BUILD UP SKILLS
ENERGY TRAINING FOR BUILDERS

Supported by INTELLIGENT ENERGY EUROPE

Build Up Skills – Part I
Status quo analysis

lavenergi programmet

Summary

Build Up Skills Norway is the national follow-up of the Intelligent Energy Europe project Build Up Skills. The purpose of the project is to identify measures to raise the level of competence in the area of energy among those active in the building industry. Building workers have been defined as a key-working group with regard to achieving energy efficiency and the use of renewable energy in buildings.

This report describes the Norwegian building industry and competence in the field of energy among the various working groups active in the building industry. The report will form the basis for further work on identifying competence measures in the field of energy aimed at active groups in the industry.

The main findings in the report are summarized at the start of each chapter. Some of the main findings are:

- The building industry in Norway is perceived as a relatively attractive and solid industry with regard to criteria such as pay, operating margins and return on investment. Turnover in building and construction has more than doubled over the last 10 years.
- The building and construction industry consisted of about 190,000 employees in 2011. Tradesmen represented less than 60% of the total employed in the building and construction industry. Carpenters are the group with the highest number of employees (around 50,000), followed by electricians (about 30,000) and plumbers (about 16,500).
- The need for the building and construction workforce, including the need for tradesmen and skilled workers, will probably increase towards 2020/2030. To meet the workforce needs, it is important to get the oldest workers to remain in the industry until retirement age while recruiting in the younger age groups.
- The consumption of energy in homes and non-residential buildings in 2009 was 83 TWh, or about 37% of the total domestic energy consumption. Energy consumption in buildings has levelled out in recent years.
- The Norwegian government has adopted an objective of increasing renewable energy production and energy efficiency by 30 TWh between 2001 and 2016. The energy objectives have not been specifically divided across different sectors and there are no official objectives for energy efficiency or the use of renewable energy in buildings.
- The government will also introduce the passive house level as the building standard in 2015, near zero energy level as the building standard in 2020 and component requirements for existing buildings. There are defined competence goals for what various executing professionals in the building industry must know so as to erect new buildings to passive/near-zero energy levels, renovate existing buildings to a very high energy standard and install renewable heating and cooling systems in both new and existing buildings.
- Compared with normal energy standards, buildings with high ambitions for energy consumption must have particular attention paid to the indoor climate and securing against damp.
- Surveys carried out among skilled workers tend to indicate that knowledge relevant to passive house is varied and in some cases lacking. However many tradesmen and skilled workers are interested in acquiring more knowledge in the energy field.
- Suggested ways of raising competence would be courses organised by building supplies companies and industry organisations, as well as the use of construction details from SINTEF Building and Infrastructure (national research institute).
- For tradesmen who wish to remain in their trades, there is no national system or offer of systematic education or craft or journeyman's certificates. A number of organisations offer courses, but none of the courses offered is in a system for lifelong learning. The building and construction industry is lower as regards participation in all forms of lifelong learning than

many other sectors. The percentage of tradesmen taking part in lifelong learning has been greatly reduced in the last three years.

- The most important barrier to energy efficiency in buildings, from society's point of view, is the generally low and sometimes zero attention given to energy use and energy related measures. The real potential for energy efficiency in buildings depends on whether the owners of buildings and homes consider these measures to be financially beneficial. It is however more important for triggering the potential if the owners are open to renovating or upgrading their buildings. It is therefore important to reach the home-owners or owners of non-residential buildings who are preparing for renovation or upgrade activity.
- At a general level, the lack of competence is a barrier than might prevent energy measures from being taken. For example, it might be important that the tradesmen who come into contact with households have the knowledge to sell up to ambitious renovation at low-energy or passive house level instead of simple renovation, since the home is to be renovated anyway.
- A lack of time and high course costs stand out as the most important barriers to tradesmen's participation in courses. Other factors that may be mentioned are a lack of motivation and that the courses are mainly found in cities rather than locally.

Disclaimer

Further information
More details on Build Up Skills can be found at www.buildupskills.eu
More details on the IEE programme can be found at http://eu.europa.eu/intelligentenergy

Contents

1. Introduction

The building industry is one of Norway's largest and most important industries. The building industry is in fact Norway's largest industry, counted by number of companies. Counted by value creation, the building industry is Norway's second largest after the oil industry [1]. Turnover in building and construction has more than doubled over the last 10 years [2]. The structure of the industry differs from that of other important industries due to the high percentage of small and medium sized companies. 96% of the companies have fewer than 20 employees [3].

Energy consumption in buildings amounted to 82 TWh in 2009, or 37% of the total energy consumption in mainland Norway. Energy consumption in buildings has levelled off since the end of the 1990s. This levelling off can be explained by steadily more energy-efficient buildings, a warmer climate, higher energy prices and the installation of more heat pumps [4].

Key instruments for reducing energy consumption in buildings and stimulating the use of renewable energy for heating purposes include energy requirements in the building regulations, energy labelling of buildings, Enova's subsidy schemes and basic mortgages from the Norwegian State Housing Bank. One barrier to achieving more energy efficiency and energy remodelling of buildings more quickly is the level of competence and knowledge in the building industry [5, 6, 7].

Build Up Skills Norway is the national follow-up of the Intelligent Energy Europe project Build Up Skills. The purpose of the project is to identify measures to raise the level of competence in the area of energy among those active in the building industry. Building workers have been defined as a key-working group with regard to achieving energy efficiency and the use of renewable energy in buildings. The focus on raising competence is tied in with the EU's climate and energy goals, that is a 20% reduction in primary energy use, a 20% increase in the production of renewable energy and a 20% reduction in greenhouse gas emissions by 2020 [8]. Raising competence levels is also important for achieving the EU's goals for improving the competitive abilities of European industry combined with sustainable development [9].

As part of Build Up Skills Norway, the following will be prepared:

- A status quo analysis that describes the Norwegian building industry and the level of competence in the field of energy among those active in the industry.
- A roadmap with concrete measures to raise the level of competence in the area of energy among those active in the building industry.
- An endorsement plan stating how the proposals can be implemented. Agreement will be sought between the authorities and the industry regarding roles and responsibilities for implementation.

The status quo analysis is the first part of Build Up Skills and will form the basis for further work to raise the level of competence in the area of energy among those active in the building industry.

All the participants in Build Up Skills are to set up a dedicated website for their projects. In Norway, the website for Build Up Skills is: http://lavenergiprogrammet.no/lavenergi-i-eu/build-up-skills/

2. Background

Summary of chapter 2:

- The status quo analysis of Build Up Skills is intended to form the basis for identifying measures to raise the level of competence in the field of energy among those working in the building industry.
- The Low Energy Programme is the project manager for the Build Up Skills project in Norway.
- A partner group, a reference group and a steering group have been established, involving key players in the building industry, which have provided input for the work.

2.1 Purpose

The purpose of this analysis is to give a basis for identifying measures to raise the level of competence in the building industry with regard to energy-efficient building and refurbishment, as well as the installation of heating systems that enable the use of renewable energy. Only groups that perform on-site construction work are covered in the project, that is to say trades and professions such as carpenters, bricklayers, plumbers, electricians, concrete workers, ventilation fitters, tinsmiths, roofing contractors, glaziers etc.

The report provides an overview of industry structure, financial prospects, necessary competence in the field of energy, vocational training, further education and training, access to a qualified workforce and barriers that stand in the way of competence raising, energy efficiency and the use of renewable energy. A roadmap describing competence-raising measures in the field of energy, aimed at the part of the building industry that performs the physical work, will be completed during November 2012.

2.2 Method

The Norwegian building industry, the building stock, training and further education possibilities, instruments and barriers etc. are all described from the basis of a literature study. Where possible, official statistics from Norwegian authorities such as Statistics Norway, the Norwegian Water Resources and Energy Directorate, the Directorate for Education and Training etc. have been used as references. Some statistics and figures that have been used in the report are subject to some uncertainty. In such cases, an attempt has been made to use several references and sources, so as to give the best possible picture of reality.

In order to describe necessary skills and qualifications in the field of energy among groups of on-site workers, a specific study has been made [10] and workshops have been held with members from the building industry associations. Even though Build Up Skills is limited to on-site workers, competence goals are also described in respect of making simple assessments of technical building solutions. This is because manual worker companies, especially outside the cities, may be asked for suggestions for technical building solutions, due to a lack of directions for example, or because the directions are difficult to put into practice.

In order to review the present level of competence in the field of energy among workers in the building industry, a questionnaire survey was carried out, aimed at foremen/building site managers [11]. Groups of trades that employ many people and that are of special significance for the energy needs and energy supply of buildings were prioritised. But the survey also gives a picture of the competence level in the field of energy for trades in the building industry

generally. Respondents were also asked about what barriers they have experienced with regard to achieving competence raising and training in the field of energy.

2.3 Organisation

For the implementation of Build Up skills Norway, a partner group was organised consisting of the Low Energy Programme, the Federation of Norwegian Construction Industries, the Norwegian Building Authority, Enova, the Norwegian Association of Plumbing, Heating and Ventilating Contractors, the Norwegian Association of Building Constructors, the Norwegian Association of Master Builders, the Norwegian Association of Building Contractors and the Norwegian Association of Master Bricklayers. The Low Energy Programme was project manager and is responsible for the formulation of the report. The partner group has contributed during the course of the project.

One of the objectives of Build Up Skills is to gather together representatives of the building industry and give a common understanding of competence level, future challenges, barriers to competence railing and necessary measures. All those who wish to commit to the project have therefore been given the opportunity to do so. A reference group has been established, which has been able to provide input during the course of the work. The reference group consisted of the Norwegian United Federation of Trade Unions, NELFO (the Federation of electrical and IT companies), the Norwegian Refrigeration and HVAC Association, the Green Building Alliance, the Roofing Contractors' Association, the Ventilation and Tinsmiths' Association, the Norwegian Heat Pump Association, the Enterprise Federation of Norway, The Solar Energy Association, The Norwegian Heating technology Association, the HVAC Association, SINTEF Building and Infrastructure, The Consulting Engineer's Association, the Master Builder's Certificate Board and the City of Oslo Education Agency. Vox and the Directorate for Education and Training participated as observers in the reference group.

The committee of the Low Energy Programme have acted as the steering group for the project. The steering group consisted of the Norwegian Building Authority, the Norwegian Water Resources and Energy Directorate, Enova, the Norwegian State Housing Bank, Statsbygg, the Federation of Norwegian Construction Industries and the Norwegian Architects' Association.

Box 2-1: The Low Energy Programme for Building and Construction (the Low Energy Programme)

The Low Energy Programme (www.lavenergiprogrammet.no) is a collaboration programme between public authorities and the building industry to achieve common goals in energy efficiency and energy remodelling in building and construction. Those included in the programme are the Federation of Norwegian Construction Industries, the Norwegian Architects' Association, Enova, the Norwegian State Housing Bank, the Norwegian Building Authority, Statsbygg and the Norwegian Water Resources and Energy Directorate. The Low Energy Programme intends to achieve a combined building industry with good, targeted information that enables the industry to construct and renovate highly energy efficient buildings. One of its main objectives is that a large proportion of the buildings constructed during the period 2014 to 2017 will be passive houses.

The organisation of the Norwegian Build Up Skills project is shown in Figure 2-1.

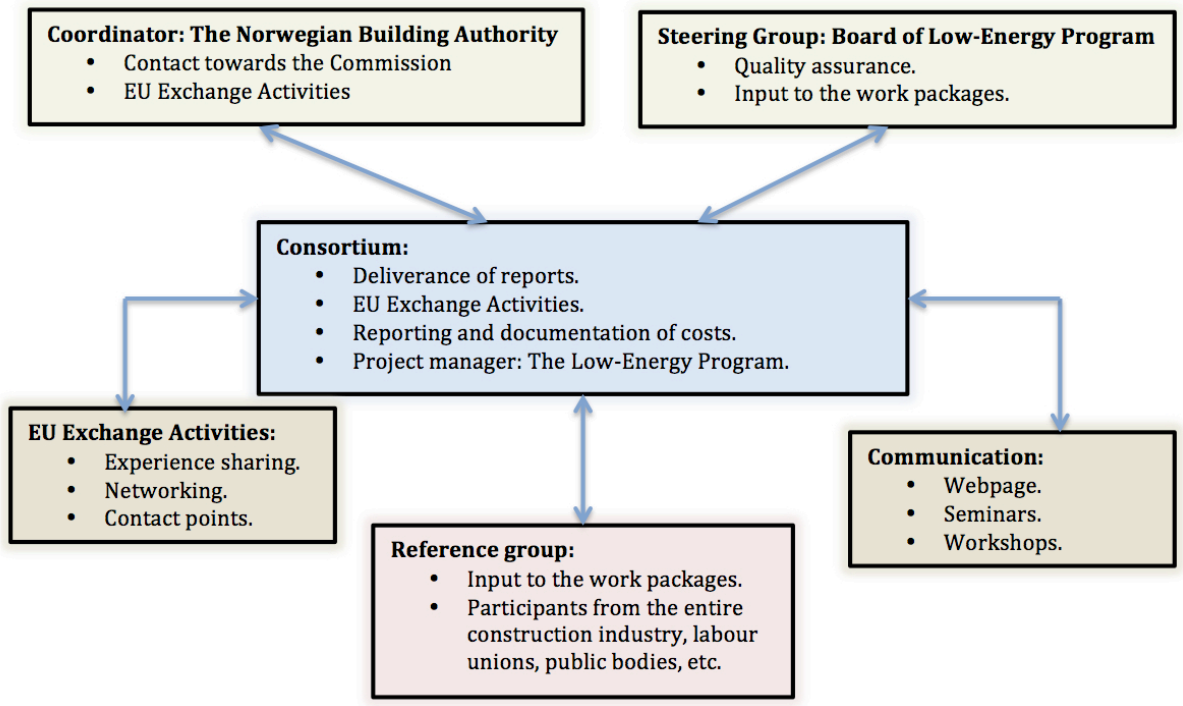

Figure 2-1: Organisation of Build Up Skills in Norway

3. The Norwegian building industry

Summary of chapter 3:

- The building industry in Norway is perceived as a relatively attractive and solid industry with regard to criteria such as pay, operating margins and return on investment.
- Turnover in building and construction has more than doubled over the last 10 years.
- The proportion of foreign workers and the use of hired-in workers have increased in recent years.
- The proportion of undeclared work is high for building worker services, especially painters, bricklayers and carpenters in the housing market, which are often not subject to an application obligation.

3.1 Turnover and value creation

The building industry is one of Norway's largest and most important industries. The building industry is in fact Norway's largest industry, counted by number of companies. Counted by value creation, the building industry is Norway's second largest after the oil industry [1]. Figures from Statistics Norway show that turnover in the building and construction industry has more than doubled in the last 10 years, from approximately NOK 130 billion in 2000 to approximately NOK 315 billion in 2010 (Figure 3-1). Turnover in 2010 represented an increase of about 2% over 2009, but still showed a slight decrease from the peak of 2008, which had a turnover of more than NOK 350 billion in building and construction activities [2].

Of the turnover in building and construction in 2010, the construction of buildings represented about NOK 145 billion, while so-called specialised building and construction activities represented about NOK 142 billion. Civil engineering construction had a turnover of approximately NOK 27 billion, which was a drop of 4.7% from 2009 [12]. If the property sector is included, turnover and value creation in the industry are much greater. Turnover of the entire building industry in 2007 was estimated at about NOK 600 billion [1].

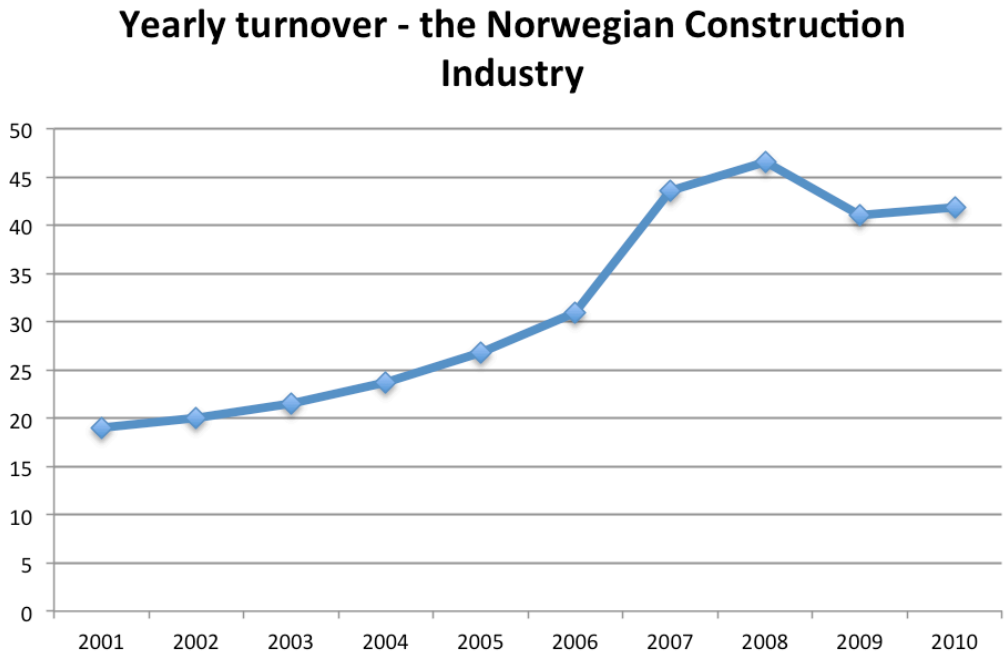

Figure 3-1: Turnover in building and construction 2001-2010 (Billion Euros). Source: [2]

Much of the turnover in the building and construction industry can be attributed to the public sector. The authorities decide through the national budget what shall be transferred to the various local authorities for operation, development and maintenance in the public sector. The equalisation of revenues, in which the largest local authorities lose some of their tax revenues from local industry to smaller local authorities, has helped to ensure that local authorities in rural areas have been able to increase activity in building and construction. Other funding is earmarked for building new schools and nursing homes or renovating public buildings. This means that the local authorities have increased purchasing power from the building industry [1].

