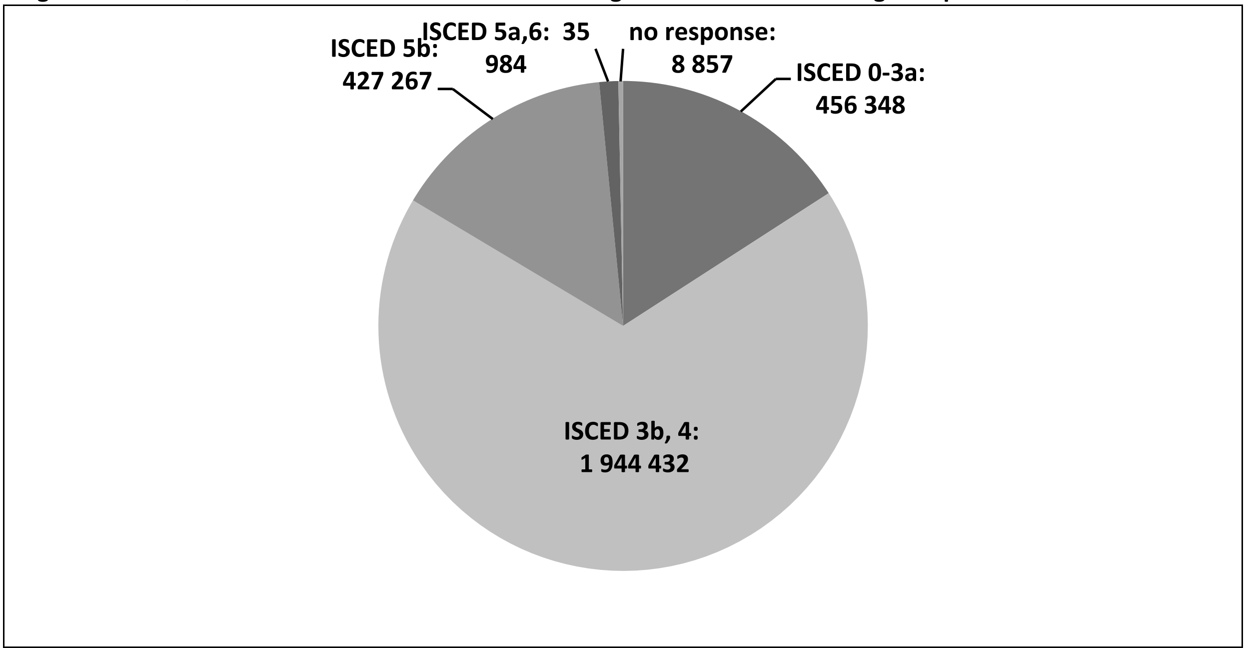
5.1.2.1 Qualification structure of those working in the selected building occupations

Figure 20 shows that just over two-thirds of those working in the selected building occupations have an IVET qualification meeting the requirements of ISCED[32] levels 3b and 4 (middle-level qualifications). 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). Some 84% of those working in the selected building occupations thus have a VET qualification. The selected building trades are first and foremost reliant on people with middle-level qualifications (i.e. ISCED 3b and 4), meaning that guaranteeing their future is to a great extent dependent on VET developments at this

[32] 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.).

level. This also means - indirectly - that the share of people with a level 5b master/engineering qualification needs to be maintained, as these are the ones with the statutory qualification authorising them to take on apprentices.

Figure 20: Qualifications structure of those working in the selected building occupations



