Bundesamt
für Wirtschaft und
Ausfuhrkontrolle

BUNDESSTELLE
FÜR
ENERGIE
EFFIZIENZ

Key occupations and key skills in energy efficiency. Analysis for the building, industry and transport sectors

Summary final report 2023 – BfEE 21/07

Summary

In order to achieve climate neutrality in Germany in the long term and at the same time be able to meet the energy needs of a growing economy, a **continuous increase in energy efficiency** is necessary in all sectors of the German economy. Implementation of the measures necessary for this requires an increasing number of qualified skilled workers for various key professions in energy efficiency. At the same time, the trained skilled workers must have the necessary expertise and skills resulting from the technological requirements of energy-efficient economic activity.

Against this background, the present study first identifies **55 occupational profiles** that are particularly relevant for achieving energy efficiency goals in the sectors of **buildings**, **industry and transport**[1] (not in the sense of an exhaustive list). Subsequently, the occupational profiles are transferred into **41 occupational subgroups** according to the classification system for occupations (KldB) of the Federal Employment Agency (BA). Finally, for a selection of **23 occupational subgroups**, **technical and methodological skills** are worked out that result from technological developments and summarised in competence profiles. The selection of the competence profiles is based on the following criteria:

- **Qualitative relevance:** Extent of qualitative change in activity and skills requirements.
- **Quantitative relevance:** Extent of quantitative relevance of the occupation (measured in terms of the number of people in employment).

A further work step identifies **15 so-called potential occupations** whose job descriptions and required skills show a certain proximity to the key occupations and whose demand tends to decrease in the future due to structural change, which is why the potential is seen for a change to the identified key professions.

In addition to a comprehensive literature review and desk research, the expertise of stakeholders from the field of science, companies or company representatives, social partners, administration and education was obtained in the course of five workshops and expert discussions.

Measures for energy efficiency and related key professions

The identification of key professions is mainly done with a view to the necessary measures to achieve the efficiency targets and related foreseeable technological developments. In the **buildings sector**, in the context of the building envelope, these are primarily the use of novel or advanced insulation materials, modern windows and doors, and the possibilities of serial renovation. In the area of heating, cooling and ventilation, the focus is on switching to heat pumps for heating, energy-efficient ventilation systems and neighbourhood planning with corresponding energy concepts such as renewable local or district heating supply. In addition, smart technologies and digital planning methods will also influence almost all occupational profiles in the buildings sector.

In **industry**, electrification, the use of waste heat and the continuous optimisation of the energy efficiency of plants and processes on the basis of energy audits and energy management systems enable more efficient energy use across all sectors. Furthermore, it is about using green hydrogen, building a circular economy through recycling as well as digitisation and networking. In addition, sector-specific technologies for the energy-intensive industries of

[1] Focus on road and rail transport.

steel (e.g. hydrogen-based direct reduction processes), chemicals (e.g. chemical recycling) and cement (e.g. use of alternative binders) were considered.

In the **transport sector**, the focus is on shift of mode of transport to rail and local public transport, on electric motors as an energy-efficient alternative to combustion engines and associated battery technologies and thermal management systems, as well as fuel cell vehicles and synthetic fuels as a complement. Furthermore, networking and digitisation enable smart traffic control and new mobility concepts.

In the selection of occupations, both planning activities and activities in implementation/ assembly and maintenance are considered. The statistically unambiguous classification of occupations (KldB) of the Federal Employment Agency (BA) is chosen for the delimitation of the occupations. The following table lists all 41 assigned occupational subgroups:

Table 1:Overview: Selection of the 41 occupational subgroups according to the classification system of occupations[2]

Building	Industry	Transport
2234 Wood construction, cabinetry & interior design	2122 Building materials production	2521 Motor vehicle technology
2621 Construction electrics	2411 Metallurgical engineering	2611 Mechatronics
2624 Renewable energy technology	2441 Metal construction	2622 Electric machine technology
3110 Construction planning & supervision	2510 Mechanical & industrial engineering (without specialisation)	2630 Electrical engineering
3111 Architecture	2512 Machine and plant operators	2631 Information and telecommunications technology
3112 Urban and regional planning	2611 Mechatronics	2633 Vehicle electronics
3212 Bricklaying	2612 Automation technology	3112 Urban and regional planning
3214 Roofing	2623 Occupations in energy and power plant engineering	5150 Supervision & control of traffic operations
3215 Façade construction	2625 Electrical engineering	5152 Supervision and control of rail transport operations
3321 Painting & varnishing work	3434 Plant, container and apparatus construction	
3322 Plasterer's work	4130 Chemistry	

[2] Four-digit KldB number.