Box 3-1: Turnover and value creation

- **Turnover:** Sales income from goods and services. The definition of turnover in section 1-3 of the Value Added Tax Act is "Supply of goods and services against payment".
- **Value creation:** The value increase or added value an (unfinished) product or service gains at each stage of a production process or value chain.

3.2 Industry structure

The structure of the building and construction industry differs from that of other important industries due to the high percentage of small and medium sized companies. 90% of the companies have fewer than 10 employees, while 96% have fewer than 20 employees [3]. Many small and medium sized companies in building and construction are cornerstone companies that are vital for employment in rural areas. Companies in building, construction and property represented over 50% of the industry of as many as fifteen local authorities in 2007. If we look at proportion of total turnover, building, construction and property represented more than 50% of industry's total turnover in 53 local authorities and over 70% of turnover in some of these [1].

There are a number of industry associations for the companies in the building industry that are involved on-site. The Federation of Norwegian Construction Industries is an umbrella organisation that brings together the Norwegian Association of Master Builders, the Norwegian Association of Building Contractors, the Norwegian Association of Plumbing, Heating and Ventilating Contractors, the Roofing Contractors' Association, the Norwegian Association of Master Bricklayers and the Ventilation and Tinsmiths' Association. Norwegian Technology is another umbrella organisation bringing together the Norwegian Refrigeration and HVAC Association, NELFO (the federation of electrical and IT companies) and the Society for Technical Systems Integrators, among others. The Federation of Norwegian Construction Industries and Norwegian Technology are members of the Confederation of Norwegian Enterprise (NHO). According to the Federation of Norwegian Construction Industries, it can be roughly estimated that 10% of the companies in the building industry are organised in employer organisations. These organised companies tend to be somewhat larger companies and therefore employ about half the employees working on site in the building industry [13].

On the employee side, the Norwegian United Federation of Trade Unions is the organisation with the most building workers as members. The Norwegian United Federation of Trade Unions is the Norwegian Confederation of Trade Unions' largest private sector organisation, with about 150,000 members. The Norwegian Union of General Workers, which also belongs to the Norwegian Confederation of Trade Unions, has about 33,000 members, including in the contracting and construction industries.

3.3 Market analysis

The Norwegian building industry has faith in the future. In a survey carried out by the Federation of Norwegian Construction Industries in 2011, half the companies responded that they had higher expectations of the current year than of previous years. This was a clear change from 2009, when only 15% of companies said the same [14]. A survey carried out at BI Norwegian Business School in 2011 showed that companies in the building and construction industry had a conscious desire to protect core competence in the processes or reorganisation that followed the financial crisis of 2009. This may have given positive long-term effects, such as more effective operation, greater awareness of competence and increased competitive ability [15]. It is important to realise, however, that the building industry is sensitive to economic fluctuations and is a sensitive industry in times of economic downturn, including in Norway.

As a whole, the building industry is perceived as a relatively attractive and solid industry with regard to criteria such as pay, operating margins and return on investment. In a 2011 survey, there were no parts of the industry that appeared to be particularly squeezed on margins. The level of pay in the building industry is also good. Average pay per employee in building, construction and property was about NOK 500,000. The best-paid employees in the industry were in consultancy, property, service and architecture. These are also the areas with the highest level of education. The survey showed that profitability and ownership attraction for companies in building, construction and property was satisfactory and often high. Conditions that could tend towards an increased level of activity include the anticipated demographic trends and population growth, especially because the population is steadily ageing [6]. In addition to this, a lag in terms of maintenance of existing buildings must be covered in future [16]. Improved energy efficiency in existing buildings could also have a positive effect in terms of employment and activity levels in the building and construction industry [5].

3.4 Immigrant workers

The building and construction industry currently attracts more people from other industries than it gives to those industries. But the supply of labour and newly qualified people is not sufficient to cover the future workforce needs, given a high level of activity [17].

The need for labour is one of the reasons behind the huge influx of workers from abroad in recent years. According to Fafo, the research foundation for labour and social welfare, the percentage of employees in the building and construction industry with a non-Norwegian national background increased from 10% to 14% over the period 2006-2008, measured in full-time equivalents. It is mainly the workforce from Eastern Europe that is growing. The number of employees from Eastern Europe increased from 4,800 in 2006 to 11,300 in 2008. There is also a relatively high proportion of employees from the Nordic region and Western Europe, while the number of people with origins outside Europe is low [17].

Figures from the Federation of Norwegian Construction Industries indicate that the proportion of foreign workers is higher. A report from 2011, which gives a summary of the number of ID cards issued, shows that 15% of all ID cards went to foreign workers. That represents about 70,000 employees. More than 140 countries are represented on Norwegian building sites. Poland, Sweden and the Baltic countries account for more than 75% of the foreign workers [18]. An important difference between the figures from Fafo and the Federation of Norwegian Construction Industries is that Fafo's estimate is based on full-time equivalents, while ID cards are issued to individuals, regardless of how much they work in a year. ID cards are also issued to types of workers such as drivers, suppliers, administrative employees on the building site etc.

The proportion of foreign workers in the building industry has thus increased considerably in recent years. Since building practices vary between the different countries of Europe,

competence-raising measures aimed at immigrant workers in building and construction will be important for ensuring the quality of execution.

3.5 Hiring in workers

Another trend in the building and construction industry is the increase in the numbers employed in the manpower supply industry. The number of temporary workers in building, construction and industry has grown strongly since the liberalisation of the manpower regulations in 2000, and particularly since the extension of the EU in 2004 [19]. Between 1996 and 2006, the number employed by the manpower supply industry more than doubled [20]. Building was the largest sector for the manpower supply industry in 2010, accounting for 15% of all hours invoiced. From the third quarter of 2010 to the third quarter of 2011, the manpower supply industry had an increase of 53% to building and construction. Many of the workers hired out to building, construction and industry come from Eastern Europe [19].

A report by De Facto indicates that all the increased activity in Eastern Norway seen by the country's six largest contractors has been covered by hiring from manpower companies and outsourcing to sub-contractors. The report estimates that the workforce hired out to the building industry by the manpower companies increased by 40% from the first quarter of 2010 to the first quarter of 2011. In autumn 2011, the six largest manpower companies had twice as many building workers in Oslo and Akershus as the six largest contractors. In plumbing, the picture is more complex and it appears that a higher proportion of growth is covered by apprentices [21].

A similar trend in the use of manpower companies can be seen in other EEA countries. In Germany for example, the number of workers linked to manpower companies rose by 54% between 2004 and 2007. The Netherlands saw an increase of 48% over the same period [22].

3.6 The black economy

There are no reliable statistics or overview of the black economy in Norway. The Swedish tax authorities have estimated a theoretical tax gap of about SEK 133 billion a year, which corresponds to about 5% of GDP [23]. If we assume that the situation is somewhat similar in Norway with about 5% of the GDP of about NOK 2,300 billion (2007) avoiding taxation, that means that tax amounting to NOK 115 billion a year is being lost [24]. The building and construction industry is often mentioned as having black economy issues. A 2003 report by The Ragnar Frisch Centre for Economic Research showed that 48% of a selection of respondents in building and construction answered that they had done undeclared work in the past 12 months in 2001. The percentage in building and construction was more than twice as high as any other industry. Including all the industries that were covered by the survey, the proportion that had done undeclared work in the last 12 months in 2001 was 16% [25].

A number of surveys have been performed to map out the population's behaviour, attitude and knowledge with regard to buying undeclared work. The main areas where people stated that they were most inclined to buy undeclared work were in cleaning, child minding and tradesmen [24, 26]. A survey that Opinion carried out for the Directorate of Taxes in 2011 showed that 20% of respondents had bought undeclared work in the last two years. Almost half of those who had bought undeclared work in the last two years had bought cleaning and washing services. But the proportion of undeclared work was also high for tradesmen, such as painters (28%), bricklayers (21%) and carpenters (18%). For electricians and plumbers the percentage was 7-8%. This tends to indicate that undeclared work is more widespread for services that are less associated with risk if poorly executed [27].

Private affluence in Norway combined with increased access to cheap labour from Eastern Europe has created a considerable market for the use of undeclared work in the private household market, with Eastern European men doing the work. The extent is uncertain [28]. In a survey of the purchase of undeclared work, 22% of those who had bought undeclared work in the past two years stated that they had bought from foreign suppliers. The distribution tends to indicate that undeclared work is mainly concentrated in a few services, such as cleaning, painting and carpentry [29]. Many measures in existing housing, which would be the most exposed to undeclared work, are not subject to an application obligation and so not subject to competence requirements for companies or local authority supervision in accordance with the Planning and Building Act (see section 6.5).

Care should be taken in interpreting the results of questionnaire surveys about participation in unlawful activities. In surveys like these, there is always a risk that people will respond according to norms and rules, rather than giving an honest answer about their unlawful activities.

4. Strategies and instruments relevant to the EU's target for 2020

Summary of chapter 4:

- Examples of instruments that will contribute to energy efficiency and the use of renewable energy in buildings include energy requirements in building regulations, mandatory energy labelling of buildings, Enova's support schemes and the Norwegian State Housing Bank's basic mortgages and competence supplements.
- The government has adopted an objective of a 30 TWh increase in renewable energy production and energy efficiency measures between 2001 and 2016.
- The government will also introduce the passive house level as the building standard in 2015, near zero energy level as the building standard in 2020 and component requirements for existing buildings.
- The European Qualifications Framework for Lifelong learning has yet to be introduced in Norway. The qualification framework is intended to strengthen opportunities for lifelong learning in the EEA countries and help in establishing schemes for testing, documentation and recognition of qualifications achieved outside the formal education system.

4.1 Strategy and instruments regarding energy use in buildings

4.1.1 Objectives regarding energy efficiency and use of renewable energy in buildings

The Norwegian government has adopted an objective of a 30 TWh increase in renewable energy production and energy efficiency measures between 2001 and 2016 [30]. The energy objectives have not been specifically divided across different sectors and there are no official objectives for energy efficiency or the use of renewable energy in buildings.

White paper No. 21 (2011-2012) states that the government will tighten up energy requirements in building regulations to the passive house level in 2015 and a near zero energy level as the building standard in 2020. The government will set rules to define the passive house and near zero energy levels later. The decision on required levels has been made on the basis of socio-economic and health consequences and competence in the building industry. The government will also introduce component requirements for existing buildings and clarify what building work and components these requirements will apply to, including on the basis of an assessment of energy effects and costs [31]. It is anticipated that on-going work on preparing the white paper for building policy will further define the government's use of instruments in energy efficiency measures for buildings.

A committee set up by the Ministry of Petroleum and Energy and a working group set up by the Ministry of Local Government and Regional Development have produced reports with recommendations to the government for determining concrete objectives for energy efficiency in buildings. Both reports showed that it is possible to halve energy consumption in buildings by 2040, which means a reduction in energy consumption from about 80 TWh a year to 40 TWh a year. It was felt to be realistic to reduce energy consumption in buildings by 10 TWh a year by 2020 [5, 32]. It is estimated that of the saving of 10 TWh a year by 2020, about 8 TWh must be realised by renovation and energy efficiency measures on existing buildings. As we approach 2040, the effect of better energy standards in new buildings will be increasingly felt [5]. Among the measures proposed in the reports were stricter energy requirements in the building regulations (Table 4-1), improvement of existing support schemes and the introduction of

competence requirements for, or certification of, consultants and executing companies in the energy field.

Table 4-1: Proposals for energy requirements in the building regulations. Source: [5]

	Regulatory requirements new building	*Regulatory requirements renovation*
Low energy level		• Public buildings: 2014 • Other buildings: 2015
Passive house level	• Public buildings: 2014 • Other buildings: 2015	• Public buildings: 2018 • Other buildings: 2020
Near zero energy level	• Public buildings: 2018 • Other buildings: 2020	

The Energy Committee was set up by the Ministry of Petroleum and Energy in 2011 to investigate the energy and power balance by 2030 and by 2050. The committee was to consider consequences of proposals for measures and instruments in the field of energy, looking particularly at measures that could limit energy consumption. Among other things, the committee proposed that the incentives for energy efficiency measures in existing buildings must be strengthened and that schemes such as white certificates, direct support schemes, tax deductions and measures to increase knowledge and competence in the building industry should be investigated. The committee also believed that a plan should be devised for raising competence in the building industry and in public property management for building and renovating to energy efficient standards and that a subsidy scheme should be set up for energy advice and planning for homes [33].

4.1.2 Following up on the Energy Performance of Buildings Directive and the Renewables Directive

The revised directive on the energy performance of buildings 2010/91/EC (Energy Performance of Buildings Directive) sets requirements for member countries for the introduction of near zero energy buildings as the regulatory level by 2020 [34]. For public buildings, the deadline is 2018. According to the directive, the EEA countries shall revise the energy requirements in the building regulations at least every five years. In Norway, the energy requirements in building regulations were revised in 2007 and adjusted in 2010 [35]. An assessment will also be made of whether the energy requirements in the building regulations are optimal for costs. The European Commission has developed a methodology for such cost assessments. This has been determined in a regulation [36]. If the energy requirements for buildings are not cost-optimised, the EEA countries should tighten up the requirements.

The revised Energy Performance of Buildings Directive has not so far been incorporated into the EEA agreement. Also, there is not yet a Norwegian definition of near zero energy buildings. It is anticipated however that a Norwegian definition could build on the Norwegian standards for low-energy and passive houses [37, 38]. The Energy Performance of Buildings Directive's rules on energy labelling of buildings and energy assessment of technical systems have been implemented in Norway through the energy labelling regulations [39].

The purpose of the Renewables Directive (2009/28/EC) is to increase the proportion of renewable energy in the EU, from 8.5% in 2005 to 20% by 2020 [40]. The percentage of renewable energy is measured in relation to the EEA countries' overall energy consumption. In order to achieve this goal, each of the EEA countries has a national target, so that together these jointly represent the goal of a 20% level. For example, the goal for Sweden is 49.5% by 2020 and that of the United Kingdom is 15%. In addition the member countries shall have a 10% proportion of renewable energy [41]. Norway has accepted the goal of 67.5% renewable energy by 2020. This corresponds to an increase of 9.5 % compared with the proportion of renewable

energy in 2005. The Renewables Directive was incorporated into the EEA agreement on 19 December 2011 [42].

Box 4-1: Calculation of renewable percentage in accordance with the Renewables Directive. Source: [41, 43]

The renewable percentage in accordance with the Renewables Directive is calculated as follows

- ***(****Renewable energy for heating and cooling + Renewable power production with normalised water and wind power + Biofuel****)*** **/ (***Total end consumption of energy + Transmission losses of power and district heat + Consumption of power and district heat in the power/heating sector + Renewable energy from heat pumps****)***

The numerator in the renewable section is calculated as a combination of figures for both consumption and production of energy. The denominator covers total energy consumption. Total end consumption of energy includes total consumption in industry, households, services, agriculture/fisheries and domestic transport. In order to comply with the Renewables Directive, it is thus vital to keep energy consumption down while increasing the production of renewable energy. If energy consumption increases in line with production, it will be more difficult to achieve the goal of increasing the proportion of renewable energy.

A key element in following the Renewables Directive in Norway is the establishment of a joint Norwegian-Swedish electrical certification market. In total the new certification system will contribute to 26.4 TWh renewable energy production in Norway and Sweden combined between 2012 and 2020. How great the increase in renewable energy production will be in each country depends on production costs, concession requirements etc. Power customers finance the scheme via electrical certification costs being added to power prices by the suppliers. Electrical certificates were introduced in Norway on 1 January 2012 through the Act on energy certificates [44]. Other instruments that could contribute to the fulfilment of national obligations under the Renewables Directive could for example include support for energy efficiency measures and renewable heating from the state-owned enterprise Enova, tightening energy requirements in building regulations, energy labelling of buildings, transport policy, tax policy etc. [45].

Finally, we come to the energy efficiency directive, now before the European Parliament. According to the directive proposals, the EU countries will set national energy efficiency targets for 2020. Roadmaps of measures will be prepared so that the targets can be achieved. The European Commission will assess whether the roadmaps are sufficiently ambitious as regards achieving the target of 20% energy efficiency improvement in the EEA area by 2020, and if necessary it can propose binding national targets. According to the European Commission's directive proposals, the EU countries will be required to renovate 3% of their public buildings a year to the level of the regulations in force at any time. Energy suppliers will be required to save 1.5% of their annual total deliveries [46].

4.1.3 Instruments regarding energy use in buildings

Several instruments exist in Norway that will contribute to energy efficiency and the use of renewable energy in buildings. There is a rough differentiation between direct regulations, such as energy requirements in building regulations, and the requirement for energy labelling of buildings, and market-based and voluntary schemes, such as support from Enova and the Norwegian State Housing Bank. The energy labelling scheme, Enova's subsidy schemes and the Norwegian State Housing Bank's basic loans and competence supplements provide an incentive

to construct buildings to a higher standard than required by regulations. This prepares the ground for stricter regulatory requirements, in that experience from projects is spread through the building industry and standards, recommendations and tools are devised based on experience (Figure 4-1).