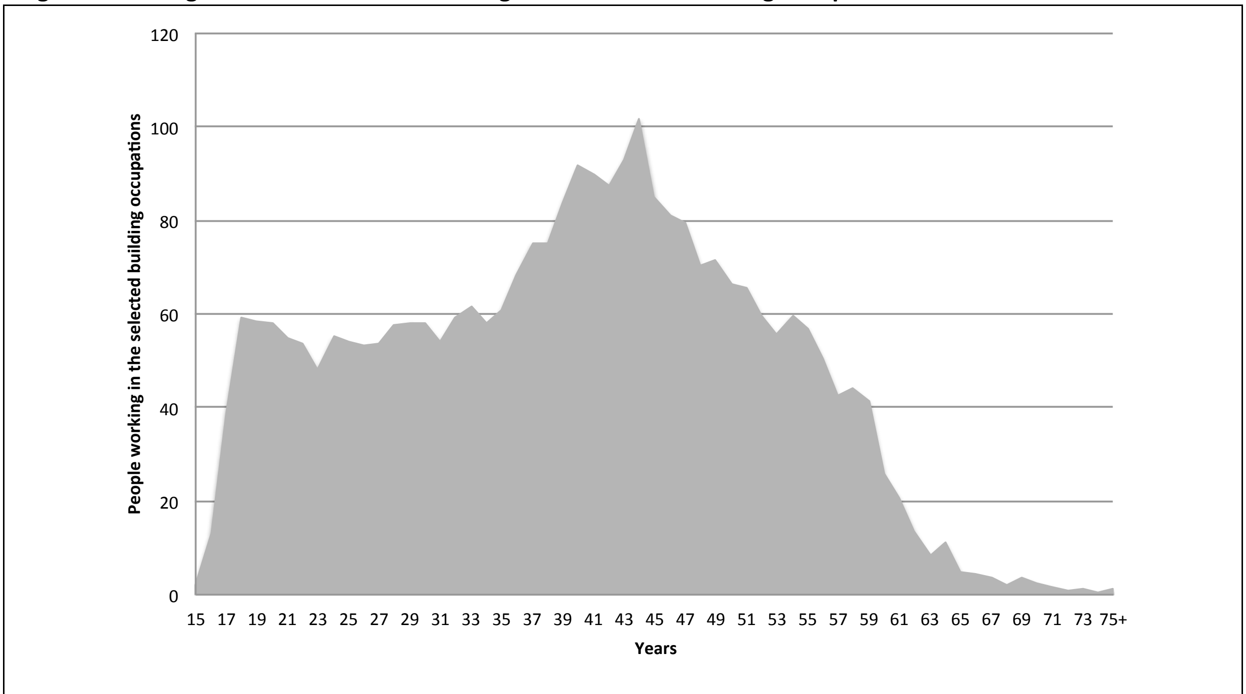
Source: 2008 microcensus of the Federal Statistical Office, BIBB calculations.

5.1.2.2 Age structure and gender of those working in the selected building occupations

Looking at the age structure of those working in the selected building occupations (Figure 21), we see that most workers are in the 35 - 50 age bracket. It can also be clearly seen that the 15 - 34 year-old cohort is not large enough to fully replace the 35-50 year-old cohort when the latter exits the labour market.

Turning to gender, it is evident that the selected building occupations are "male" occupations, with only 5.6% of all those working in them being women (2008 microcensus; BIBB statistics).

Figure 21: Age structure of those working in the selected building occupations



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

5.1.3 People with a formal IVET qualification in the selected building occupations

In 2008, some 4.515 million people gained an IVET qualification[33] in one of the selected building occupations. This means that 70% more people have a formal IVET qualification in one of the selected building occupations than actually worked in them in 2008. Summarising the selected building occupations under the respective BIBB occupational fields (see Chapter 7.2, Table Table 31), we see that the "over-supply" of people with an IVET qualification is greatest in the following building occupations: metal building (*Metallbau*), plant construction (*Anlagenbau*), installation (*Installation / Montierer*), and technical draughtsmen (*Technische Zeichner*). By contrast the master trades summarised under engineers (*Techniker*), and chimney sweeps (assigned to the cleaning and waste disposal category of occupations) are

[33] BIBB calculations based on the 2008 microcensus of the Federal Statistical Office and after marginal value adjustment aligning them with the National Accounts.

barely able (if at all) to cover their employment needs through people with an IVET qualification in these fields. This imbalance between those with a formal IVET qualification and those actually working in the respective occupation has an effect on the employment patterns of those concerned: Not all those with a formal IVET qualification in a specific occupation are able to actually work in that occupation, meaning that instead they take up other occupations. The other side of the coin is that those occupations where the supply of workers with an appropriate IVET qualification does not meet demand are dependent on an "in-migration" of people with other qualifications or people without any formal qualifications. The ratio of those with a formal IVET qualification to the employment needs in a specific occupation can therefore be seen as an indicator for the extent the demand for skilled workers is covered. The lower the coverage, the more difficult it is to recruit people with the right qualifications (cf. Kägi, Sheldon, & Braun 2009, p. 26ff.).