3332 Carpentry	4131 Chemical and pharmaceutical engineering
3410 Building services engineering	4132 Chemical-technical laboratory
3420 Plumbing	4231 Environmental protection management & consulting
3421 Sanitary, heating and air-conditioning technology	7138 Occupations in business organisation and strategy
3423 Refrigeration engineering	
4231 Environmental protection management & consulting	

Key energy efficiency skills

Cross-occupational skills:

In the course of the ongoing transformation processes, **transformative skills** such as readiness for change, innovation and problem-solving skills are gaining importance in all sectors. There is also a greater focus on social skills such as communication, teamwork and leadership.

Due to increased complexity and networking of technologies and work processes, **interdisciplinary work** is also becoming increasingly important in many professions. **Interdisciplinary work** is becoming increasingly important, especially in the **buildings** sector. A variety of professions are usually involved in building and renovation projects – in addition to skilled trades such as roofers or plant mechanics in the plumbing, heating and air-conditioning sector, there are also planning professions such as architects, civil engineers or urban and regional planners, as well as people who have been trained as energy consultants. Therefore, skilled workers are required to think systemically and have a deeper understanding of the networking of individual work processes and, in some cases, the fundamentals of other trades.

Professional skills

Building: There is a growing need for skills in the planning professions to improve the energy efficiency of buildings. Particularly in existing buildings, the interaction of building systems and the building envelope leads to **increasing complexity in the planning process**. Therefore, architects working in building renovation need a higher level of expertise in technical building planning, and specialist planners in building services engineering need a basic understanding of the building envelope in terms of construction. In the curricula as a whole, there is a need for stronger integration with practice.

In trades and professions in the skilled trades, the technical skills requirements are changing with regard to new **energy-efficient building systems (including heating) and innovative insulation materials** and **processes**. This has an impact on the technical skills requirements of almost all trades and professions, e.g. building energy consultants, plumbing, heating and air-conditioning plant mechanics or roofers. Depending on the trade, training regulations, framework curricula and instruction plans are adapted differently to the respective technological challenges, leading sometimes to a necessary update. In some trades, such as the electrical trade, the need for adapting the occupational profile was seen with the technological and structural changes and a new occupational profile was created in the form of the "electronics technician for building systems integration".

In the context of insulation measures, the activities of skilled workers could shift more towards the **assembly of industrially prefabricated building elements** on the construction site in the future. However, due to the diversity of buildings, there will continue to be a high demand for custom solutions, especially in the roof and façade area.

Industry: The development and planning of **more energy-efficient production plants and processes** requires not only a deeper awareness of energy supply and efficiency issues, but above all comprehensive knowledge in various areas of **process engineering**, such as **energy and environmental engineering**, **materials engineering** or **chemical engineering**. This primarily concerns highly qualified professionals such as engineers. In order to promote integrated thinking and drive innovative solutions, the entire range of topics must be taught in engineering courses. However, there should also be a focus on the new technological challenges of carbon offsetting/ energy efficiency, especially hydrogen at the same time.

But also at the level of professions in production as well as maintenance and servicing, changed work and production processes, thus also skills requirements can arise in the course of measures to increase energy efficiency, for example in the **control, monitoring** and **maintenance** of **new machinery and production plants**. In the course of electrification, skills in **electrics, electrical engineering** and **electrochemistry** are increasingly required. It can be assumed that the increasing complexity of energy and production systems will increase the skills requirements at almost all qualification levels. In recent years, training regulations and framework curricula have increasingly focused on the topic of digitisation. The technological challenges of carbon offsetting, in particular also the possibilities for the use, transport and storage of green hydrogen have not yet been taken into account to the same extent. Qualification offers are currently more likely to be created by companies and chambers of commerce and industry, but they should also be carried across the board via training in the form of additional qualifications.