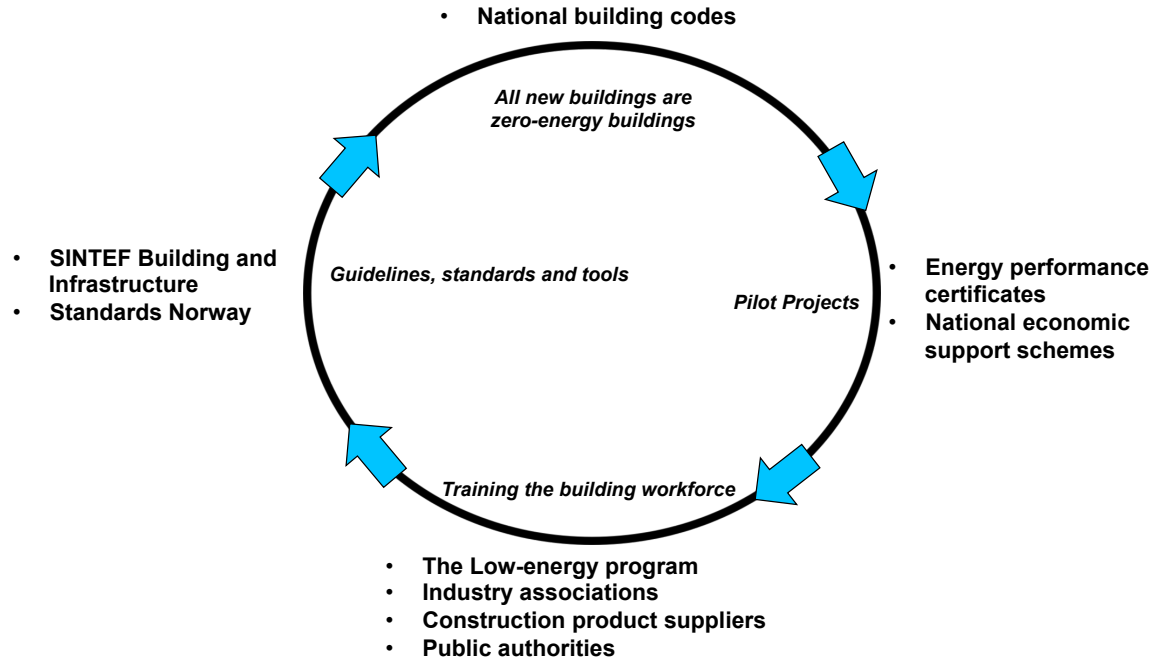

Figure 4-1: Interaction between different measures/instruments

Building regulations

The technical building regulations (TEK 10) are administered by the Norwegian Building Authority. The regulation's requirements cover the energy needs and energy supply of buildings. The rules apply to both new buildings and measures in existing buildings. However the Planning and Building Act allows for exceptions in respect of less comprehensive measures in existing buildings, such as if the energy requirements are unreasonable compared with any energy saving that would result. In the case of major rebuilding or change of use, the same regulatory requirements apply as to new buildings. The regulations provide rules for a building's energy efficiency, including ceilings for net energy needs. The energy ceilings are derived from actual energy measures (Box 4-2). There is also a requirement that energy for heating purposes can be based on energy supplies other than fossil fuels or direct-effect electricity. There are exceptions to the energy supply requirement in cases where natural conditions make it impossible to comply with the rules in practice. For homes, there is also an exception if the net heating requirement is less than 15,000 kWh a year or if the requirement would give excessive costs over the building's lifetime. For new buildings within the concession area for district heating, the building's heating system shall be arranged so that district heating can be used [35].

Box 4-2: Energy requirements in the building regulations. Source: [35]

- *Transmission heat loss:*
  - Proportion of window and door area ≤ 20% of heated gross floor area
  - U value of outer walls ≤ 0.18 W/(m² K)
  - U value of roof ≤ 0.13 W/(m² K)
  - U value of floor ≤ 0.15 W/(m² K)
  - U value of glass/windows/doors inc. frame ≤ 1.2 W/(m² K)
  - Normalised thermal bridge value where m² is stated in heated gross floor area:
    - single family houses/terraced houses ≤ 0.03 W/(m² K)
    - other buildings ≤ 0.06 W/(m² K)
- *Infiltration and ventilation heat loss:*
  - Air tightness at 50 Pa pressure difference:
    - single family houses/terraced houses, exchange of air ≤ 2.5 times per hour
    - other buildings, exchange of air ≤ 1.5 times per hour
  - Annual mean efficiency of heat recovery in ventilation systems:
    - residential buildings and areas where heat recovery carries a risk of spreading pollution or infection ≥ 70%
    - other buildings and areas ≥ 80%.
- *Other measures:*
  - Specific fan power in ventilation systems (SFP):
    - residential buildings ≤ 2.5 kW/(m³ /s)
    - other buildings ≤ 2.0 kW/(m³ /s)
  - Possibility of reducing indoor temperature at night and weekends
  - Measures to eliminate the building's need for local cooling.

The instruments of the Norwegian State Housing Bank

The main focus areas of the Norwegian State Housing Bank with regard to housing quality are in the areas of universal design, energy and the environment and building practice/area upgrades/living conditions. The Norwegian State Housing Bank provides competence supplements for the development of knowledge and competence, pilot projects and the distribution of information about energy, environmental and climate friendly solutions in housing. The Norwegian State Housing Bank also provides subsidies for assessment of condition and total planning in residential and environmental renewal, which can help to reduce energy needs in existing buildings. The main target groups for the scheme are housing cooperatives, co-owners etc. The criteria do not state any specific requirement or ambition level. The Norwegian State Housing Bank's mortgages can be given for building or renovating buildings with energy qualities above what is required by the regulations. The Norwegian State Housing Bank's basic loan has a lower interest rate than the market rate. The main target groups for the Norwegian State Housing Bank's basic loan are local authorities and developers, including housing cooperatives and the like.

Enova's subsidy schemes

Enova is a state-owned enterprise, owned by the Ministry of Petroleum and Energy. As part of its management of the Energy Fund, Enova gives subsidies for energy efficiency measures, converting to renewable heating and the production of energy based on bioenergy and district heating. Support from Enova provides the trigger for measures to be implemented. Total revenues to the Energy Fund in 2012 were estimated at NOK 1,926 million, made up of NOK 780 million from a mark-up on the grid tariff for withdrawing power in the distribution network (1 øre/kWh), NOK 130 million from interest, NOK 996 million from returns on the basic fund and NOK 20 million from the national budget [47]. Enova was established in 2001 and in it first ten years it supported energy projects corresponding to about 16.6 TWh. In building, investment support is given to new passive houses, comprehensive renovation to low-energy and passive house level and energy efficiency measures for existing buildings and structures with an annual results objective of at least 100,000 kWh. In 2011, Enova contracts accounted for 541 GWh of saved energy in these programmes, covering non-residential buildings, public buildings and

homes [48].

Energy labelling of buildings
The Norwegian Water Resources and Energy Directorate administers the energy labelling scheme for buildings and the rules for regular energy assessment of technical systems in buildings. The purpose of the energy labelling scheme is to make the building's energy qualities evident, so that energy-efficient buildings will be more attractive for sale or rent and action will be taken to improve energy qualities. The requirement for an energy certificate when selling or renting applies to all homes, leisure properties and non-residential property over 100 m². Non-residential properties over 1000 m² shall always have an updated energy certificate, which must be visible to all the building's users and visitors. The certificate is valid for 10 years, but can be renewed at any time. The certificate includes a mark in the form of a letter to describe the building's estimated energy requirement. The scale goes from A to G, with A being best. The letter is also coloured green, yellow or red. Green means that a high proportion of the energy requirement can be met with energy supplies other than electricity or fossil fuels, while red means exclusive use of electricity or fossil fuels for heating purposes (Figure 4-2) [39].

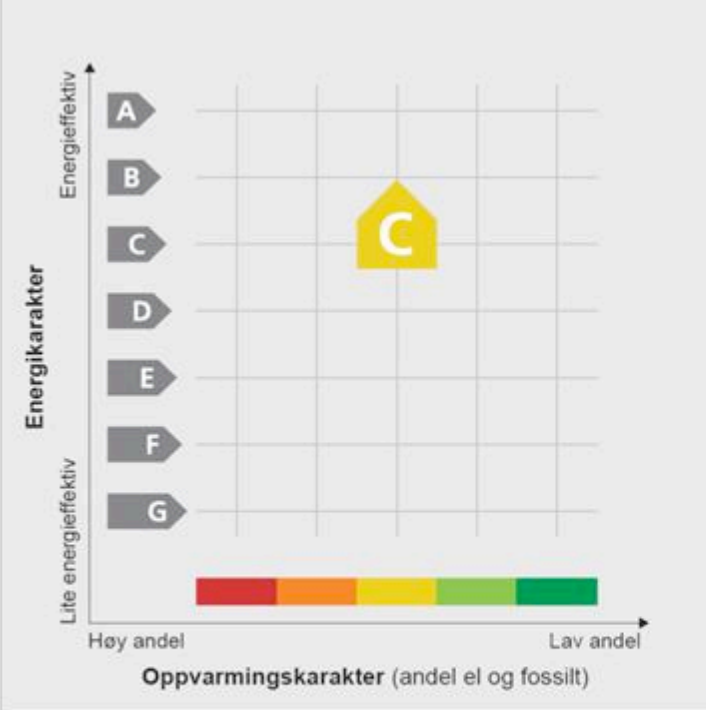

Figure 4-2: Example of energy certificate with energy labelling of buildings

Buildings with a heated floor area of over 400 m² that have a boiler system using fossil fuels and all buildings with air conditioning over 500 m² shall have a valid energy assessment of the technical systems. Ventilation systems, cooling systems and heating systems with boiler and distribution covered by the scheme. Energy assessments shall be shown when selling or renting. Energy assessments are valid for four years, but if the boilers cover an area over 2000 m² and burn fossil fuel, the assessment must be made every other year. The assessment shall include information about measured energy consumption in the past year, as well as a report with key information about the system and the building [39].

The instruments described above are directed at various target groups in the industry. Table 4-2 shows which instruments are relevant for stimulating equipping new and existing homes and non-residential buildings with energy qualities beyond the requirements of the building regulations.

Table 4-2: Instruments in the field of energy beyond the building regulations

	Residential		Non-residential building
	Dwellings	*Co-owners/housing cooperatives*	
New buildings	• Energy labelling • The Norwegian State Housing Bank's mortgage • Enova support: - Passive houses and low-energy buildings - Passive house study	• Energy labelling • The Norwegian State Housing Bank's mortgage • Enova support: - Passive houses and low-energy buildings - Passive house study	• Energy labelling • Enova support: - Passive houses and low-energy buildings - Passive house study
Existing buildings	• Energy labelling • The Norwegian State Housing Bank's mortgage • Enova support: - Passive houses and low-energy buildings - Passive house study - Household supplements (heating solutions)	• Energy labelling • The Norwegian State Housing Bank's mortgage • The Norwegian State Housing Bank's subsidies for assessment of condition • Enova support: - Existing buildings and structures - Passive houses and low-energy buildings - Passive house study	• Energy labelling • Enova support: - Existing buildings and structures - Passive houses and low-energy buildings - Passive house study

4.2. Strategy and instruments regarding education/further education in the field of energy

4.2.1 Green skills and jobs

Green skills and jobs is an important concept in the European Commission's 2020 strategy, which is intended to strengthen the competitive ability of European industry, within the framework of sustainable development [9]. A report from the European Centre for the Development of Vocational Training (CEDEFOP) describes the concept as necessary skills for employees, as well as new or amended professional profiles, which contribute to structural changes that promote a green economy - i.e. growth combined with sustainable development [49]. In this report, the concept of green skills and jobs has been interpreted to mean that employees shall raise their level of skills so that the building industry as a whole can be developed in a sustainable direction, rather than any particular groups of employees being greener than others.

Innovation Norway is a company formed by special statute that is owned by the Ministry of Trade and Industry (51 %) and the county councils (49 %). The company also administers funding from the Ministry of Local Government and Regional Development, the Ministry of Fisheries and Coastal Affairs, the Ministry of Agriculture and Food, the Ministry of Foreign Affairs and the County Governors. Innovation Norway shall contribute to innovation in industry, development in rural areas and competitiveness among Norwegian companies. In 2009, Innovation Norway distributed about NOK 9.8 billion to Norwegian companies and gave advice to the value of NOK 235 million [50]. The development of environmental technology is one of Innovation Norway's focus areas. The purpose is to contribute to more competitive, effective and sustainable industry.

The public sector buys goods and services to the value of about NOK 330 billion a year [51]. The Public Procurement Act obliges public organisations and agencies to consider environmental and social responsibility in procurement and to take lifetime costs and environmental effects

into account [52]. The intention is that the public sector shall contribute to increasing the market share of environmentally friendly goods, services and technology. Building products and property management are focus areas. The Norwegian government put forward a three-year roadmap for environmental and social responsibility in public procurement in 2007 [53].

The Low Energy Programme (www.lavenergiprogrammet.no) is a collaboration programme between public authorities and the building industry to achieve common goals in energy efficiency and energy remodelling in building and construction [54]. The Low Energy Programme intends to achieve a combined building industry with good, targeted information that enables the industry to construct and renovate highly energy efficient buildings and to use renewable energy in buildings. The programme has a number of projects to raise the level of skills in the field of energy among those active in the building industry.

Box 4-3: Passive house courses and courses in energy renovation for tradesmen

The Low Energy Programme has initiated the work of developing courses in passive house (new buildings). The development work is being carried out during spring 2012. The project is intended to result in a freely-available, modular course in passive house that can be compiled and adapted for all trades and professional groups in the building industry, such as building clients, consultant engineers, project architects and the various trades.

The Norwegian Association of Master Builders, the Norwegian Association of Master Bricklayers and the Low Energy Programme have developed a further education course in energy renovation for tradesmen. The course places the emphasis on building constructions that were normal between 1910 and 1997 and gives details of building solutions for renovating to the levels of today's building regulations. The target group for the course is all those who work on the post-insulation and renovation of brick and timber constructions.

4.2.2 Implementation of the European Qualifications Framework for Lifelong learning

The European Qualifications Framework for Lifelong learning (EQF) was adopted in February 2008 [55] and was incorporated into the EEA agreement on 17 March 2009. The Ministry of Education and Research sent the proposed National Qualifications Framework out for consultation on 26th of January 2011.

The EQF describes qualification levels on a European level in the form of learning outcome and is a means of comparing the educational systems of different countries. The aim is not to harmonise the different countries' educational systems but to make it easier to read, understand and compare the systems. The framework is intended to make the educational systems more understandable nationally and internationally, to increase mobility within the EEA area and to contribute to more flexible paths of learning and thereby strengthen motivation to lifelong learning among employees. The EEA countries will create national points of contact for the qualifications frameworks. The task of these contact points will be to inform internationally about the frameworks and about their connection to the EQF. In Norway, this task has been assigned to the Norwegian Agency for Quality Assurance in Education (NOKUT) [56].

The basic element in the qualifications framework is that the qualifications are described though learning outcome and not input factors. The aim is that the learning outcome for the individual qualifications is described in such a way that it is easy to see the connection between the different qualifications, and thereby also the actual differences in learning outcome between different levels and the different paths through the educational system. It is what the candidate knows at the end of the course that is described, not what he or she had to do to get there.

While the European qualifications framework has eight levels, the national qualifications framework has only seven levels (the lowest level is omitted). The framework includes the qualifications that are found in the formal Norwegian educational system (Table 4-3).

Table 4-3: National qualifications framework Source: [56]

Level	*Description of learning outcome*	*Exams, tests and grades for qualifications*
1	Primary and lower secondary schools completed	• Certificate from 10 years of primary and lower secondary schools.
2	Basic competence in upper secondary education.	• Certificate for basic competence in upper secondary education.
3	Upper secondary school completed • Subject and vocational qualifications (3A) • General study qualifications (3B).	• Examination from upper secondary education. • Craft certificate. • Journeyman's certificate
4	Vocational college completed • Vocational college 1 (shorter vocational college education) • Vocational college 2 (two-year vocational college education)	• Certificate from vocational college.
5	First stage of higher education (bachelor degree)	• Bachelor degree. • General teacher training programme. • Sub-level: university college graduate
6	Second stage of higher education (master's degree)	• Master's degree or equivalent
7	Doctorate (Ph.D.)	• Ph.D. • Dr. Philos. • Diploma, artistic development programmes.

The national qualifications framework comprises qualifications in the formal educational system. The framework is not sufficiently detailed or subject specific to be able to relate competence gained at work or in the voluntary sector directly to the framework. Real competence must be assessed and related to curricula, subject and study plans for the individual educational courses. According to the Ministry of Education and Research's consultation paper, the voluntary sector and industry have no great tradition of describing their activities in terms of learning outcome. These cannot therefore be expressed in terms of course certificates or other documentation [56].

One of the aims in introducing the qualification framework is to strengthen opportunities for lifelong learning in the EEA countries and help in establishing schemes for testing, documentation and recognition of qualifications achieved outside the formal education system. Better tools for describing and assessing learning outcome in this way will therefore be an important field for development, so as to be able to assess whether real competence is equivalent to learning outcome in the formal educational system, which is described in curricula, study plans etc. [56].

5. Statistics

Summary of chapter 5:

- The total built-up area in Norway is estimated to be about 385 million m². The greater part of Norway's buildings is owned by private individuals.
- In total, the consumption of energy in homes and non-residential buildings in 2009 was 83 TWh, or about 37% of domestic energy consumption. Energy consumption in buildings has levelled out in recent years.
- The number of completed passive house projects is limited. But the proportional area at low-energy/passive house level is greatly increasing. Several projects are in the process of planning or construction.
- The building and construction industry consisted of about 190,000 employees in 2011. Tradesmen and craft workers represented less than 60% of the total employed in the building and construction industry.

5.1 Buildings in Norway

The total (gross) built-up area in Norway is estimated to be about 385 million m². 256 million m² is residential, of which about 3.5 million m² is public sector. 129 million m² is non-residential, of which 44 million m² is public sector. The residential section includes units that are currently registered as leisure/holiday homes. Other leisure cabins, roughly estimated at 28 million m², are not included. Neither does the summary include operational buildings on farms. Figure 5-1 gives a summary of built-up area in Norway in 2011 [57]. As regards the number of buildings, according to Statistics Norway there are about four million buildings in Norway, of which 1.5 million are residential. The remainder are made up of about 750,000 non-residential buildings and 1,725,000 leisure/holiday buildings, private garages etc. In non-residential buildings it is agriculture and fisheries buildings that dominate, with about 500,000 buildings [58]. The greater part of Norway's buildings is thus owned by private individuals. About half of the country's built-up area is wholly owned by private individuals (detached and terraced houses) [5].