Table 21: People with a formal (I)VET qualification and people actually working in the selected building occupations

Selected building occupations within occupational fields	Potential labour force	Acutal labour force	Coverage (demand of skilled wokers)
Stoneworking, construction materials production, ceramics, glass related occupations	36	29	1,2
Metal construction, plant construction, sheet metal construction, installation, fitters	1131	542	2,1
Electrical occupations	1166	670	1,7
Construction, woodworking, plastics manufacture and processing occupations	1747	1135	1,5
Technicians	139	140	1,0
Specialist skilled technicians	173	82	2,1
Engineering draughtsmen, related occupations	104	76	1,4
Cleaning and waste disposal occupations	19	23	0,8
Gesamt	4516	2697	1,7

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

5.1.4 Summary

We can summarise by saying that that the existing number of people working in the selected building occupations cannot be deduced from one single source. Instead we need to use several sources, correlating them with each other. The National Accounts produced by the Federal Statistical Office (FSO) list the numbers of people working by sector and not by occupation. Though the FSO's microcensus contains data both on which sector a person works in and what his occupation is, it is not fully equivalent in its findings to the National Accounts. These were the reasons why the microcensus results were adjusted to reflect the numbers of people working in the sectors listed in the National Accounts. Our findings:

- In 2011, some 2.428 million people worked in the building sector (National Accounts figure).
- Just over a half of those working in the selected building occupations were actually working in the building sector (2008 microcensus).
- In 2008 some 2.697 million people were working in the selected building occupations; estimates put the corresponding number for 2011 at 2.678 million (microcensus and National Accounts).
- Two-thirds of those working in the selected building occupations have a middle-level qualification (ISCED level 3b or 4). About half of the remaining one-third has a master/engineering qualification (ISCED 5b), whereas the other half has no formal VET qualification (ISCED 0 - 3a) (2008 microcensus).
- The majority of those working in the selected building occupations are in the 35 - 50 age bracket (2008 microcensus).
- A mere 5.6% of those working in the selected building occupations are women (2008 microcensus).
- In 2008, there were some 4.515 million people[34] with a formal IVET qualification in the selected building occupations (microcensus and National Accounts). Were all these people to be available to the employment market in the occupation for which they were originally qualified,, the demand for labour in these selected building occupations could - from a mathematical perspective - be satisfied.

[34] Calculations based on the 2008 microcensus of the Federal Statistical Office and after marginal value adjustment aligning them with the National Accounts.