Transport: In addition to a deeper awareness of energy efficiency issues, the development of **more energy-efficient vehicles** requires above all comprehensive knowledge in various **areas of drive technology**, such as battery systems or fuel cell technologies, as well as in the **networking of vehicles**. The development and design of new systems primarily involves highly qualified professionals such as engineers. But also at the level of the professions in assembly as well as maintenance and servicing, changed work processes, thus also skills requirements can arise in the course of the measures to increase energy efficiency, for example in the maintenance of **high-voltage systems** or in the further development of the charging infrastructure. In the course of electrification, skills in **electronics and electrical engineering** are increasingly required. Although an electric motor has a less complex structure than a classic combustion engine, the new vehicle components associated with electrification will change the skills requirements at almost all qualification levels.

The necessary skills are also shifting in the context of **smart traffic control** as well as **new mobility concepts** especially against the background of the increasing networking of vehicles. Due to the increasing share of electrical, electronic and **software components** in vehicles and the simultaneous reduction of the share of mechanical components, skills in the area of mechanics become less important, while skills in the area of **electronics and software** need to be improved. This primarily affects employees in the **development and integration of vehicle electronics**. But **traffic engineers** and **technicians** are also affected by the (further) technical developments in vehicle networking. For example, they increasingly evaluate data collected by networked vehicles to optimise traffic management. In railway operations, too, new technologies bring with them new skills requirements, such as the operation of **modern train control systems** or **digital signal boxes**. The adjustments to the training regulations and framework curricula in recent years have especially focused on the topic of digitisation and electrification.

Digital skills

Digitisation and networking represent a decisive lever for increasing energy efficiency. In connection with this, the demand for digital skills is also increasing.

In the **building sector**, **basic digital skills** as well as **specific IT user skills** will be part of the core professional skills in varying degrees in almost all occupations due to the growing complexity of digitised and automated systems technology. For example, planning professions require knowledge in the use of digital planning and simulation models - in the future, this could be further strengthened by the **use of Building Information Modelling (BIM)**. Professions in technical building equipment especially require in-depth knowledge of **digital measurement, control and regulation technology**. Digital interfaces and building systems integration will play an increasingly important role in energy efficiency in the building sector, for example with regard to the **energy-efficient networking of various technical components and systems**, which is also increasingly taking place through the Internet of Things (IoT) or artificial intelligence (AI).

In **industry**, too, the importance of networked machines and systems as well as automation is growing in all sectors. This goes hand in hand with an increasing demand for **digital skills** in all professions under consideration. For example, the use and **evaluation of measurement data from smart sensors, big data** or **artificial intelligence** will increase significantly in the future in mechanical and industrial engineering or in mechatronics. In professions in metallurgy as well as in chemical and pharmaceutical engineering, knowledge of **autonomously controlled production processes** as well as **knowledge in dealing with virtual reality** and **augmented reality** are also playing an increasingly important role – in some cases, even now.

Digitised and networked vehicle systems in the **transport** sector mean that, in addition to technical expertise, **system knowledge** and **holistic thinking in combination with IT user skills** are increasingly in demand. In many professions, **specific IT skills** are also increasingly in demand, e.g. in professions in vehicle technology for data acquisition and evaluation by means of **digital measurement, control and regulation technology** (e.g. sensor technology, predictive maintenance) or in professions in the monitoring and control of transport operations, railway transport operations for the use of **big data**. The handling or use of **augmented reality (AR), exoskeletons** and **cobots** is playing an increasingly important role in professions in vehicle technology and vehicle electronics.

For 23 select professions (see above), detailed competence profiles are drawn up in the study. These break down in detail which skills requirements result from technological developments, both with regard to occupation-specific activities and with regard to digital and cross-trade requirements. As far as possible, target requirements are compared with current basic and advanced training opportunities.

Potential occupations in energy efficiency

One strategy for securing skilled labour can be to enable people to make a lateral entry who may no longer be able to work in their learned profession in the future.