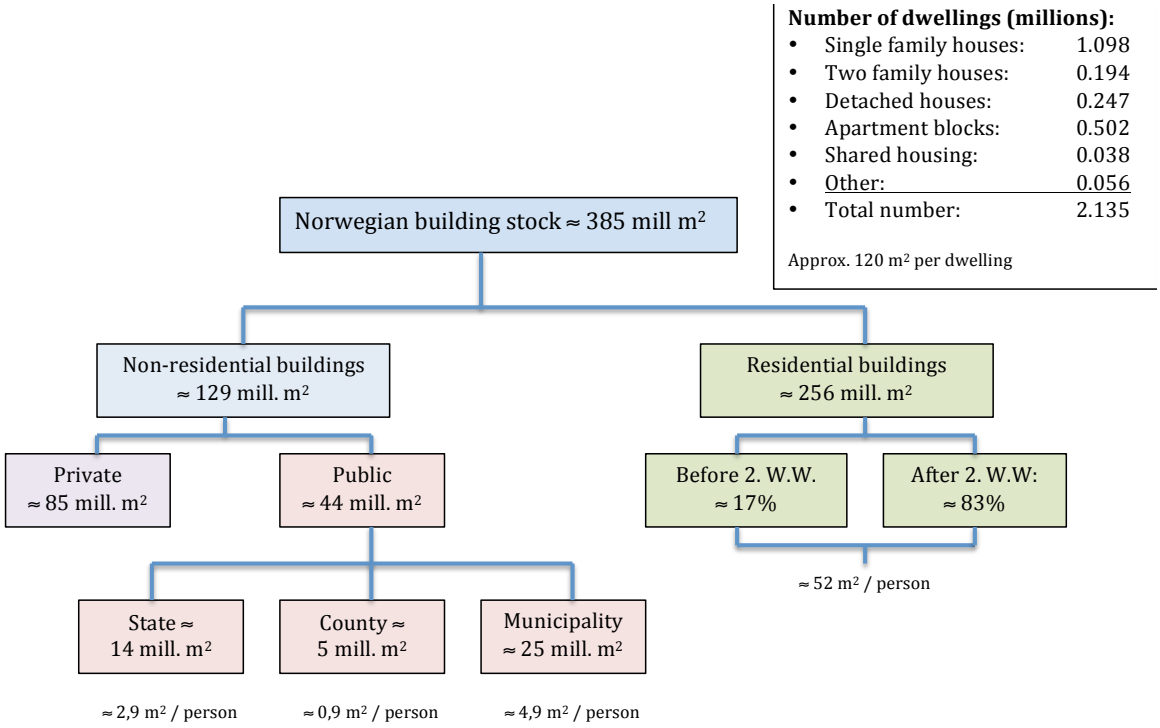

Figure 5-1: Norway's built-up area in 2011. Source: [57]

There is uncertainty regarding the annual rate of new building, renovation and demolition. Demolition and renovation, for example, is not registered, in spite of the fact that an application is often required. There is therefore uncertainty in relation to the total number and area of buildings that are actually in use. According to Multiconsult, it is probably that there are very many buildings standing that are not actually in use. The demographic trend from country to town is behind this development [57]. Table 5-2 shows estimated annual rates for new building, renovation, energy-efficiency measures and demolition for residential and non-residential buildings. Here, rate of energy-efficiency measures means the building area where such measures are carried out in a year. The percentage rates have been estimated on the basis of total building area.

Table 5-1: Annual changes in built-up area. Source: [32]

	Percentage rate		Number of m² usable area per year	
	Homes	Non-residential building	Homes	Non-residential building
New building rate	1.3 %	1.9 %	2.9 mill. m²	2.9 mill. m²
Renovation rate	1.5 %	1.5 %	3.3 mill. m²	1.9 mill. m²
Energy efficiency rate	2.0 %	2.0 %	4.4 mill. m²	2.5 mill. m²
Demolition rate	0.6 %	1.2 %	1.3 mill. m²	1.5 mill. m²

Building activity in Norway has not occurred evenly, but has come in several "booms". The first building boom is the typical urban apartment buildings of the 1800s, which still exist. It has been roughly estimated that 17% of the residential area was built before the Second World War [57]. Statistics from Statistics Norway indicate that 277 million m² of buildings were completed during the period 1967 to 2010, made up of 146 million m² non-residential and 131 million m² residential [59, 60]. The figures are uncertain. We can however state that there is little demolition or renovation of residential buildings, in comparison with non-residential buildings. On average in Western and Northern Europe, just over 40% of the building area was constructed

before 1960 [61].

5.2 Energy use in buildings

The total end consumption of energy in mainland Norway, including the mainland energy sector, was 222 TWh in 2009. The most important end consumer groups are households, service industries, industry and transport. The long-term trend for energy consumption is that fuel for transport and electricity for the energy sector are increasing, while energy consumption in other sectors is levelling off [4, 62]. In total, the consumption of energy in homes and non-residential buildings in 2009 was 83 TWh, or about 37% of energy consumption in mainland Norway (Figure 5-2).

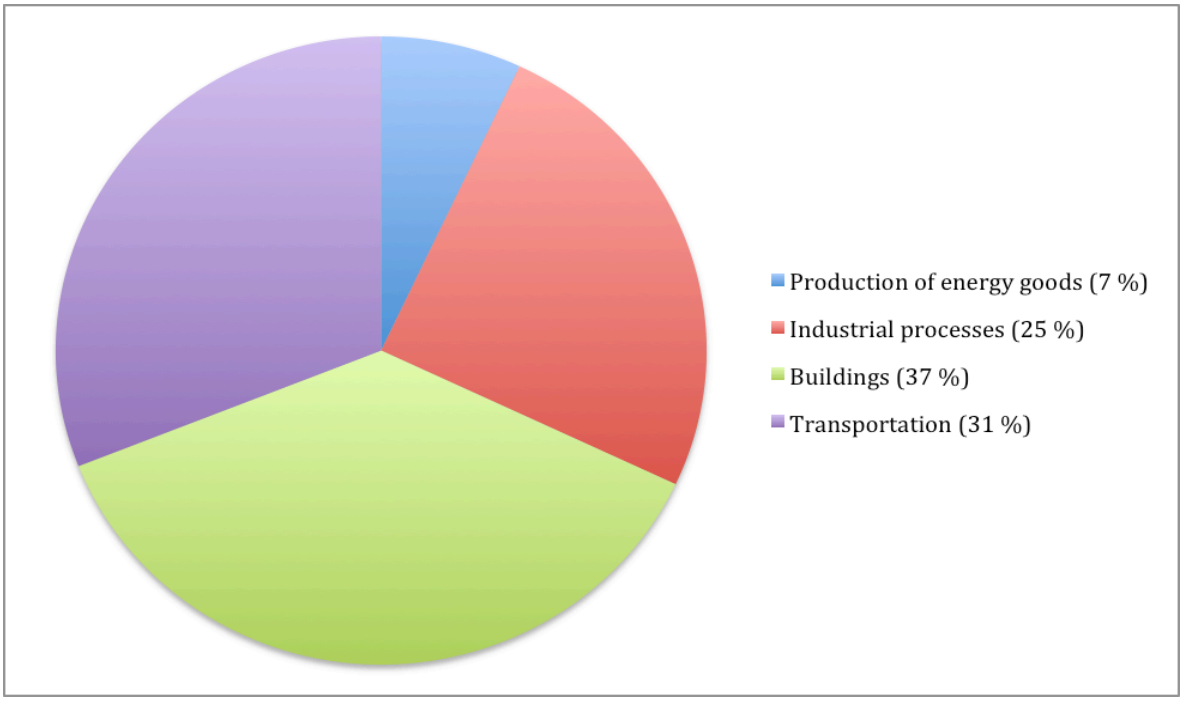

Figure 5-2: Distribution of energy consumption in mainland Norway in 2009. Source: [4]

Energy consumption in households stayed level during 1996 to 2009, after many years of increase. In the service industries, the growth in energy consumption in buildings has decreased since the 1990s. Possible explanations could be a warmer climate, higher energy prices, heat pumps and more energy-efficient buildings [4]. Factors having an opposite influence would include demographic trends, including an increase in area per person and per household. The number of persons per household is also falling, while the population is increasing, leading to an increase in the number of households. This also contributes to increasing energy consumption [4]. But there has been a slower growth in living area per person since 1990 than in the decade before 1990. A report from Vestlandsforskning (2012) concludes that this is the most important reason for the levelling out of energy consumption in homes [63].

Energy consumption in buildings was made up of 46 TWh in housing and leisure buildings, 29 TWh in non-residential buildings in the service industries, about 4 TWh in industrial buildings and 4 TWh in non-residential buildings in the primary industries and construction sector. Energy consumption in holiday homes represents a steadily increasing part of household energy use, even though the percentage is still low. The use of electricity in holiday homes increased from about 0.7 TWh in 1993 to about 1.6 TWh in 2009. This is due to more and larger cabins, for which a greater proportion is now connected to the electricity grid [4]. The figures for energy use in non-residential buildings is more uncertain than for households and industry, because

few thorough surveys have been made into real energy consumption in this end user group [4, 64].

Electricity is the most widely used form of energy in Norway. Electricity is the dominant form of energy in both households and non-residential buildings. In 2009, electricity represented about 80% of energy consumption in buildings. The use of electricity has increased in recent years. It is normal to make a distinction between electricity used for room heating, hot water and ventilation air and electricity used for technical equipment and lighting. While technical equipment and lighting can only normally be covered by electricity, energy for heating purposes can come from various sources. Room heating represented 55-60% of energy consumption in homes and 40-50% of energy consumption in non-residential buildings [4].

It has been estimated that it is possible to save 10 TWh by energy efficiency measures in buildings by 2020 and to achieve a halving of energy consumption in buildings by 2040 [5, 32]. The estimates for possible energy efficiency savings assume that present buildings are replaced by more energy-efficient ones and that there will be comprehensive energy measures in existing buildings. One challenge will be to get the investment decisions among building owners that lead to sufficiently ambitious energy measures in existing buildings. Table 5-2 shows estimates for average energy consumption in existing buildings and anticipated future building standards.

Table 5-2: Energy consumption at different ambition levels. Source: [5]

Ambition level	Non-residential building	Residential building
Average existing buildings	283 kWh/m²	201 kWh/m²
Estimated energy consumption after conventional renovation	215 kWh/m²	160 kWh/m²
Present regulatory level (TEK 10)	150 kWh/m²	120 kWh/m²
Low-energy level (according to NS 3700 and NS 3701)	115 kWh/m²	95 kWh/m²
Passive house level (according to NS 3700 and NS 3701)	80 kWh/m²	70 kWh/m²
Nearly zero energy level	60 kWh/m²	55 kWh/m²

5.3 Nearly zero energy buildings, passive houses and low-energy buildings in Norway

There are no official Norwegian statistics for the building of or renovation to buildings at passive house or low-energy level. Near zero energy buildings have yet to be defined in Norway. There are however examples of model projects in the energy field, such as by Enova [65], the Norwegian State Housing Bank [66] and Ecobox [67]. Buildings that are built or renovated to low-energy or passive house level can receive public support from Enova (Table 5-3).

Table 5-3: Support measures by Enova as at 01.01.2012: Source: [68]

	Passive house level Residential / Kindergartens	Passive house level Non-residential building	Low-energy level: Residential / Kindergartens	Low-energy level: Non-residential building
New buildings	NOK 450/m²	NOK 350/m²	NOK 300/m²	NOK 150/m²
Renovations	NOK 700/m²	NOK 550/m²	NOK 600/m²	NOK 450/m²

Enova has statistics on the number of projects in building and construction that have received support. The statistics can be read as cumulative energy-efficiency measures (kWh) the support has contributed to or cumulative usable area that has been built/renovated at passive or low-energy building level. Enova's statistics show that since 2006 about 275,000 m² gross area has received support for new buildings at passive level (Figure 5-3 – Norwegian only). The largest

area that has received support for passive house (new building) is non-residential. Altogether, the focus on new buildings on passive house level contributed to contracted energy efficiency measures totalling 25 GWh by the end of 2011 [69].

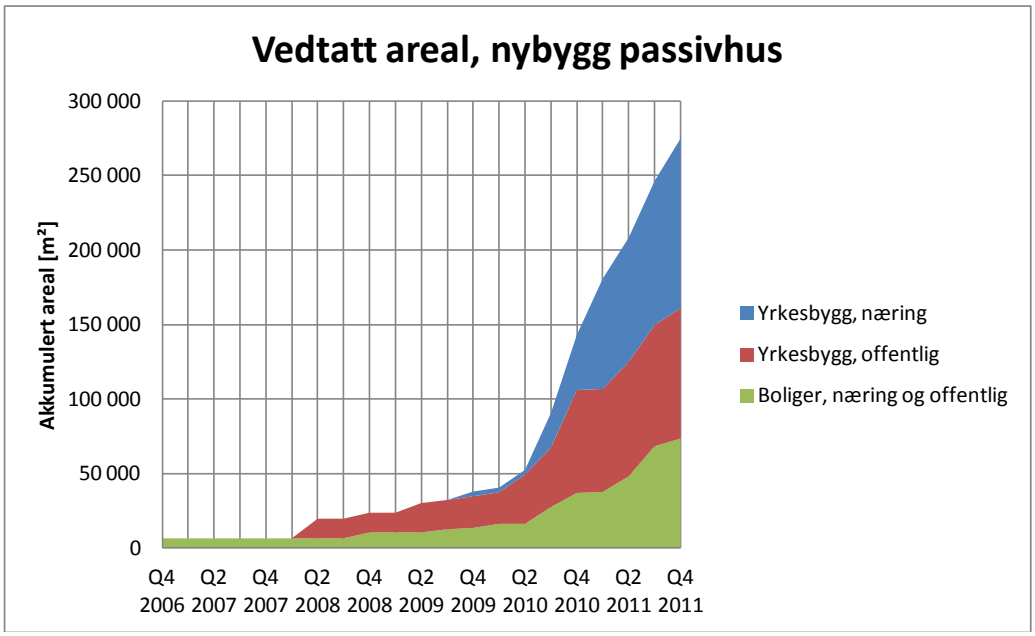

Figure 5-3: Cumulative area that has received financial support from Enova for building at passive house level. Source: [69]

As regards renovation of buildings to passive level, the figures for the area that has received support from Enova are smaller. This is naturally connected with the fact that renovation to passive house level is challenging, whatever the level of support. At the same time, the energy-efficiency effects are greater than for new buildings. Since 2009, support has been given to the renovation of about 50,000 m² gross area to passive house level. The greater part of this area is in private, non-residential buildings. The support has led to contracted energy savings of almost 6 GWh. Support for new building to low-energy level has contributed to contracted energy savings of more than 60 GWh since 2005. Over 600,000 m² gross area has received support for building to low-energy level, primarily in private, non-residential buildings. Finally, about 130,000 m² gross area has been renovated to low-energy level since 2009, once again mainly in private, non-residential building. This has given contracted energy saving of about 15 GWh [69].

If we summarise the figures, the Enova statistics show that since 2005 support has been distributed to creating just less than 900,000 m² gross area at low-energy level or better. The statistics from Enova are not official Norwegian statistics, but there is reason to believe that most model projects at this level have received official support from Enova and so have been recorded by them. If we assume that annual new building activity amounts to about 6 million m² gross area, a simple calculation shows that on average 2.5% has been built to low-energy or passive house level over the last six years. The greater part of this area is private, non-residential building. It should be noted that the proportion of area that has been built to low-energy or passive house standard has been greatly increasing in recent years.

The number of completed Norwegian passive house projects is still limited, especially as regards larger projects including housing. Several projects are in the process of planning or construction, however. According to SINTEF Building and Infrastructure, more than 30 residential projects at passive house level have been built or planned in Norway. The residential projects vary in size from detached houses to large areas of many housing units at passive house level [70].

5.4 Companies and employees in the building industry

The building and construction industry consisted of about 190,000 employees in 2010, distributed around approximately 50,000 companies [12]. The number employed increased by 0.9% over 2009. If we go back to 2000, about 134,000 people were employed in the building and construction industry, in about 34,000 companies [71]. If the property sector is included, it is estimated that the number of companies in the building industry increased by 86% between 1998 and 2007 [1]. Of the total number of companies in the industry in 2007, companies actually involved in building represented less than 20%, while companies in property (including finance) represented over 60%. The growth in the number of companies is an important figure for describing trends in the building industry. The entry barriers to starting your on company are small and there are no requirements for education, experience or competence for performing building work that is not covered by the general requirements for education and practice in the Planning and Building Act. The period from 1998 to 2007 was also marked by strong economic growth, which made it attractive to start up a company [1]. Many of the companies registered as being actively involved in building are self-employed tradesmen.

Well over half those employed in the building and construction industry and about half of the companies are located in seven counties: Oslo, Akershus, Buskerud, Hordaland, Rogaland, Østfold and Sør-Trøndelag [72]. One explanation of this could be that the municipalities in which companies are registered are strongly correlated with where the owners of the companies live. It is also in these counties that most people in Norway live. The structure of the industry differs from that of other important industries due to the high percentage of small and medium sized companies. 90% of the companies have fewer than 10 employees, while 96% have fewer than 20 employees [3]. The smallest companies do not usually have their own administration employees.

Tradesmen in building and construction represented about 108,000 employed in 2011, or slightly less than 60% of the total employed in the building and construction industry [73]. These figures are not comparable with those for previous years, because from 2011 Statistics Norway has used a revised standard for job classification based on international guidelines (STRYK-08). The new standard gives a lower figure for tradesmen because supervisors in building and construction have been moved to university college occupations [74]. The great majority of those in trades are men [75].

The number of tradesmen employed went down by about 20,000 from 2008 until 2010. The reduction was particularly marked among carpenters and joiners, with about 13,000 fewer employed, about 8,000 of them carpenters. This reduction must be seen in the context of the economic downturn that occurred in building and construction during these years. [76]. Table 5-4 shows the number of tradesmen employed in the fourth quarter of 2010 for some selected vocational groups in building and construction [77]. The figures will vary somewhat based on which employees are counted as being within each classification.

Table 5-4: Employed tradesmen in selected vocational groups. Q4 2010 Source: [77]

Vocational code	*Vocation*	*Total employed Q4 2010*
7121	Bricklayers etc.	6,370
7122	Concrete/foundation workers, building	3,340
7125/7421-2	Carpenters/joiners	56,850
7131	Roofers	1,170
7132	Insulators	1,300
7133	Glass workers	1,460
7134	Plumbers and HVAC fitters	16,660
7213	Tinsmiths	3,590
7241	Electricians and similar	32,670
9310	Auxiliary workers in building, construction, maintenance etc.	11,530

6. Existing education, further education and competence requirements.

Summary of chapter 6:

- Vocational education in Norway is normally four years. The first two years are normally in upper secondary school and the final two years as an apprentice in one or more approved teaching companies.
- All four years have centrally imposed, competence-based curricula. The measures of competence are relatively general and the schools have a good deal of freedom in how instruction is given.
- There are many formal further educational courses based on craft and journeyman's certificates. The commonest are master's degree, vocational college, the so-called Y path or engineering to bachelor degree level.
- For tradesmen who wish to remain in their trades, there is no national system or offer of systematic education or craft or journeyman's certificates. A number of organisations offer courses, but none of the courses offered is in a system for lifelong learning.
- The learning conditions monitor for 2010 shows that the building and construction industry is lower as regards participation in all forms of lifelong learning than many other sectors. The percentage of tradesmen taking part in lifelong learning has been greatly reduced in recent years.