5.2 The building sector in figures

Christian Welzbacher

5.2.1 Building stock - numbers and sizes of buildings

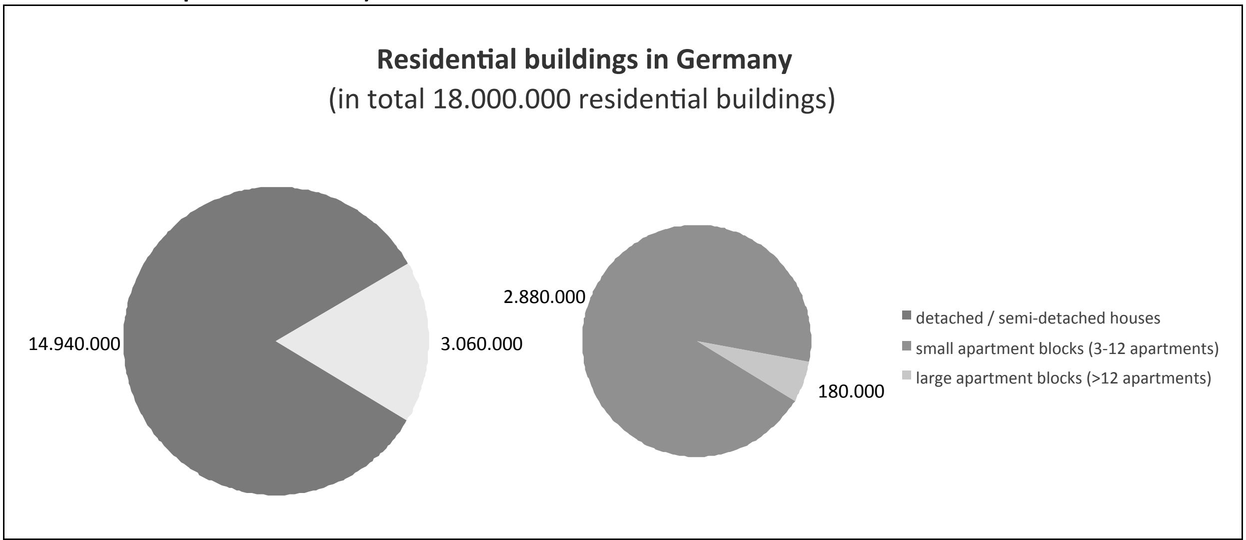
Chapter 4.3.2 on the development of a political-technical scenario for assessing to what extent the building sector's energy efficiency targets can be met already contains figures on Germany's building sector. There are a total of 20.48 million buildings in Germany. This total is the sum of two figures: the 18 million residential buildings (with a total of 40 million residential units) found in the German Energy Agency's Building Report (dena 2011a p. 4) and based on figures of the Federal Statistical Office (Destatis); and the 2.48 million non-residential buildings stated in a BMVBS publication (2011, p. 102). Figures on non-residential buildings vary somewhat in the available literature, frequently dependent on whether a building is heated (i.e. in accordance with the EnEV). The BMVBS report for instance gives a figure of 1.258 million heated non-residential buildings (2011, p. 103).
Total floorspace of all buildings (residential and non-residential) amounts to around 5.9 billion m², with some 58% (3.4 billion m²) belonging to residential buildings and 42% (2.5 billion m²) to non-residential buildings (dena 2011a p. 4, BMVBS 2011 p. 102).

5.2.2 Type of building - residential or non-residential

The first categorisation of buildings is whether they are used for residential or non-residential purposes.

Residential buildings
Residential buildings are either detached or semi-detached houses (14.49 million buildings in Germany) or apartment blocks (3.06 million buildings). Apartment blocks are classified according to size (3-12 apartments / > 12 apartments), as seen in Figure 22 below.

Figure 22: Residential buildings in Germany (detached and semi-detached hoses, large and small apartment blocks)



Source: The dena building report.

Non-residential buildings

Non-residential buildings are classified according to their use (BMVBS 2011, p. 102):

- 44,000 care institutions[35]
- 189,000 office buildings
- 665,000 agricultural buildings
- 311,000 non-agricultural commercial buildings
- 355,000 factory buildings and workshops
- 634,000 retail buildings and warehouses
- 49,000 hotels and restaurants/pubs
- 233,000 other non-residential buildings (incl. schools, universities, nurseries)

5.2.3 Number of low-energy houses

Before determining the number of low-energy houses, we must first draw a line as to when a building is classified as being a low-energy house. According to Feist, a house with a heating requirement of ≤ 70 kWh/m²a and an apartment block with a heating requirement of ≤ 55 kWh/m²a are deemed to be low-energy buildings (Feist o. A., p. 1). Using the dena Energy Passport database, which lists 9,000 houses and 4,000 apartment blocks, an estimate can be made of the number of low-energy residential buildings in Germany. According to this database, 12% of houses have a heating requirement (as defined by the EnEV) of ≤ 70 kwh/m²a and ca. 6% of apartment blocks a heating requirement of ≤ 55 kwh/m²a (dena 2011b). Applying these percentages to the figures presented in Chapter 5.2.2, we can reckon with ca. 1.79 million houses and 367,000 apartment blocks being low-energy buildings. This means that about 10% of all residential buildings can be classified as low-energy. An

[35] Care institutions: all buildings in which people are cared for and which have a central management (e.g. hospitals, homes for senior citizens and children).

evaluation of the KfW report (cf. Kuckshinrichs 2011) is of little value here, as the report only contains figures on measures receiving financial support from the KfW.