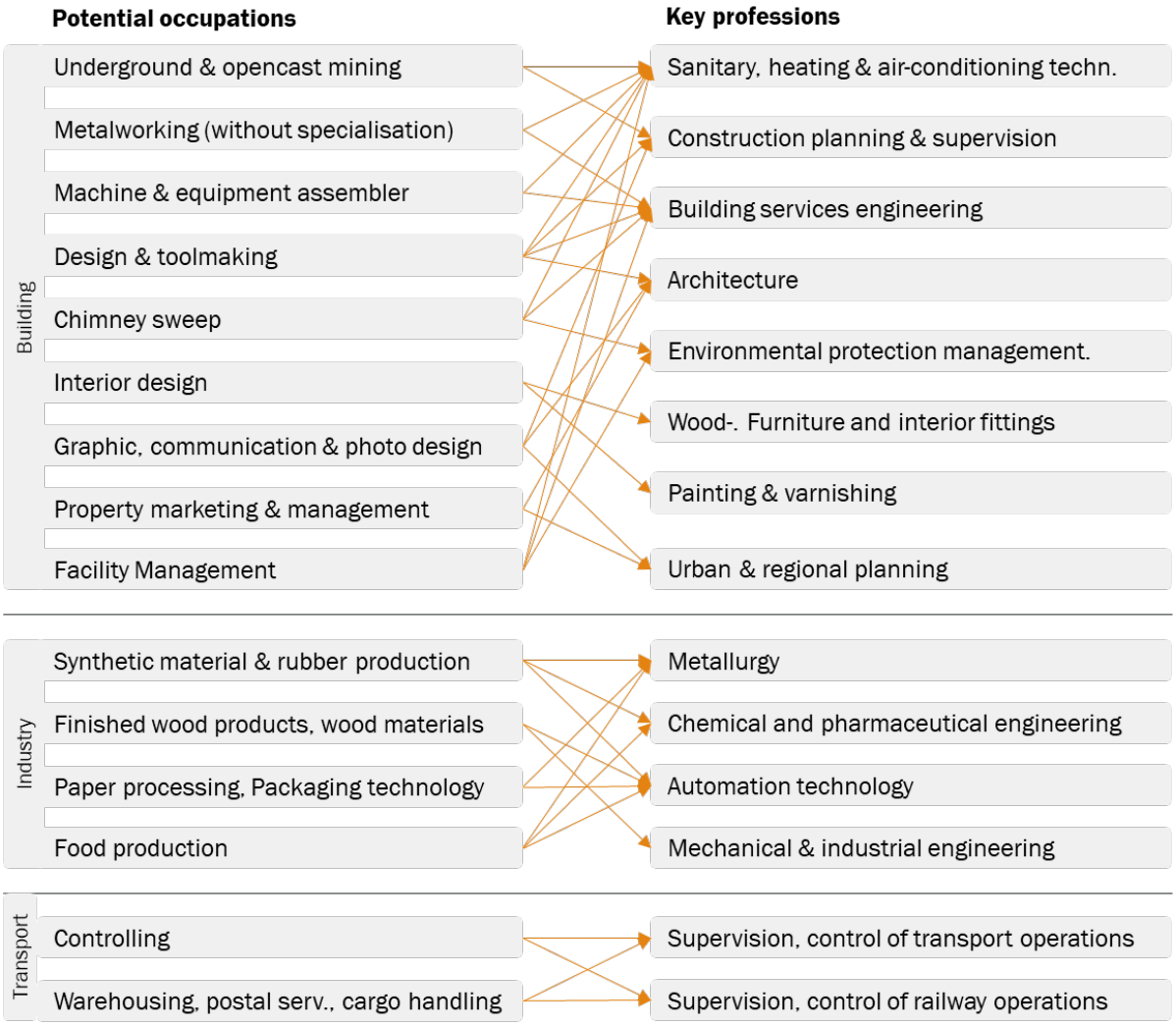
When selecting the so-called potential occupations, i.e. occupations that could be considered for a change to energy-efficient occupations in the building, industry and transport sectors, priority was therefore given to occupations,

- for which the empirical probability of a change to one of the key professions is at least one per cent, thus being above average,
- in which approx. 10,000 gainfully employed persons are currently working,
- which have interfaces in the job description with the key professions and
- whose demand will tend to fall in the future.

Example: The occupation of **chimney sweep** is one of the occupations in environmental protection technology and comprises about 13,000 gainfully employed persons. The statistical probability of the associated main occupational group switching to the building and building services engineering occupations is a good 2 per cent. There are already bottlenecks in this occupational group which reduces the likelihood of a change. However, due to the conversion and further development of firing and ventilation systems, the occupational profile of chimney sweeps could change significantly in the future. The activities of chimney sweeps include the inspection and cleaning of combustion and ventilation systems. They also measure and test exhaust gases and ensure that the systems function smoothly in an environmentally friendly manner. Advising customers on the topics of energy efficiency and fire protection is also part of their field of activity. Due to these activities and the skills required for the exercise of the profession, e.g. with regard to energy consulting, energy-saving and heating technology, there are greater similarities to the key professions in **plumbing, heating and air-conditioning technology (3421)**, the professions in **building services (3410)** and the professions in environmental protection administration and consulting (4231), especially for further training as an **energy consultant**.