6.1 Vocational education in Norway

Vocational subjects in Norway are organised into nine vocational education programmes in upper secondary schools. Vocational education in Norway is normally four years, the first two in upper secondary school and the final two as an apprentice in an approved teaching company. Companies that take on teaching responsibility for apprentices and apprentice candidates must be approved by the county council vocational education office.

Vocational education and training in Norway is conducted as a partnership between the social parties in the vocational sector, that is to say employer and employee, the teaching organisations, the counties and the national educational authorities. Each of the nine vocational education programmes has a specialist council made up of these parties. The Federation of Norwegian Construction Industries is currently chairing the specialist council for building and construction. Figure 6-1 shows the programme structure for building and construction techniques (in Norwegian only).

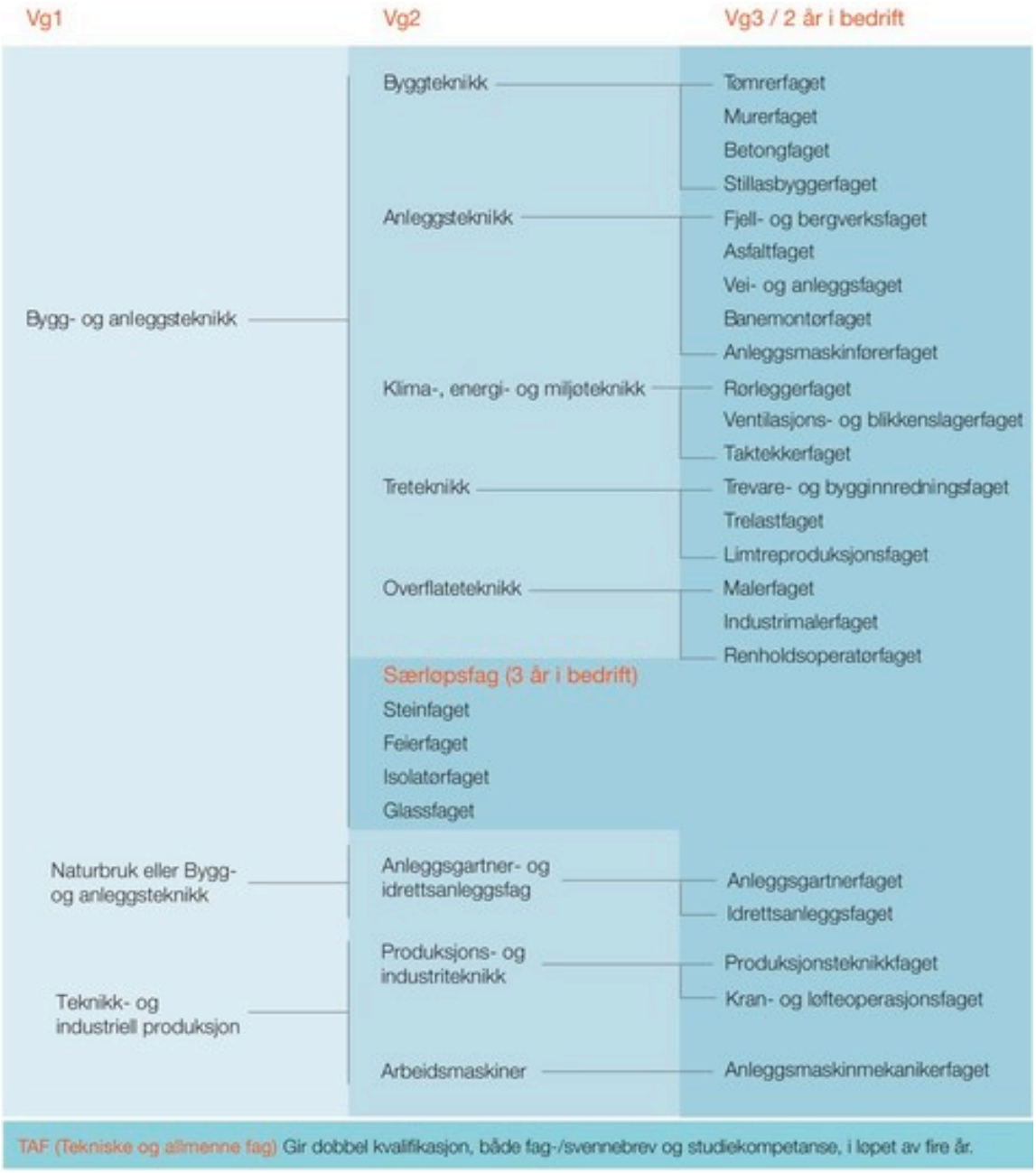

Figure 6-1: Upper secondary education for building and construction techniques. Source: [78]

During the first two years, students go through the basic elements of the vocational subjects, in addition to the common subjects, which are Norwegian, English, physical education, mathematics (VG1), science (VG1) and social studies (VG2). During the first year of vocational education (VG1), many of the vocational subjects are combined, which makes the curricula somewhat general. In the second year (VG2), the competence goals are more concrete for the different vocational subjects, but many subjects are still combined. For example, VG2 for climate, energy and the environment comprises roofing, ventilation and tinsmith work and plumbing. The students also have practical training in companies during the school year. For the final two years (VG3), the student is an apprentice in a company. Here the education is in a single vocational subject and attainment in that subject is measured. After the course of education is completed, the apprentice takes an examination for a craft or journeyman's certificate, which is a practical examination that normally lasts a week [79].

Box 6-1: Vocational education in carpentry

VG1 building and construction techniques (first year in upper secondary school) is common to 22 subjects. The curriculum for VG2 building techniques (second year) covers four subjects: carpentry, bricklaying, concrete work and scaffolding. At this level, the curriculum moves more towards the individual subjects. For example, the competence goals for production state that the student shall be able to build complete, load-bearing outer walls and joists, as well as carrying out measurements and calculations in connection with the construction. In the third year (VG3), the curriculum becomes more directly aimed at carpentry. This means among other things that the strident shall be able to plan, execute, document and assess their own work for both new building and work on existing buildings.

All four years have centrally-determined curricula that are regulated in accordance with the Education Act. There are separate parts for school time and training in companies. The curricula are competence-based, so that school and company have a good deal of freedom in how instruction is given. Table 6-1 shows examples of competence goals that could be relevant to the energy field for several of the vocational subjects (VG3).

Table 6-1: Competence goals (VG3) that could be relevant to the energy field. Source: [79]

Vocational subject	*Competence goal in the curriculum with regard to the energy field (VG3)*
Carpentry	• Building and assembling various types of complete wall structures. • Building and assembling various types of complete roof structures. • Fitting windows and doors an insulating and sealing around them. • Converting existing buildings to new functional areas in accordance with current regulations. • Choosing structures and solutions for renovation and extension work that prevent damage.
Bricklaying	• Insulating, draining and anchoring brickwork. • Laying and assembling chimneys and fireplaces. • Renovating various types of brickwork.
Concrete work	• Fitting embedded items, insulation products and openings.
Plumbing	• Fitting, insulating and starting up simple water-based energy systems according to fitting guidelines. • Using digital tools for heat calculations. • Explaining different energy sources for heating and explaining how a heat pump system works. • Choosing materials for heat pumps. • Assembling a simple heat pump system.
Ventilation and tinsmith work:	• Explaining various ventilation systems, energy-saving measures and energy-efficient ducting networks. • Making piercings of roofs and walls and preventing the intrusion of damp. • Performing simple control, start-up, operation and maintenance of simple ventilation systems. • Using different types of insulation against cold, heat and sound. • Roofs: explaining underlay, fixing methods, insulation and airing.

Roofing	• Perform diffusion sealing. • Improving and reroofing older roofs. • Perform insulation with the necessary drainage fall construction.
Glazier work	• Producing insulated panes in various sizes and styles. • Jointing, fixing and sealing into various types of building materials. • Using digital calculation programs for energy saving and glazing design. • Explaining various kinds of sun screening and performing fitting, servicing and maintenance of them.
Insulation	• Selecting and fitting insulation and fire safety products against heat, cold, fire and sound. • Fitting various types of insulation and surface protection on pipes, valves, containers and tank systems. • Making and fitting insulation and fire protection cushions. • Using materials that take environmental and economic considerations into account.
Electrician	• Plan, assemble, start up and document various heating and lighting systems. • Explain and assess energy costs with the use of technical solutions and alternative energy carriers. • Plan, assemble, start up and document energy efficiency electrical measures, maintaining building requirements.
Refrigeration and heat pumps	• Assessing systems with regard to improvements and upgrades. • Advising customers about the profitability of repairs to refrigeration and heat pump systems. • Performing work so as to safeguard environmental use of resources and sustainable development.

Companies that take on teaching responsibility for apprentices and apprentice candidates must be approved by the county council vocational education office. A written apprentice contract shall be entered into at the start of the training period, showing who is responsible for the various parts of the training according to the curriculum for the subject. It shall state which competence goals the apprentice shall receive training in. The education office and the education circle are two forms of organised collaboration between two or more companies, so that the apprentice/candidate can be exchanged between the collaborating companies. If training is to be given in more than one teaching company, an attachment to the apprentice contract must be completed showing which company is responsible for which training. There must also be fixed routines to ensure that training is given according to the curriculum. [80]. In some counties, more than 80% of new apprentice contracts are signed with education offices [81].

The building industry has expressed its concern that the present vocational training does not give the industry or the companies the technical competence they need. This applies for example to knowledge about energy efficiency measures for existing buildings and constructing new passive houses. The Federation of Norwegian Construction Industries has suggested for example that the educational programme for building and construction techniques (VG1) should be split into two - one for construction and one for building - and that arrangements should be made to allow a greater part of the upper secondary training in subjects and theory to be done in the teaching companies [82].

6.2 Formal further education

Formal further education is defined as education in new tasks and positions, but usually based on own subject and competence. There are several educational courses based on craft and journeyman's certificates. The commonest are master's degree, vocational college, the so-called Y path or engineering to bachelor degree level. These courses are very suitable for tradesmen who wish to be educated for positions such as middle manager or designer. It is possible to build further on the bachelor degree to master's degree or doctorate (Figure 6-2).

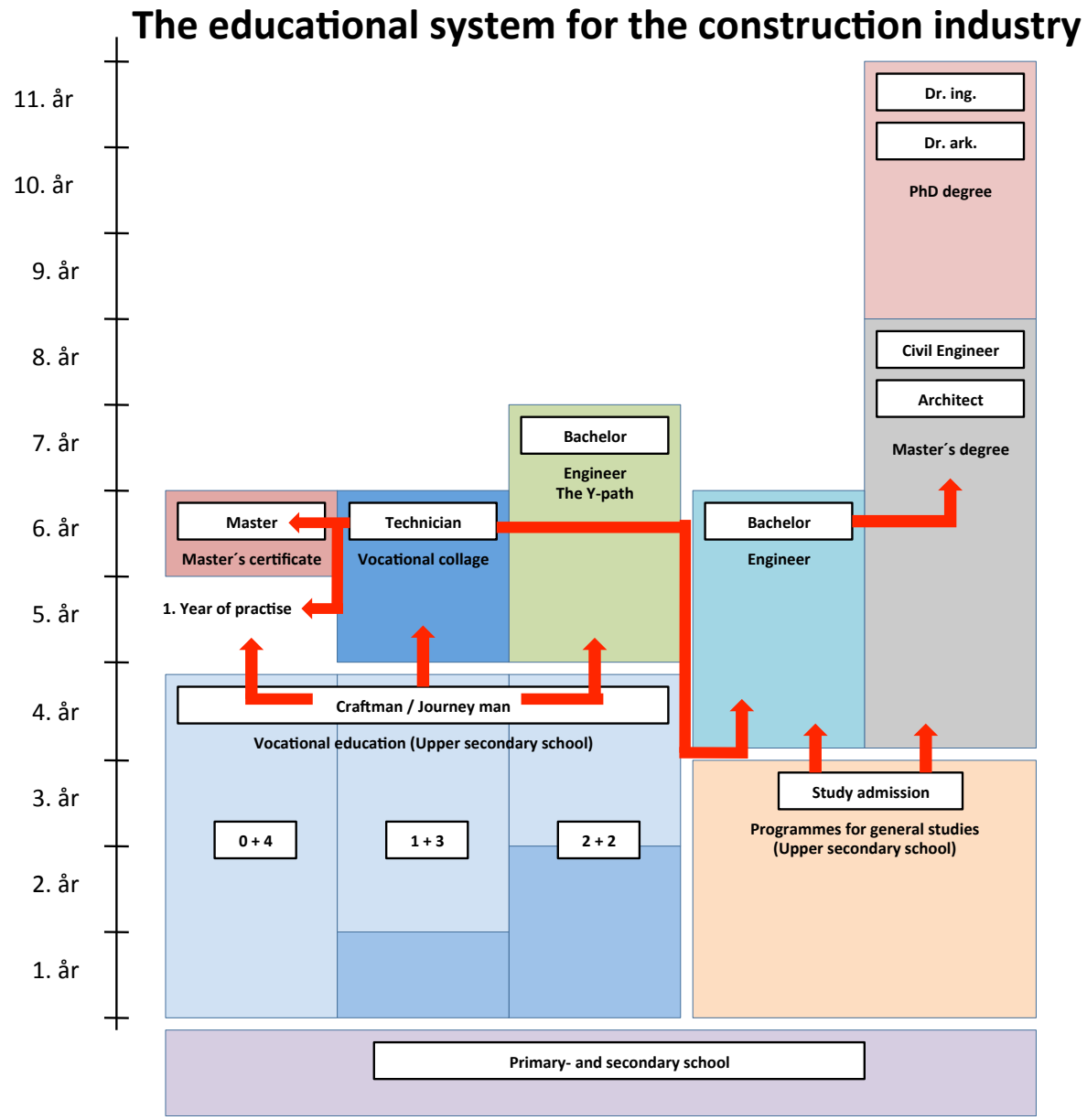

Figure 6-2: Educational system for the building industry

Vocational college

Vocational college education builds on upper secondary training or equivalent real competence and is an alternative to university college or university education. The entry requirement for vocational college education is vocational competence, with or without craft or journeyman's certificate, or general study competence. Vocational college is intended to give vocationally directed further education that can be put to direct use in working life without further training.

According to the Act on vocational college education, the course shall be from a minimum half study year to a maximum two study years [83]. Vocational college education is approved by the Norwegian Agency for Quality Assurance in Education (NOKUT). There are a number of privately or county council approved vocational college courses that are relevant for tradesmen in the building industry, such as for building and construction, electrician, climate, energy and the environment in building, energy management etc. [84].

Master's certificate
The master's certificate is a formal further education for tradesmen in their own trades and gives competence as a company manager or technical manager. The Act regarding master's certificates in trades and other industries was adopted by the Norwegian Parliament (Storting) on 20 June 1986 and came into force on 15 January 1987. This replaced the former Tradesmen's Act. The Act regarding master's certificates gives legal protection to the title of master so that only those with a valid master's certificate may use it [85]. The master's certificate system currently covers 73 subjects, 13 of them in building and construction [86]. To apply for a master's certificate, a candidate must have a craft or journeyman's certificate in the subject and at least six years vocational experience in it, or two years after receiving the craft or journeyman's certificate. Exemption can be given for all or part of the master's certificate education on the basis of an assessment of real competence (other education and work practice). This scheme is founded on its own regulation. No exemption is given to the requirement for a craft or journeyman's certificate in the same subject [87].

The master's certificate education currently has two main modules, each of which concludes with an examination. The module "Establishment and management", covers the theoretical basis for understanding how an organisation functions, marketing management and financial management. The main aim of the module "Technical management" is to give a further introduction into the technical management tasks and themes that are particular to the vocational subjects. The requirement for achieving the title of master is to pass the examination at the master's certificate college or educational equivalent with a mark of D or better [86].

The Y path
The Y path is further education at University College for students with a background in a relevant vocational subject. The Y path is aimed at applicants with an exam pass from a vocational education programme and a relevant craft or journeyman's certificate. The subject composition is tailored to the student's background, so that studies can be completed during the course of three years without the student first having to take a course in general studies [78]. Y path students are integrated with those who have a background in general subjects, but the lack of mathematics, physics, Norwegian and English is compensated because basic building and construction, electrics etc. and some optional subjects can be removed from the studies.

The Y path in building and construction, electrics, mechanics etc. is offered at a number of university colleges in Norway. In autumn 2002, Telemark University College took in the first students for a three-year bachelor degree course for those who had passed the vocational subjects examination; it is the university college with the longest experience of the Y path in Norway [88].

6.3 Further education and training for tradesmen

Further education and training is defined as a technical top-up and perfecting in order to stay up to date and go into one's own trade/subject in more depth. According to the Federation of Norwegian Construction Industries, tradesmen and skilled workers are the group of employees in the building industry who currently have the poorest opportunities for further education or in-service training. For tradesmen who wish to remain in their trades, there is no national system or offer of systematic education or craft or journeyman's certificates. A number of

organisations offer courses, but none of the courses offered is in a system for lifelong learning. Neither is there any official approval, accreditation or certification of courses offered or any national goals for content, quality or evaluation. This means that it is difficult to make a general assessment of the quality of further education and training offered to those who are already active in the building industry. The lack of development opportunities can also make it difficult to take care of and keep skilled workers and tradesmen and reduces the attractiveness of vocational training in the building trades [89].

In the building industry, the day-to-day work on building sites has always been an on-going learning arena for each tradesman, in order to maintain and extend technical competence. However the rapid pace of change in technical issues today also requires tradesmen to acquire new technical knowledge that cannot be gained through experience alone [90]. Examples could include the knowledge of building physics, building structures and the installation of heating, ventilation and air conditioning systems that are necessary for passive and near zero energy buildings, renovation with ambitious energy goals and the use of renewable energy for heating and cooling.