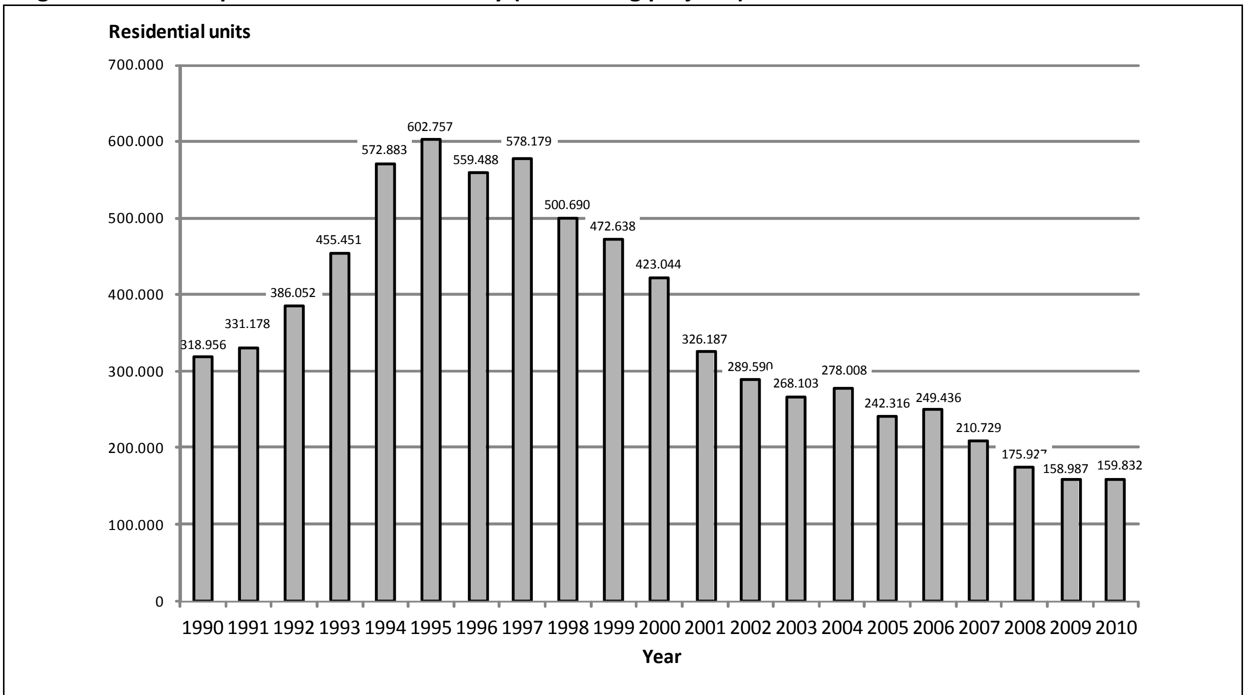
The 2009 figures for residential buildings classified as low-energy show ca. 2.27 million residential units in detached and semi-detached houses and a further 1.28 million units in apartment blocks. Compared with Germany's overall stock of 40.2 million residential units (dena 2010a), this means that around 9% of residential units can be classified as low-energy homes.

There are no figures available in this respect on non-residential buildings.

5.2.4 New housing construction rate

The new housing construction rate can be used to determine the annual percentage of new buildings / residential units added to the existing stock. An evaluation of Destatis data shows that the construction rate has been decreasing over the last few years. Whereas 602,757 residential units (apartments in both residential and non-residential buildings) were constructed in 1995, the figure dropped to 423,044 in 2000, to 242,316 in 2005 and to just 159,832 in 2010 (Destatis 2012b). Expressed as a percentage of Germany's total 40.2 residential units, the current construction rate is 0.39% (dena 2011a p. 5). However 2009 probably saw new construction figures bottoming out, as since then numbers have been rising (cf. Figure 23).

Figure 23: Completed homes in Germany (all building projects)



Source: Federal Statistical Office (Destatis 2012b), own calculations.

5.2.5 The energy-related refurbishment rate

The energy-related refurbishment rate states the percentage of the building stock being subjected to energy-related refurbishment each year - i.e. only projects aimed at increasing a building's energy efficiency are taken into account. There are however no adequate figures available for ascertaining the rate for non-residential buildings.
The housing data available shows different refurbishment rates. The overall modernisation rate with regard to upgrading a building's envelope is put at 0.83% (Diefenbach et al. 2010, p. 70). The Federal Ministry of Economics puts the annual refurbishment rate at an average of 1.3%, with a downward trend (BMWI 2007, p. 61). Kohler points to a refurbishment rate of 0.9 - 1.3% (Kohler 2011). It can be assumed that all sources are referring to the annual refurbishment rate for residential buildings.