The following figure shows an overview of the identified potential occupations and associated key professions.

Figure 1: Overview of identified potential occupations and associated key professions



Own representation Prognos AG

When interpreting the potential occupations, it should be noted that the selection is only an **initial indicator**. Further research and analyses are necessary to design instruments based on this. Aspects such as salary differences, legal framework conditions, mobility, etc. play a central role for an actual change.

Fields of action for the further development of qualification offers

Finally, the study discusses fields of action for the adaptation or creation of suitable qualification and advanced training offers for energy efficiency.

Field of action 1: Regular skills monitoring

In order to systematically record the necessary qualification and skills requirements in energy efficiency in the future, **regular competence monitoring**, in which changes in occupational requirements can be continuously observed and the associated need for adaptation of education and training can be assessed, is needed. The establishment of a responsible body or platform can be helpful in institutionally anchoring this process. It is particularly important to **involve and network all relevant stakeholders**, such as chambers of commerce, sectoral and professional associations, social partners and scientific experts. It is also important to avoid **duplication of structures** by ensuring close involvement of those responsible for training regulations and study curricula.

Field of action 2: Adaptation of training and study curricula

In the course of the transformation towards climate neutrality and energy efficiency, training and study curricula must take into account the changed qualification and skills requirements. Opportunities for acquiring knowledge and skills in energy efficiency should be expanded within state-recognised training courses and technical degree courses. In addition to **adapting the whole range of relevant curricula**, there is also the possibility of enabling the acquisition of skills in depth through the creation **of new additional and elective qualifications** or **well-defined specialisations** and **fields of study**.

Field of action 3: (Further) development of further education and advanced training:

The continued development of further education and advanced training courses should be tailored to the target group.

When developing qualification offers for **employees**, it should be taken into account that further education and advanced training take place for the most part in the company context. Therefore, qualification offers should always be **closely linked to company practice**. Particularly in SMEs, **offers that are suitable for everyday use**, **workplace-related and, if necessary, modularised** can mitigate existing hurdles for employees and companies, such as a lack of time and financial resources. Company cooperation also offers an opportunity to build up cross-company continuing education capacities. In this context, inter-company qualification offers in cooperation with chambers or associations also play an important role.

In order to increase the **potential of semi-skilled and unskilled workers through partial qualifications**, it should be examined to what extent energy efficiency and climate-relevant work can be made possible for this target group through **partial qualifications**. As an existing instrument, partial qualifications are explicitly aimed at adults without a recognised vocational qualification who are unable to undertake traditional training or retraining due to their personal situation (e.g. language barriers, learning difficulties). With regard to technologies relevant to the energy transition, such as heat pumps or photovoltaics, there are corresponding initiatives by individual companies and manufacturers as well as corresponding industry initiatives. In order to achieve a comprehensive vocational ability to act, the long-term goal of partial qualifications should always be the attainment of a **full vocational qualification**.

In order to promote occupational mobility, **tailor-made qualification offers for career changers** as well as accompanying support measures are necessary. Depending on the proximity of the previous training and activities as well as the personal situation of the person, different qualification offers can be considered with regard to the breadth and depth of the skills imparted. Particularly in larger companies with a high demand for skilled workers, it may be advisable to design in-house or at least company-related retraining programmes in order to integrate potential lateral entrants directly into the operational processes in the company or enterprise and to facilitate the start in the new occupational field. Smaller companies and enterprises usually do not have the resources for such extensive programmes. Therefore, inter-company cooperation between companies should be strengthened for these needs. Similar to the concept of inter-company training, inter-company advanced training and retraining programmes could be designed in which the contents taught are divided among the participating companies and can thus be imparted to lateral entrants in a resource-saving manner.

Finally, **immigrants** can also represent an important target group for professions relevant to energy efficiency and climate change. With the reform of the Skilled Workers Immigration Act in summer 2023, existing access requirements for labour and skilled workers from abroad were reduced and new access opportunities were created. In practice, there are often difficulties in assessing and recognising existing qualifications from abroad. If **post-qualification offers are created in the area of vocational qualifications,** whereby, here too, the offer can be organised differently for larger and smaller companies as described above, this can also represent an opportunity for this target group to enter a profession that is relevant to energy efficiency and climate change.