Since 2003, participation in lifelong learning and other learning conditions in Norwegian working life has been measured through the so-called learning conditions monitor [91]. The reports are based on data from Statistics Norway's workforce survey, including supplementary questions on lifelong learning. They distinguish between:

- Participation in further education that gives formal competence, i.e. all public education that gives formal competence and is not taken as part of the initial education.
- Participation in courses and training, i.e. all forms of education and training that do not give formal competence. This comprises educational and training activities such as courses, seminars and other activities whose main purpose is training.
- Learning-intensive work, which describes the extent of informal teaching in day-to-day work.

The learning conditions monitor for 2010 shows that participation in both training and further formal education is falling throughout the labour market, among both women and men and in all age and educational groups. For the first time since measurements started in 2003, less than half of all those employed now take part in courses or training during the course of a year [91]. There are clear differences between different industries when it comes to the proportion of employees with learning-intensive work. In general, building and construction scores lower for all forms of lifelong learning than a number of other sectors (Figure 6-3 – in Norwegian only).

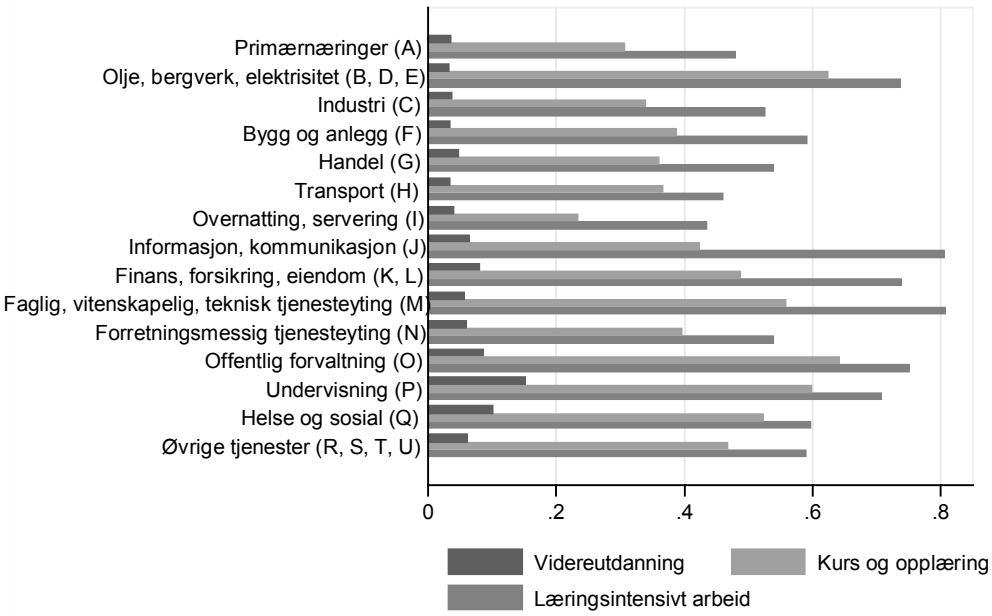

Figure 6-3: Lifelong learning in different sectors in 2010 (%). Source: [91]

Lifelong learning varies between different vocational categories. Company managers, academic and university college occupations clearly have the highest proportion participating in formal further education, courses/training or learning-intensive work. At the other end of the scale are trades that do not require education. The proportion of tradesmen and skilled workers participating in lifelong learning is low compared with the "high-status" professions, but relatively high compared with trades that do not require education. The percentage of tradesmen taking part in lifelong learning has been greatly reduced in the last three years [91].

The learning conditions monitor survey of 2010 shows that participation in courses/training and the proportion with learning-intensive work becomes higher in proportion to the size of the company. As regards formal further education, the lowest participation is in the smallest companies, but otherwise participation does not increase with company size. Participation in formal further education also varies with educational level. The variation depends on how old people are. Among the youngest, we find little or no difference between the educational groups, while in the 36-44 age group the highest proportion taking further education is among those with a short university or university college education. Among the oldest workers, people with higher education at all levels participate significantly more in further education than those with primary and lower secondary education and upper secondary training. For the building industry, which has a high proportion of small and medium sized companies and a high proportion of employees with upper secondary vocational training, these trends will result in a low participation in the lifelong learning that is on offer [91].

The competence reform (White paper No. 42, 1997-1998) was implemented with effect from 2000 and had two main parts: adults who had not previously completed primary and lower secondary school or upper secondary education should have the opportunity to do so. Additionally, the reform should also contribute to better learning opportunities in connection with the workplace, through training and other forms of learning on the job [92]. The results of the learning conditions monitor for 2003 to 2010 indicate that these goals have not been realised. There has been no increase in post-qualifying and further education, the proportion in learning-intensive jobs is stable and the difference in learning conditions between different social groups is unchanged. The trend of the last few years shows an even more negative change [91].

Vox investigated the attitudes of the general population and company managers to the need for learning and strengthening basic skills. The survey gives a somewhat different picture of lifelong learning to that of the learning conditions monitor. The results show that 78% of the working population have taken part in at least one training activity organised by the company they work for in the past year. Employees whose highest completed education is upper secondary vocational training participate in training and education almost as much as those with higher education (77& and 80% respectively). Employees with only primary and lower secondary and upper secondary general subjects are below the average. Respondents stated that they had a good learning outcome from their day-to-day work, especially through collaboration in solving specific working tasks. Those whose highest completed education is further education or upper secondary vocational training consistently had a stronger perception of learning outcome than other educational groups [93]. Vox also has statistics of Norwegian companies' willingness to finance training and education for their employees. 42% of a sample of 1,000 companies said they were willing to finance training in its entirety, while 26% said they were willing to part finance it. Among companies in building and construction, 38% said they were willing to finance training in its entirety, while 32% were willing to part finance it [93].

6.4 Examples of course offers and tools for tradesmen

A number of industry organisations in building offer courses for their vocational groups and have their own courses. For example, courses are available through the Norwegian Association of Building Constructors, the Norwegian Association of Master Builders and NELFO (the Federation of electrical and IT companies) etc. The courses cover topics such as regulations, building techniques, health and safety, the environment and management/economics. The industry organisations arrange courses all over the country and usually in close partnership with local associations. Examples of such courses for tradesmen in the energy field in recent years include courses on new energy requirements in the building regulations (the Norwegian Home Builders' Association and the Norwegian Association of Master Builders) and courses in energy renovation for carpenters and bricklayers organised by the Norwegian Association of Master Builders and the Norwegian Association of Master Bricklayers. Seven industry organisations (the Norwegian Heating Techniques Association, the Norwegian Association of Plumbing, Heating and Ventilating Contractors, the Norwegian Bioenergy Association, the Norwegian Heat Pump Association, the Solar Energy Association, the Norwegian District eating Association and the HVAC Association) have developed a course compendium on water-borne heating and the use of renewable energy such as solar energy, bioenergy, heat pumps and district heating in heating systems. As per 2011, 18 in-depth courses have been held with 467 participants.

In addition to the industry organisations, there are a number of privately organised courses. With the introduction of new regulations, public subsidy schemes etc., it has also become a tradition for the Norwegian authorities to organise so-called guide courses, the purpose of which is to reach resource persons in the building industry who can then disseminate the information. Such a series of courses was organised for example by the Norwegian Building Authority when the new energy rules were introduced into the building regulations in 2007. Building product suppliers also hold themed seminars, breakfast meetings etc. aimed at the professional market among their customers, including local tradesmen. The courses by building product companies can be anything from pure product presentations for marketing purposes to a focus on regulations or building solutions.

It may be possible to use knowledge gained in informal courses to document formal competence, such as when taking a craft certificate in several vocational subjects. This would require the course participants to be conscious of documenting the knowledge gained in such courses.

Box 6-2: The Building and Infrastructure (Byggforsk) series. Source: [94, 95]

In 2008 the Building and Infrastructure series celebrated its 50th jubilee. The Building and Infrastructure series *"building industry quality norms"* has been developed by SINTEF Building and Infrastructure and gives documented solutions and construction details that can be used to satisfy the requirements of the building regulations. The Norwegian Building Authority recommends the use of this series as documentation for building jobs, as a basis for control plans and checklists and for general competence development. The series is therefore a useful tool for the entire building industry, including tradesmen and skilled workers, to ensure the quality of building work.

The purpose of the Building and Infrastructure series is to organise the experience and results of practice and research in such a way as to allow them to rapidly benefit practical building work. The series includes more than 700 instructions giving documented solutions, construction details and recommendations for planning, execution and management of buildings. The Building and Infrastructure series consists of three parts: Planning, Building Details and Building Management. Items about new building are in the first two parts while items about existing buildings are found in the third.

Planning covers information about user requirements, project planning, planning applications, area use inside and outside, suggested planning solutions, fittings and adaptation of equipment. The directions in *Building Details* give more detailed descriptions of structures and materials, finished solutions with detail drawings and design and quantities tables. *Building Management* covers tasks and functions that are necessary to operate, care for and develop existing buildings, i.e. management, operation, maintenance, improvement and remodelling. The entire Building and Infrastructure series can be found on the Internet: http://bks.byggforsk.no/

In a survey carried out by Respons Analyse AS for the Low Energy Programme in 2010, 50% of the 400 tradesmen companies responded that the Building and Infrastructure series was a good way of implementing competence raising and updating changes to and tightening of the regulations. According to SINTEF Building and Infrastructure, more than 7,000 companies and tradesmen in the building industry use the series as part of their quality and competence development system.

6.5 Requirements for education and practice for tradesmen in building jobs

The Planning and Building Act sets general requirements for education and practice for companies that are to perform building work. The requirements are to ensure that companies that assume responsibility for building jobs are able to complete the project in accordance with the building regulations. The requirements for education and practice qualifications do not apply to building projects where planning application is not mandatory.

The principle is based on local authorities awarding a right to assume responsibility to companies that have adequate and necessary qualifications to take on specified tasks. The approval is not uniform. It can cover one or more functions (responsible applicant, responsible project planner, responsible executing company or responsible controlling company) and it can be given for different classifications of tasks that state the complexity of the building projects [96]. Table 6-2 gives a guideline for the requirements for education and practice that are set for companies for public sector buildings [97].

Table 6-2: Qualification requirements for building jobs. Source: [97]

Class	Function	Educational level	Practice (number of years)
1	Applicant	Education meeting the requirements for master's certificate or vocational college in specialised subjects	4
1	Planning	Education meeting the requirements for master's certificate or vocational college in specialised subjects	4
1	Controlling project planning	Education meeting the requirements for master's certificate or vocational college in specialised subjects	4
1	Executing	Vocational training meeting the requirements for craft or journeyman's certificate	2
1	Controlling execution	Vocational training meeting the requirements for craft or journeyman's certificate	2
2	Applicant	Education meeting the requirements for master's certificate or vocational college in specialised subjects	6
2	Planning	Education meeting the requirements for college of engineering examination	6
2	Controlling project planning	Education meeting the requirements for college of engineering examination	6
2	Executing	Education meeting the requirements for master's certificate or vocational college in specialised subjects	3
2	Controlling execution	Education meeting the requirements for master's certificate or vocational college in specialised subjects	3
3	Applicant	Education to university level as civil engineer, master of architecture or corresponding degree.	8
3	Planning	Education to university level as civil engineer, master of architecture or corresponding degree.	8
3	Controlling project planning	Education to university level as civil engineer, master of architecture or corresponding degree.	8
3	Executing	Education meeting the requirements for college of engineering examination	5
3	Controlling execution	Education meeting the requirements for college of engineering examination	5

Vocational competence is understood to mean formal education and practice. It is the company's total vocational competence that forms the basis for approval and gives both the central approval scheme and the local authority greater flexibility when assessing a company's competence. The term *"meeting the requirements for"* in the table underlines that there is not an absolute requirement for craft or journeyman's certificates, for example. But it must be substantiated that education or training corresponds to this level. The company must have personnel with relevant practice at its disposal, but there is no requirement for them to be permanent employees. The company shall have at its disposal personnel with necessary and relevant competence, but can assume responsibility for tasks they do not have the competence for themselves, provided the undertake to use companies that have such competence as sub-contractors.

When assessing relevant practice, emphasis is given to how up to date the practice is, its duration and connection to the area to be approved. The requirement for length of practice can be reduced if the practice is particularly qualified or there is greater relevant education or training. Similarly the education or training requirement can be reduced with particularly qualified practice or longer practice than otherwise required.

Companies in the building industry can apply for central approval from the Norwegian Building Authority. Companies applying for central approval must demonstrate that they have competence in the form of education and practice that is suited to the area to be approved. If central approval is given, the company is incorporated into a central and open national register. The company does not then need to provide documentary evidence that it is qualified to be given local responsibility for every new building job. The task of the local authority in processing a local approval application will then consist of assessing whether the company uses the necessary and relevant technical competence for the actual project.

6.6 The Recognition of Professional Qualifications Directive and the Directive on Services in the Internal Market

Through the EEA agreement, Norway is part of the internal market, the purpose of which is to dismantle barriers to the free movement of services and persons between member states. This means that persons belonging to an EEA member state shall have the right to work (or continue to work) as self-employed or employed persons in a state other than the one in which they completed their education. According to the Directive on Services in the Internal Market (2006/123/EC), EEA citizens who are legally established in an EEA country shall in principle be able to provide services in another EEA country using his or her professional title without applying for approval of his or her qualifications [98].

The Recognition of Professional Qualifications Directive (2005/36/EC) applies to EEA citizens who wish to perform a regulated service in an EEA country other than the one in which they completed their education. Regulated service as used here means professional activities conditional on specific qualifications, which are proved by formal education, competence certificates and/or relevant practice. In essence, member countries shall recognise qualifications gained in one or more other EEA countries and permit those holding these qualifications to exercise their professions under the same conditions as for Norwegian citizens [99].

As regards the right to become established in another EEA state, i.e. the right to perform services on a permanent basis, the Recognition of Professional Qualifications Directive includes three approval systems:

- A general system for approval of professional qualifications (which is used as a fall-back for professions that are not covered by specific approval conditions).
- A system for automatic approval certified by work experience in some industrial, trades and commercial sectors.
- A system for automatic approval of qualifications for specific professions (doctors, nurses, dentists, midwives, veterinary surgeons, pharmacists, architects).

For the building industry, it is the second system that is relevant. This means that in essence the host state shall approve earlier activities in the country of origin as sufficient proof of knowledge and competence, provided that the activities have been performed in line with the directive's conditions regarding the duration and form of work experience. Experience as both self-employed and employed shall be taken into consideration. Earlier education and training in the country of origin can also shorten the required length of work experience, provided the person concerned can produce certificates approved by the host country or professional organisations.

7. Skills and workforce necessary to achieve the 2020 goals

Summary of chapter 7:

- The need for the building and construction workforce, including the need for tradesmen and skilled workers, will probably increase towards 2020/2030.
- To meet the workforce needs, it is important to get the oldest workers to remain in the industry until retirement age while recruiting in the younger age groups.
- The drop-out rate among students in upper secondary schools taking building, construction and electrical subjects is high, compared with many other lines of study.
- There are defined competence goals in the energy field for various executing professions. The competence goals are more concrete and specific than those in the curricula for vocational education. Buildings with high ambitions for energy consumption require particular attention to indoor climate and securing against damp.
- Surveys carried out among skilled workers tend to indicate that knowledge relevant to passive house is varied and in some cases lacking. However many tradesmen and skilled workers are interested in acquiring more knowledge in the energy field.
- Suggested ways of raising competence would be courses organised by building supplies companies and industry organisations, as well as the use of the Building and Infrastructure series from SINTEF Building and Infrastructure.

7.1 Developments in the labour market, necessary workforce and access to labour

The Federation of Norwegian Construction Industries and the Norwegian Association of Building Contractors have commissioned a report that estimates the need for labour in the building and construction industry up to 2020 [17]. Future workforce needs depend on economic cycles. Three courses of development have therefore been outlined:

- **Continued growth:** This outlook assumes good growth in the economy up to 2020. It assumes a 2.5% growth in employment each year during the period 2010 to 2014 and a building boom with an annual growth of 4% over the period 2015 to 2017. From 2018 to 2020 the average growth rate from the national budget of 2.5% per year is again applied. Altogether, employment increases by 40% over the period 2008-2020.
- **Stability:** This outlook assumes that the financial crisis and debt situation in several European countries dampens activity levels in the Norwegian economy and building industry. Neither does it anticipate any specific stimuli from the authorities. It assumes a growth in employment of 1% every other year in the period 2010 to 2020, which would mean employment growing by 6% altogether by 2020.
- **Decline:** In this outlook, the financial crisis and debt situation in the EU countries has a more severe effect on the Norwegian economy There is little new building in either the residential or non-residential sector over the period. It assumes an annual decline of 1% in employment over the period 2009 to 2014, a 5% annual decline during 2014 to 2017 and then 1% per year for the rest of the period. Altogether, employment would be reduced by 21% by 2020.

Table 7-1 shows the results of the projections of the need for new labour in the building and construction industry up to 2020. A correction has been made for natural wastage of 3,000 persons aged over 62 each year, but no account is taken of retirement before the age of 62. The results show that employment in building and construction will go from 185,000 in 2008 to about 145,000 in 2020 in the decline projection. Up until 2014, the building and construction industry would need an average of about 1,200 new persons each year, and thereafter 5,000 to 6,000 fewer each year up until 2017, after which 1,500 new persons a year on average would be needed for the rest of the period. This means that, even with a sharp decline in employment, natural wastage due to retirement would remove much of the effect on employment at macro

level. The stability projection shows employment going from 185,000 to about 197,000 in 2020, or an increase of 12,000 over the period. If a correction is made for the natural loss of 3,000 persons aged over 62 each year, this scenario would need a growth of 4,000 new employees in building and construction every single year. In the continued growth projection, employment goes from 185,000 to about 260,000 in 2020. During the growth period up until 2015, about 36,000 new employees would be needed, or an average of 8,000 per year. During the building boom of 2015 to 2017, the building and construction industry would need about 12,000 new employees a year, while in the rest of the period about 9,000 a year would be needed [17].