5.2.6 Companies operating in the construction and fitting & finishing sectors

Though Federal and *Bundesland* statistics contain a lot of data referring to the building sector, they do not furnish a complete picture of the two sectors' companies, employment figures and turnover. This is due to the company size limits used in the surveys as a way of reducing red tape for small companies (i.e. companies with less than 'n' employees are not required to participate in such surveys). These have resulted in a major under-representation of small companies, especially in the fitting & finishing sector. For instance, the monthly reports on building activity in Germany only include companies with 20 or more employees when looking at investments and cost structures. This has led to a supplementary survey being conducted each year throughout the main construction industry (irrespective of company size). Even so, when looking at the fitting & finishing industry, here only companies with 10 or more employees are recorded (Destatis 2012, footnote on p.128). This means that the majority of companies operating in the fitting & finishing sector are not included in the official building statistics, resulting in a major underestimation of the actual situation.

A better insight into the building industry is gained by looking at the statistical company register. This is a "regularly updated database of all companies in virtually all business sectors with taxable turnover derived from supplying products or services and/or with employees subject to social security regulations (hereinafter referred to as ‘employees’)" (Statistische Ämter 2012). Looking at its Section F (the building industry), the 2009 company register lists a total of 384,299 companies. Of these, the vast majority (350,138 or 91.1%) have 0-9[36] employees. A further 8.1% of companies have 10 - 49 employees. This shows that SMEs and micro-enterprises dominate the industry (see Table Tabelle 22).

[36] Companies with 0 employees are 1-man companies with no employees.

Tabelle 22: Number of persons

Company size (in employees)	Number of companies	Employees	Net turnover in EUR 1,000
0-9 employees	**350,138**	**550,045**	**91,192,561**
10-49 employees	**31,174**	**560,889**	**65,204,009**
50-249 employees	**2,769**	**246,431**	**36,289,409**
250 or more employees	**218**	**131,945**	**26,491,943**
Total building industry	**384,299**	**1,489,310**	**219,177,922**

Source: Federal Statistical Office (destatis 2012a).

Though the statistical company register provides much greater insight into the composition of the building and fitting & finishing sectors than the official construction statistics, it still does not provide a complete picture. This is due to the following reasons:

- The company register only contains companies with either an annual turnover exceeding EUR 17,500 in the fiscal year or having at least one employee. This means that several thousand micro-enterprises and start-ups do not appear in the register.
- Companies providing services related to the building trade are not always classified as building companies, but - as is the case with the whole metal-building branch - as companies belonging to the “industry and manufacturing sector”.
- A much greater deficit applies to the number of employees, where neither company owners nor those only working a few hours a week ("*geringfügig Beschäftigte*") are included in the figures.

These are all reasons for taking a look at the skilled craft sector, responsible for a major share of all building, fitting and finishing work in Germany. 2011 saw the Federal Statistical Office and its counterparts at Bundesland level publishing data on the structure of this sector for the first time since 1995. In contrast to the traditional skilled craft surveys conducted up to now, in which all skilled craft companies were surveyed, the new method, used from 2008 onwards, involves evaluating the contents of the statistical company register (Destatis 2011, p. 4). This method has the advantages over the above-described sector-related evaluation of the register that it is conducted on the basis of occupations, thus taking into account all building, fitting and finishing trades, and that estimated numbers of company owners and those only working a few hours a week are included. This provides a much more comprehensive insight into the whole building industry in Germany, reflecting much better the overall company landscape (see Table 23). Even here, micro-enterprises with annual turnover below EUR 17,500 were not included. Also listed in the table below is the number of companies registered with the skilled craft chambers. This enables a comparison with the official statistics, showing how many companies are not included in the latter.

Table 23: Number of companies and employees in the various building trades

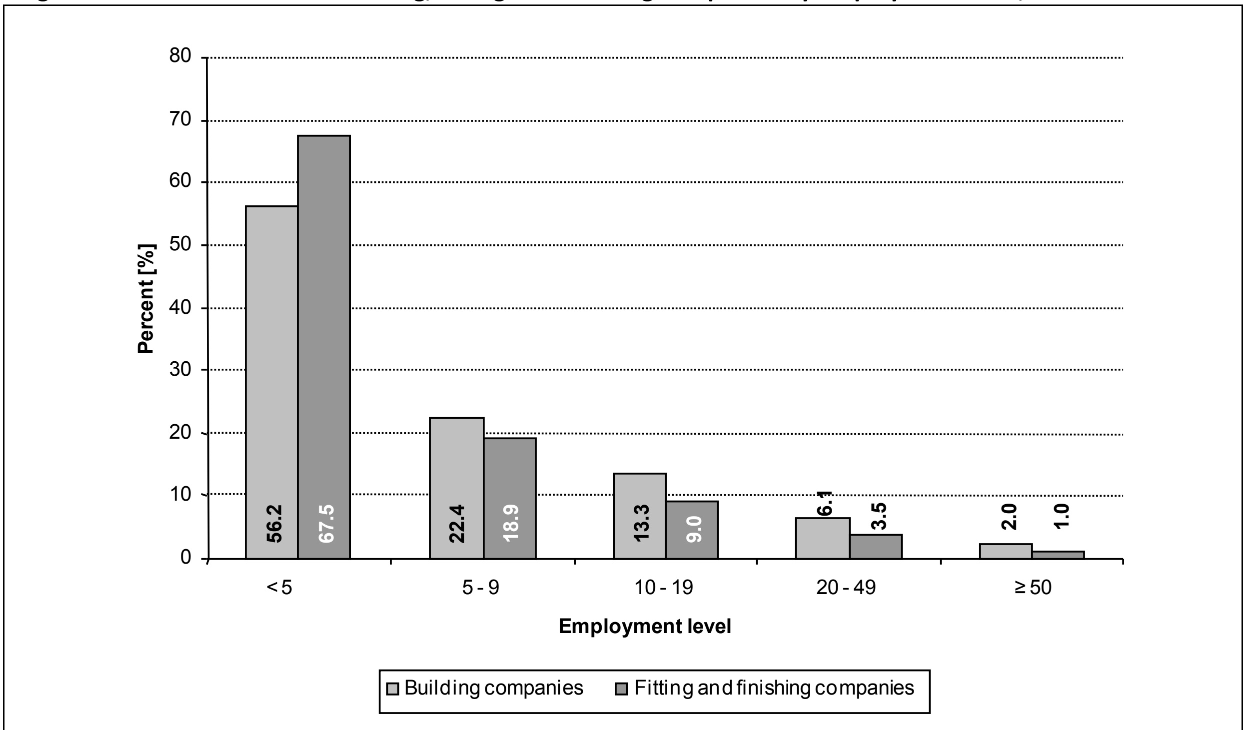
	Trade	Number of companies (2011), registered with the skilled craft chamber	Number of companies (2011, in the official statistic)	Number of employees (2011)	Net turnover in EURO 1,000
Attachement A	Masons and concrete masons	45,035	36,489	328,750	41,572,740
	Builders of stoves and air heating systems	2,452	2,145	8,818	956,830
	Carpenters	17,773	14,623	80,675	9,235,318
	Roofers	15,964	14,626	92,083	9,031,438
	Thermal and noise insulation fitters	1,660	1,572	13,330	1,472,563
	Well builders	705	562	5,043	584,424
	Stone masons	5,656	4,842	21,059	1,764,425
	Stuccoists	5,915	5,070	27,752	2,491,643
	Painters and varnishers	42,754	36,974	195,279	14,011,263
	Scaffolders	3,989	3,225	22,467	1,671,403
	Chimney sweeps	7,832	7,755	19,288	1,123,148
	Metal workers	29,470	24,097	239,635	26,972,259
	Builders of refrigeration systems	2,745	2,308	25,059	3,940,906
	Plumbers	4,975	4,286	27,741	2,713,646
	Heating installers	51,678	45,252	294,180	31,321,542
	Electronics technicians	63,190	48,455	407,301	47,565,592
	Builders of electrical machinery	1,222	1,065	16,275	2,053,960
	Joiners	41,289	33,503	201,564	19,849,392
	Glaziers	4,399	3,822	26,260	2,833,244
Attachment B1	Tile and mosaic layers	65,402	32,471	69,693	5,293,262
	Concrete block manufacturers	881	632	4,177	420,317
	Screed lavers	5,271	3,206	12,038	1,350,675
	Parquet layers	7,209	4,177	11,363	1,096,923
	Roller shutters and sunshade technicians	3,587	2,779	14,465	1,651,852
	Interior decorators	25,457	14,101	40,942	3,103,260
TOTAL		**456,510**	**348,039**	**2,205,238**	**234,082,026**

Source: Federal Statistical Office (Destatis 2011), own calculations.