Statistics Norway has also forecast workforce needs in Norway up until 2030. The forecast shows that the need for labour with vocational subjects in building and construction, i.e. probably mainly tradesmen and skilled workers, would increase steadily from about 100,000 persons employed in 2010 to about 125,000 in 2030 [100].

Table 7-1: Projections of workforce needs in building and construction. Source: [17]

	Annual need for new employees 2010-2014	*Annual need for new employees 2015-2017*	*Annual need for new employees 2018-2020*	*Number employed in 2020*
Continued growth	+8,000	+12,000	+9,000	260,000
Stability	+4,000	+4,000	+4,000	197,000
Decline	+1,200	- 5,000/- 6,000	+1,500	145,000

During the period 2006 to 2008, the building and construction industry managed to attract over 55,000 new employees, more than half of whom came from other industries. During the same period, 23,000 people left to go to other industries. The net effect of recruitment from other industries was thus 4,300, or 2,150 a year. The other half consisted of about 17,000 with a Norwegian national background (almost all from the school system) and 11,000 with a non-Norwegian national background. Approximately 14,200 left working life, giving a net growth of about 18,000 employees during the period (Figure 7-1). On the basis of this approach, the building industry is in a reasonably good position to fill the future workforce needs [17]. The balance between the different recruitment paths will be of significance in covering the future workforce needs. For example, the need for recruitment from the school system will increase as recruitment from other industries and access to a workforce outside Norway's borders is reduced. In addition, there will probably be more people leaving the building and construction industry than the 3,000 reaching normal retirement age, such as through disability pensions and rehabilitation etc.

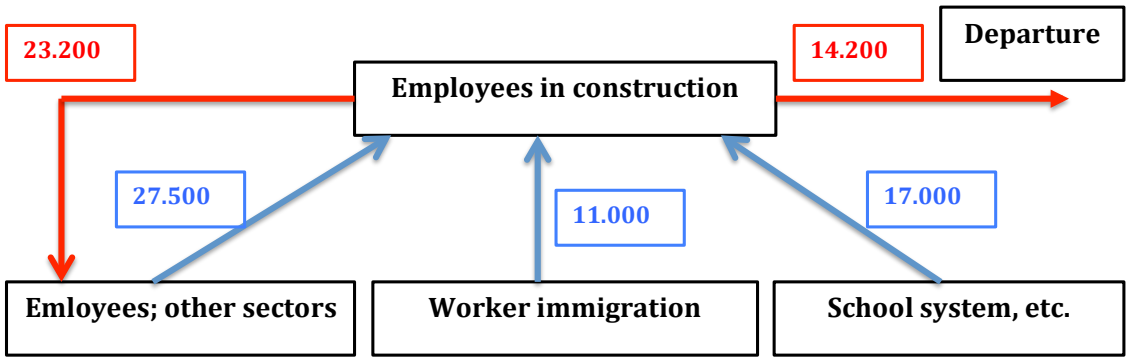

Figure 7-1: Change in the number of people employed in building and construction: 2006-2008

The Directorate for Education and Training has an overview of the number of pupils in the

Norwegian school system by educational programme (Table 7-2). The drop-out rate among pupils in vocational subjects is high. For example, the table shows that in building and construction techniques, fewer than 70% of those who start VG1 take up an apprentice place in a company. The drop-out rate in general studies for example is much lower [101, 102]. An official Norwegian report in 2008 stated that the numbers dropping out of upper secondary school, and especially in the vocational subjects, must be reduced [103]. There will also be drop-out from the final two years of vocational training, which are done in companies. However a survey carried out by Fafo, the research foundation for labour and social welfare, and the NIFU research institution indicates that apprentices generally (not just in building and construction) are well motivated to learn in the workplace, with almost all wanting to complete their apprenticeships. Approximately 80% of apprentices want to get a job in their trade after their apprenticeship [104].

The number of applicants for vocational training in building and construction techniques has been relatively stable over the last four years, at just over 4,000 a year. In 2012 there were about 600 fewer applicants than there were places available in building and construction techniques. For electricians, the number of applicants for VG1 increased from about 5,500 in 2009 to over 6,000 in 2012 [101]. Figures from the Directorate for Education and Training show that only a small proportion of those who take the examinations for craft or journeyman's certificates fail to pass. For building and construction techniques, the failure rate has been about 8-9% over the last three years [105].

Table 7-2: Applicants for upper secondary education in 2012 by chosen educational programme. Source: [101]

Educational programme	*VG1*	*VG2*	*VG3/Apprenticeship*	*Total*
Building and construction techniques	4,223	4,024	2,849	11,096
Electrician	6,081	4,428	3,995	14,464
Design / craft	2,596	2,128	1,081	5,805
Study specialisation	28,382	24,780	23,256	76,418

The building and construction industry has fewer employees aged over 50 than the labour market generally. Departure starts to occur from the age of 45. While 30% of the general labour market is aged over 50, for building and construction the figure is 24%. Half of those who work in the industry are under 40. The industry also differs from the labour market generally in having many employees aged under 25. For the 25-50 age group there is little difference between building and construction and the rest of the labour market. Those taking normal or early retirement or disability pension accounted for almost half of those who left the building and construction industry during the period2006 to 2008 [17].

The figures indicate that many employees do not see the building and construction industry as being particularly attractive as they approach the last half of their working lives. Employees whose educational level is either lower secondary or upper secondary are mostly either very young or over 50. For this group, the drop-off in numbers employed is very marked after the age of 62. For those with a higher education level, there is not the same "break" in the curve at 62 or above. This is especially evident for employees with upper secondary education, which predominantly means those with a craft or journeyman's certificate (Figure 7-2 – in Norwegian only). The building and construction industry manages to recruit well in the younger age groups, but there is also a high drop-out rate among the youngest employees. Employees aged under 35 made up almost half of those leaving the industry in 2008 [17].

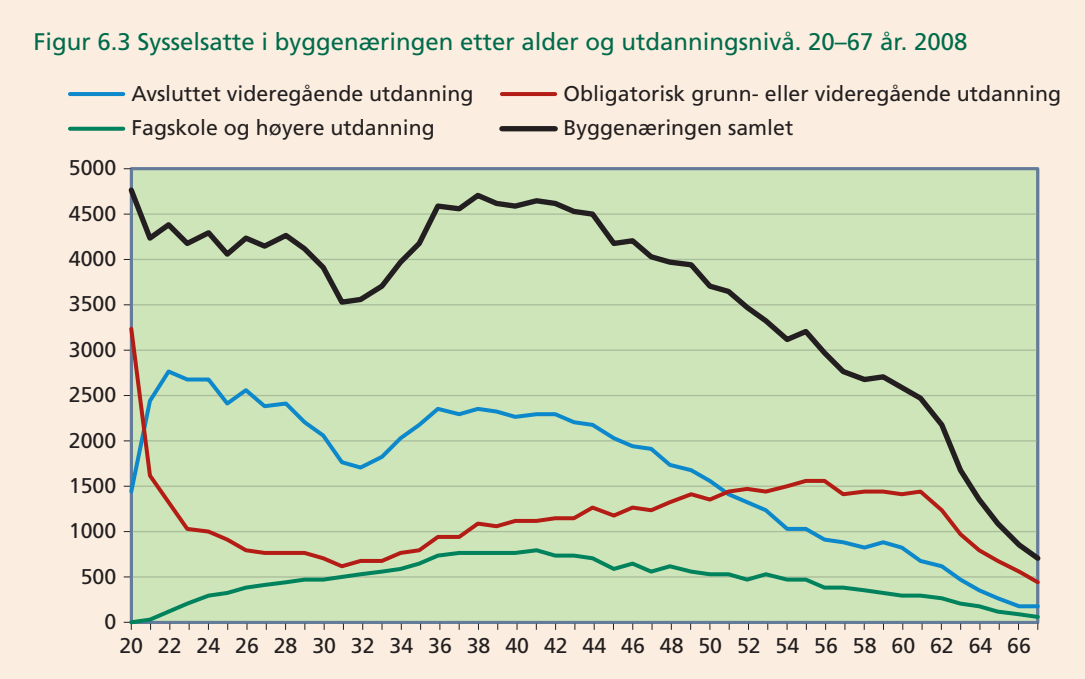

Figure 7-2: Employment in the building industry by age and educational level. Source: [17]

According to Fafo, the research foundation for labour and social welfare, the best instrument for meeting workforce needs is to hold on to the workforce you already have. This involves holding on to the experienced workforce and getting the oldest employees to stay in the building and construction industry until retirement age. It is also important to work on recruiting the youngest age groups [17].

7.2 Necessary knowledge and skills for tradesmen / craft workers

Compared with normal energy standards, buildings with high ambitions for energy consumption must have particular attention paid to the indoor climate and securing against damp. Among other things, it is important to reduce the risk of high temperatures, ensure that no damp enters the structures, limit air leakages and avoid thermal bridges. As part of Build Up Skills in Norway, competence goals have been defined for the energy field for the various executing professions. The competence goals are based on the criteria for passive houses [37, 38] and regulatory requirements aimed at facilitating for energy supplies other than direct-effect electricity and fossil fuels [35].

Even though Build Up Skills is limited to the building industry's executing professions, competence goals are also described in respect of making simple assessments of technical building solutions. This is because manual worker companies, especially outside the cities, may be asked for suggestions for technical building measures and solutions, due to a lack of directions for example, or because the directions are difficult to put into practice [10]. This may be particularly relevant in respect of renovating homes, where it is usually the tradesmen and skilled workers who are in contact with the households. In many cases therefore, the tradesmen performing the work should have the theoretical knowledge to enable them to asses technical building solutions, without this meaning that they have to take on project planning responsibilities.

Table 7-3 describes the competence goals for what various executing professionals in the building industry must know so as to:

- erect new buildings to passive/near-zero energy levels,
- renovate existing buildings to a very high energy standard,

- install renewable heating and cooling systems in both new and existing buildings.

Here, competence goal means sufficient additional competence for correct execution, in relation to what is considered normal within the profession in question. In addition to the competence goals that have been formulated, it is important that the person carrying out the work knows the theory behind the goals and what the consequences of error might be. A distinction is made between competence goals where it is sufficient to have the overall competence ("shall be familiar with ...") and goals where the person should have a more thorough competence ("shall know that .../shall be able to ..."). Table 7-3 gives examples of competence goals. A more comprehensive list of competence goals may be found in the report "Competence goals for execution" prepared by Rambøll AS on assignment for the Low Energy Programme [10].

The most important competence goals are connected to the following working operations:
- Planning risk-reducing measures to avoid damp damage to buildings.
- Tasks intended to achieve good results for air tightness.
- Tasks connected with insulation and avoiding thermal bridges.
- Insulating heat generating pipes and components so as not to give off excessive heat.
- Adjustment of air volumes in ventilation systems and executing ducting systems so as to achieve the lowest possible Specific Fan Power (SFP) factor.
- Design, execution and adjustment of heating systems.
- Extending and post-insulating existing structures.

Generally speaking, work in existing buildings will be more challenging in execution than new buildings to passive house-/nearly zero energy levels. Also, the work of preparing recommendations, construction details and standard solutions has not got as far in respect of energy measures in existing buildings.

Table 7-3: Examples of competence goals in the energy field for those performing the work. Source: [10]

Trade/profession	*Theme*	*Competence goals*
Carpentry	Securing against damp	• Knowing what materials and components are sensitive to damp, what additional requirements this sets for construction and how to secure structures against damp during the building period. • Awareness of methods for drying out, dehumidifying and damp measurement. • Knowing that damp in the insulation increases heat loss and increases the risk of mould and rot. • Knowing the difference between damp proofing, damp braking and wind proofing as regards damp resistance properties. • Knowing how a window shall be secured against damp intrusion and that the risk of damp intrusion is greatly increased when the window is placed further into the wall.
	Heat loss (insulation, thermal bridges and air tightness).	• Knowing how to perform sealing for the most important detail solutions. • Knowing that insulation shall be carefully tailored so as to achieve the planned U value, i.e. that all irregularities must be completely filled and compression avoided. • Knowing which materials in building solutions create thermal bridges. • Being familiar with the most important detail solutions for breaking thermal bridges and achieving low thermal bridge values, especially around windows, around foundations, on the front edge of decks, in corners and

		in the transition between floor and wall and wall and ceiling.
	Jobs in existing buildings	• Knowing how to select robust and secure solutions for post insulation of building parts and structures. • Knowing that exterior insulation involves an increased risk of damp intrusion around windows (especially the bottom edge) because windows are then further into the wall. • Knowing that post insulation makes a damp proof layer more important. • Knowing about possible consequences of interior post insulation when their is an outer cladding of brickwork, plaster or concrete. • Knowing about measures to improve air seals and reduce air leakage and that sealing jobs in existing buildings must be assessed against ventilation needs.
Bricklaying	Damp proofing	• Knowing what materials and components are sensitive to damp and how to secure structures against damp during the building period. • Knowing that there shall be drainage and air spaces on the back of outer side walls. • Knowing that there shall be open vertical joints and membrane/covering in the lowest course o the outer wall so that water is led out and airing out from the air space can be done. • Knowing that there shall be a seal covering under windows, doors and other openings and that this is especially important when windows and doors are recessed into the wall.
	Heat loss (insulation, thermal bridges and air tightness).	• Knowing how wind and damp proofing shall be sealed against penetration of the climate screen and how it shall be secured against perforation after fitting. • Knowing that plaster and rendering on masonry is important for wind proofing, especially on light clinker concrete. • Knowing that insulation shall be fitted precisely and how to cross insulate or displace joints so as to avoid breaks and reduce heat loss between insulation boards. • Being aware of the thermal bridge properties of various walling materials and knowing about materials that can be walled into a masonry structure to reduce thermal bridges.
	Jobs in existing buildings	• Knowing how to select robust and secure solutions for post insulation of building parts and structures. • Knowing that post insulation makes a damp proof layer more important. • Knowing about possible consequences of interior post insulation when there is an outer cladding of brickwork, plaster or concrete, for example the risk of frost damage to bricks in the façade (because the zero point can be drawn into the wall.
Roofing	Damp proofing	• Knowing which materials and components are sensitive to damp and what additional requirements this sets for construction. • Knowing how to secure structures against building damp during the building period, that one should not work with insulation or roofing when it is raining and that the roofing layer shall be brought to a conclusion at

		the end of the working day or if it rains, so that the insulation does not get damp. • Knowing that damp in the insulation increases heat loss and increases the risk of mould and rot.
	Heat loss (insulation, thermal bridges and air tightness).	• Knowing that insulation shall be precisely fitted and that there shall be no air pockets in the insulation layer, for example between insulation sheets, against openings or between roof insulation and outer wall at gables. • Knowing that all joints and connections must be taped, glued, clamped or welded so as to achieve low leakage figures. • Knowing how to seal damp proofing at openings and being able to use suitable products for this such as sleeves and tape. • Being aware of the air sealing function of roofing and that roofing shall be sealed to wind proofing.
Ventilation and tinsmith work	Damp proofing	• Knowing how insulation of ducts and components that carry cooling air indoors shall be executed so as to prevent condensation. • Knowing how sill fittings under windows and outer doors that are recessed in the structure (so as to prevent thermal bridges) shall be executed. • Being aware of roofing methods, solutions and execution to ensure a sealed roof.
	Heat loss (insulation, thermal bridges and air tightness).	• Being aware of the definition of Specific Fan Power (SFP) and understanding the connection between air resistance and the design of details in the ducting network. • Knowing which components shall be used and how details in the ducting system shall be designed and fitted so as to achieve the least possible air resistance. • Knowing how much thermal insulation is needed on intake and exhaust ducts. • Knowing how ventilation ducts and components shall be insulated so as to prevent chilled supply air being warmed in intake or ventilation ducts. • Knowing how a ventilation system shall be initially adjusted, especially demand controlled variable air volume (VAV) systems.
Electrician	Heat loss (insulation, thermal bridges and air tightness).	• Knowing that there shall be as few openings in the climate screen as possible and understanding the significance of avoiding perforations in the damp proofing. • Knowing how insulation should be laid around a cable or cable tube that goes through the climate screen, so as to avoid thermal bridges. • Knowing how to seal between a cable or cable tube that goes through the climate screen and being able to use suitable sealing products such as sleeves and tape.
	Energy supply	• Being able to design heating solutions and distribution based on the buildings heat/output needs and being familiar with the execution of simplified heating systems in passive houses. • Being familiar with alternative energy supplies for heating purposes, electrical equipment and lighting.
	Equipment and lighting	• Knowing which components give of heat and how these shall be located so as to prevent undesirable heat to interior air.