As seen in Table 23, 2011 saw a total of 348,039 companies operating in skilled building, fitting and finishing trades, generating overall turnover of EUR 234.1 billion and employing 2.2 million people. Of all the official statistics, the craft registers of the building craft chambers best reflect employment figures (the Destatis National Accounts listed the building sector as employing 2.428 million people in 2011). The figures thus reflect the economic importance of the skilled building, fitting and finishing trades for Germany's whole building sector.

The skilled craft building, fitting and finishing sector is characterised by a plethora of small companies (see Figure 24). Looking at the 2008 figures for the main construction industry, 56.2% of companies had fewer than 5 employees (including the owner), 22.4% had 5-9 employees and 13.3% 10-19 employees. Turning to the fitting and finishing sector, companies here are even smaller: Over two-thirds (67.5%) of companies operated with less than 5 employees. 18.9% had 5-9 employees and 9.0% had 10-19 employees.

Figure 24: Distribution of building, fitting and finishing companies by employment level, 2008



Source: Federal Statistical Office (Destatis 2011), own calculations.

5.2.7 Buildings: final energy consumption

Using the energy data of the Federal Ministry for Economics and Technology (BMWi 2011), a picture of the final energy consumption of buildings in Germany can be painted. The 3,517 PJ consumed here represent 38.8% of Germany's total energy consumption (2010: 9,060 PJ).
A distinction is made between heating, hot water, refrigeration/air conditioning and lighting in residential and non-residential buildings, as seen in Table 24.

Table 24: Final energy consumption of all buildings

	Final energy consumption [PJ]	Final energy consumption [TWh]
All residential buildings	2,216.40	616.16
Heating	1,832.50	509.44
Hot water	339.80	94.46
Refrigeration/air conditioning	0.00	0.00
Lighting	44.00	12.23
All non-residential buildings	1,300.60	361.57
Heating	922.20	256.37
Hot water	87.70	24.38
Refrigeration/air conditioning	50.30	13.98
Lighting	240.40	66.83

Source: BMWi 2011.

For both types of buildings, heating is the main consumer of final energy, with refrigeration/air-conditioning only playing a role in non-residential buildings.

5.2.8 Buildings: share of renewables

Renewable energy sources ("renewables") are playing an increasing role in the generation of electricity, with their share of gross energy consumption rising from 16.4% in 2009 to 17.1% in 2010. Looking at buildings, only the share of renewables used for heating is taken into account, with a distinction being made between the different energy sources (cf.Table 25). The share of renewables in the overall final energy consumption for heating, hot water and other household heat uses (cooking, drying, etc.) reached 10.2% in 2010 (BMU 2011, p. 7).

Table 25: Share of renewables in heating

Energy source	Amount of final energy generated [GWh]
Solid biofuels	103,360
Liquid biofuels	7,945
Biogas	13,654
Sewage gas	1,086
Landfill gas	294
Biowaste	7,566
Solar heating	5,200
Geothermics (vertical)	285
Geothermics (horizontal)	5,300
Total	144690

Source: BMU 2011, p. 7.

5.2.9 Missing data

For residential buildings, the situation regarding the availability of statistical data is unsatisfactory. Turning to non-residential buildings, the situation is even worse, with hardly any data at all available. To be in a position to come up with reliable and incontrovertible statements, concrete surveys need to be systematically conducted for producing data on the following aspects:

- Number of buildings
- Type of usage
- Floorspace
- Energy consumption values
- Energy requirements

Moreover, in the field of building refurbishment, a comprehensive and systematic survey showing the refurbishment rates of both types of building (residential and non-residential) would be very helpful.

Similarly, no statistics currently exist with regard to the energy efficiency levels of the different kinds of buildings. In this field as well, it would be very helpful to have a corresponding survey conducted. In doing so, it would be a good idea to set down fundamental definitions for frequently used terms (such as a low-energy house, nearly-zero energy house).