		• Knowing which types of light sources and fittings have a low energy requirement and give off least heat to their surroundings. • Being familiar with various types of systems for controlling lighting, ventilation and heating systems.
Concrete work	Damp proofing	• Knowing how damp and radon proofing shall be sealed in joints and transitions and at openings, as well as knowing how they can be secured against perforation after fitting. • Knowing how to seal in transitions between sections in different types of sectional structures. • Being familiar with the air and damp sealing function of concrete. • Knowing how to avoid poor seals in concrete structures and poured joints when pouring concrete, as well as which structure it is important to seal when pouring.
	Heat loss (insulation, thermal bridges and air tightness).	• Knowing that insulation shall be cut and fitted precisely so as to achieve the planned thermal bridge value/U value. • Knowing how joints between insulation sheets shall be sealed, for example with jointing foam. • Being familiar with products and solutions for avoiding thermal bridges with embedded items and openings.
Refrigeration and heat pump fitter	Damp proofing	• Knowing how insulation of ducts and components that carry cooling air indoors shall be executed so as to prevent condensation and undesirable cold to interior air.
	Heat loss (insulation, thermal bridges, air tightness and effective ducting network)	• Being aware of the definition of Specific Fan Power (SFP) and understanding the connection between air resistance and the design of details in the ducting network. • Knowing which components shall be used and how details in the ducting system shall be designed and fitted so as to achieve the least possible air resistance. • Knowing which components shall be insulated to avoid undesirable heat to interior air and being familiar with different insulation materials and applications. • Knowing how insulation shall be laid around a pipe that goes through the climate screen so as to prevent thermal bridges and being able to use suitable sealing methods and products such as sleeves and tape so as to achieve low leakage figures.
	Energy supply	• Knowing about different heat solutions and combination possibilities and being able to give advice about energy solutions in buildings on the basis of a simple assessment of heating needs, building type and local conditions. • Knowing about different heat pump systems and being able to select, design and initially adjust heat pump systems.
Plumbing	Damp proofing	• Knowing about measures and routines for preventing water damage to installations. • Knowing about measures and routines for preventing water leaks from pipe systems, such as pressure testing.
	Heat loss (insulation, thermal bridges, air tightness and	• Knowing how pipes and components that give off heat shall be run, located and insulated to avoid undesirable heat to interior air and being familiar with different insulation materials and applications.

	effective heat distribution)	• Knowing how details in pipe systems in heating and cooling systems shall be executed so as to achieve minimum air resistance (specific pump performance heating systems). • Knowing how insulation shall be laid around a pipe that goes through the climate screen so as to prevent thermal bridges and being able to use suitable sealing methods and products such as sleeves and tape so as to achieve low leakage figures.
	Energy supply	• Knowing about different heat solutions and combination possibilities and being able to give advice about energy solutions in buildings on the basis of a simple assessment of heating needs, building type and local conditions. • Being able to design heating solutions and distribution based on the buildings heat/output needs and being familiar with the execution of simplified heating systems in passive houses. • Being familiar with low-temperature systems and knowing how to avoid air problems. • Being able to initially adjust water-borne heating and cooling systems.
Glazier work	Damp proofing	• Knowing how damp intrusion shall be prevented when windows/doors are placed further into the wall (so as to avoid thermal bridges). • Knowing that a joint shall have two-stage sealing and that a joint shall be damp-open on the cold side. • Knowing the significance of clamping strips for air sealing and leakage figures and knowing how these shall be fastened.
	Heat loss (insulation, thermal bridges and air tightness).	• Knowing how to execute correct sealing around windows and doors. • Knowing the significance of good U values on glass surfaces.
	Risk of over-temperature	• Knowing that good sun screening on façades exposed to sunlight is important for reducing the risk of high temperatures in passive houses.

In addition to the competence goals in Table 7-3, it is essential that tradesmen have a general understanding of passive/near-zero energy buildings and the use of renewable energy. It is also important to be conscious of the contact areas with other trades. Different professions should understand what significance their own trade has for the overall result and not only be concerned with their own trade and tasks. Finally, tradesmen who choose and order which building products are to be used shall know about product selection. The choice of products can be decisive for the quality of buildings with ambitious energy goals and there may be a need to formalise product advice in building projects.

7.3 Reviewing present-day competence among tradesmen on site and the need for training

In order to review tradesmen's competence in low-energy and passive houses, Respons Analyse AS carried out a questionnaire survey among foremen/site managers in various vocational groups. In order to measure the level of knowledge, respondents were given 12 statements on three topics and asked to say whether they were right or wrong (or i they were uncertain). The results showed that knowledge about the selected topics was variable and in some cases lacking

[11].

Figure 7-3 shows the results for the statements about passive houses for various vocational groups. The figure only shows the proportion that gave the correct answer for each statement. This does not necessarily mean that the rest gave the wrong answer; since respondents also had the option of saying they were not sure.

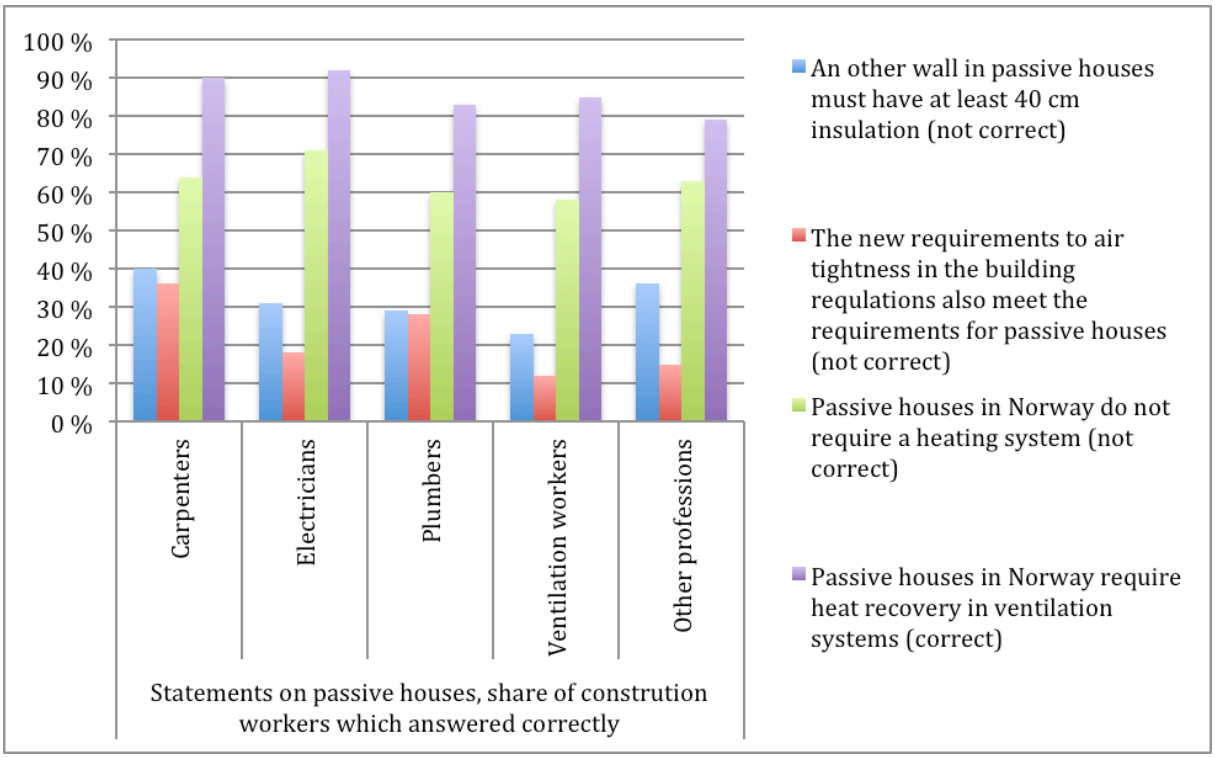

Figure 7-3: Results of the questionnaire survey: Statements about passive houses. Source: [11]

Another topic in the Respons Analyse AS survey was to test knowledge about avoiding damp in structures. There has been concern about the increased risk of mould and damp in highly-insulated building structures, because the humidity level can increase when the outside of the structure becomes colder, as well as its taking longer for building damp and accidental leaks to dry out when the thickness of insulation is increased. In most cases these effects can easily be countered with the right choice of materials and structures and the correct execution [106]. However a relatively high proportion of tradesmen did not give the correct answer for statements about avoiding damp in structures (Figure 7-4). The results indicate that knowledge about damp prevention should be a priority in courses about passive house and renovations with ambitious energy goals.

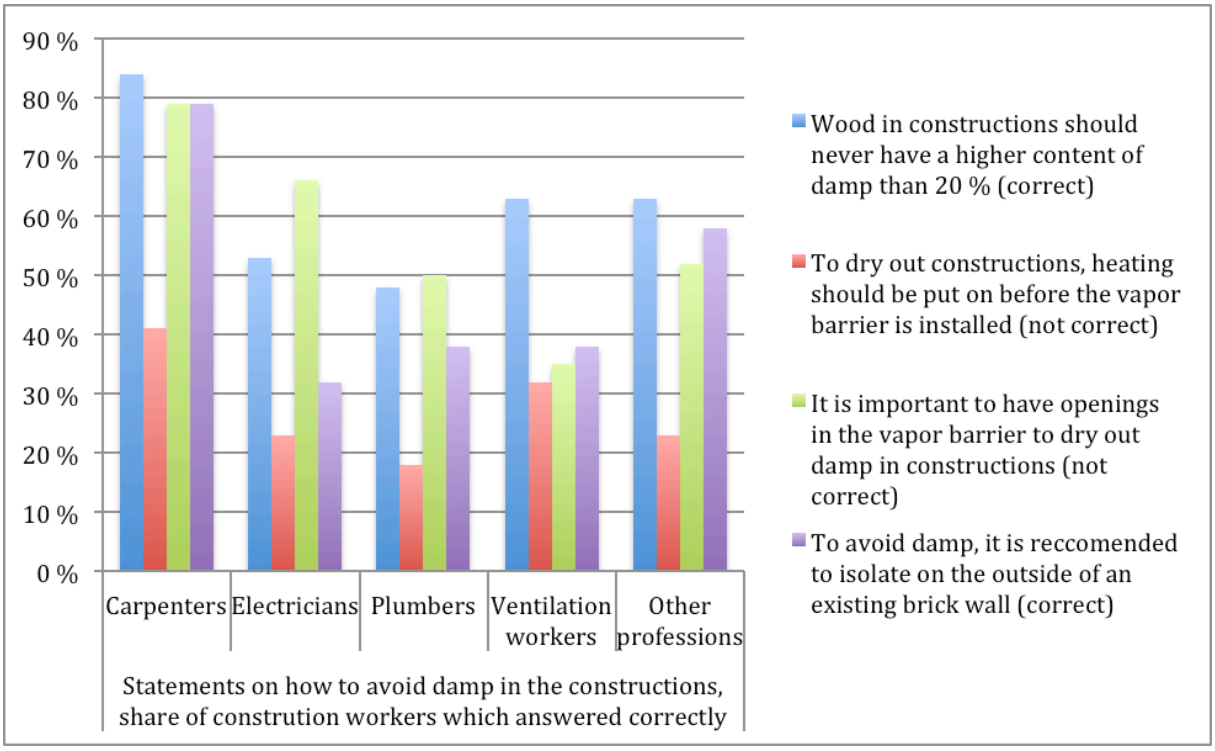

Figure 7-4: Results of the questionnaire survey: Statements about damp prevention. Source: [11]

The different professions were also asked to assess their own energy competence in six areas that were specific to their vocational group. On a scale of 1 to 10, most placed themselves just above the middle (about 6) in most of the areas. The tradesmen working in ventilation were the ones who gave themselves the highest score for their own competence [11]. In spite of the fact that the survey shows that knowledge among tradesmen is variable and lacking for many topics concerning energy, it is positive that the majority of respondents said that they wanted to gain more competence in this area (Figure 7-5). Of course the desire of so many for more competence also indicates that present-day competence levels for many in these trades are not good enough. But it also indicates a widespread willingness to acquire more competence in the energy field. This means that it is important to better facilitate this type of competence being acquired by the various vocational groups [11].

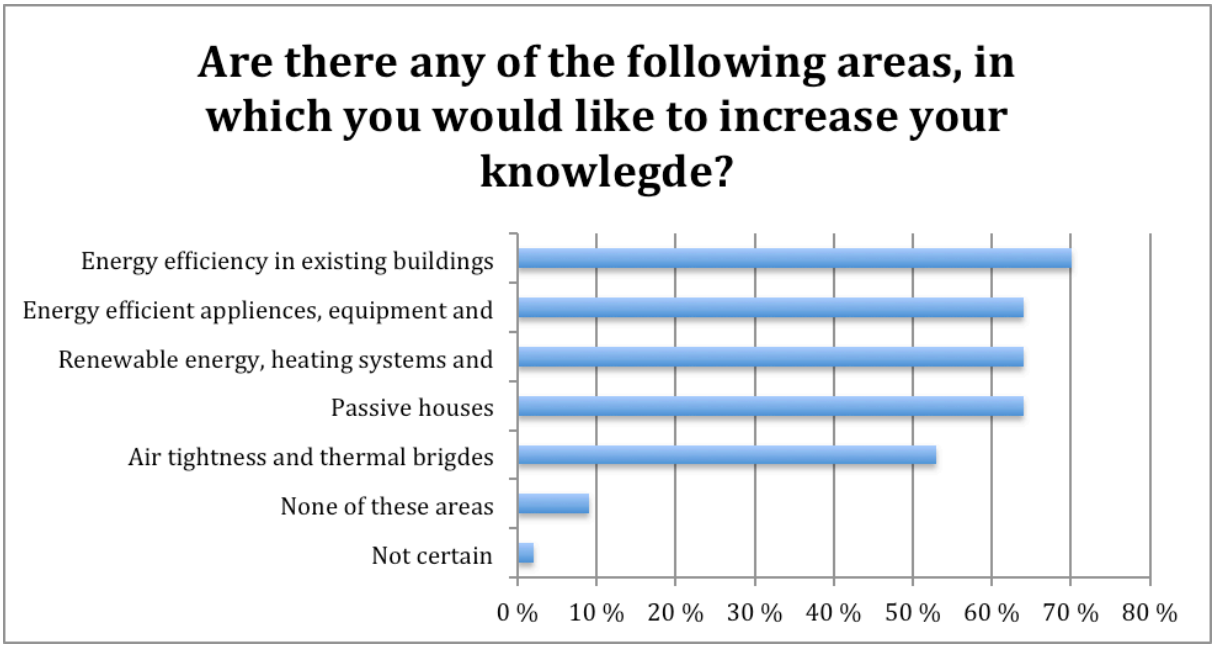

Figure 7-5: Desire for more competence among tradesmen by energy topics. Source: [11]

7.4 Necessary scope, and preferred forms, of competence raising

If we begin on the basis that there are about 50,000 carpenters who shall all have knowledge about passive house and energy-efficient renovation over the next eight years, this means that an average of 6,000 to 7,000 carpenters a year must take part in training measures in the energy field. After carpenters, it is electricians (about 30,000) and plumbers (about 16,500) that are the groups of tradesmen with most people employed in the building and construction industry. (See table 5-4). The task of ensuring that training is given becomes less extensive for vocational groups with fewer people employed. At the same time, there will probably be a smaller market for courses for these professions.

A survey carried out by Respons Analyse AS for the Low Energy Programme in 2010 indicates that the preferred methods for competence raising were external courses outside the companies and the use of the Building and Infrastructure series (see Box 6-2). Learning from colleagues in the workplace was the third most answered alternative, while internal company courses were in fourth place. Over 60% of the executing companies used offers from building goods chains and suppliers to send employees on courses. Almost 40% used course offers from industry associations and about 20% stated that they used course offers from the authorities or official course providers. The proportion of companies making use of course offers from industry organisations or trade unions increased noticeably with company size. Among companies, the proportion making use of such course offers increased from about 20% in companies with 1-2 employees to about 70% in companies with more than 15 employees. The use of course offers from the authorities and official course providers also increased with company size [95].

In the survey by Respons Analyse AS in 2012, the sample of tradesmen was asked whether they had taken part in organised training or courses in the last two years. The results correspond closely with the 2010 survey. 40% had taken part in courses organised by suppliers and the building goods trade and 36% had taken part in courses organised by industry organisations. 27% had taken part in organised training in the company, while 14% had used other course organisers. 28% of respondents had not taken part in any organised training in the last two years [11].

It was difficult to conclude which procedure is best to raise competence in practice in the building industry. The strategy chosen will be of significance for the number of courses and instructors that will be necessary to give all tradesmen the necessary competence lift. For example, raising competence by using information from SINTEF Building and Infrastructure does not in itself require the use of external courses or instructors. Another procedure may be to offer courses and further education for individual resource persons in the tradesmen companies, who can in turn take responsibility for disseminating this knowledge to colleagues through internal courses and informal teaching during the day-to-day work on site. The results of an evaluation by the educational wing of the Norwegian Association of Building Contractors showed that almost 80% of the companies who responded to the survey had concrete training measures within the company [107].

Many of the smaller companies make use of courses offered by the building goods chains. In order to ensure the quality of such courses, it may be appropriate to develop quality-assured course material centrally. It will also be necessary to develop the content and extent of the courses offered by industry organisations, trade unions and the authorities. It will probably be necessary to increase the focus on many of the training programmes offered so as to achieve the necessary competence raising, since what is best suited to different companies will vary, depending on company size and geographical location, for example. The weighting and prioritising of the various procedures for training will decide the number of courses and instructors needed.

7.5 Necessary qualifications measures

No studies have been made that give a combined overview of courses currently offered in the field of energy that are aimed at tradesmen in the building industry. Neither has any assessment been made of the quality of existing courses. It is therefore difficult to assess what new courses might be needed, which existing courses should be upgraded, the number of course instructors needed and any need for accreditation or certification of instructors or courses. One advantage of using accreditation or certification is the greater guarantee of the quality of courses being implemented. A disadvantage is that this would probably increase the cost of participation in training, which could give lower participation. In rural areas with fewer tradesmen to form a customer base for courses, there may be a risk that the expenses of accreditation, certification or the like will make costs too high to make it interesting for private course organisers to initiate training measures.

One strategy may be to develop quality-assured training material centrally, which could be used by organisations, course providers and others. It would be difficult to be able to guarantee the quality of training without knowing anything about the quality of the course instructors. This may be resolved by arranging instructors' courses for resource persons in the building and construction industry.

The Federation of Norwegian Construction Industries has stated that a national framework should be established for systematic, documentable further education for tradesmen and skilled workers, so that individuals can receive the necessary professional update to enable them to be able and willing to continue in their trades. It has been proposed that the framework should be controlled by the parties in industry in collaboration with the authorities and should include:

- Structure for documentable professional updating at craft/journeyman's certificate level.
- Structure of defined levels for formal competence after craft/journeyman's certificate.
- Facilitation of the building of interdisciplinary competence at all levels.

In the energy field, it is proposed to establish a pilot scheme for further education in collaboration with Enova and the Low Energy Programme [89].

7.6 Need for follow-up and tools for control

Traditionally it has been the task of each tradesman to keep his or her CV updated with education and experience. As things stand, it is not possible for either the authorities or the building industry to maintain an overview of skills among different vocational groups or to identify any disparity between the present competence level of tradesmen and the skills that are necessary, in the energy field for example. However questionnaire surveys have been carried out, by the Low Energy Programme for example, that can give an impression of competence levels in the industry. If such surveys are carried out over a period of time, they can show developments in the level of skills in the building industry and reveal areas in which competence raising is particularly necessary.

At present, there are no control tools that can be used to give an overview of competence levels in the building industry. But it may perhaps be possible to further develop existing tools. One example pointed out by the industries is Ifag, which is an information and administration system for vocational training. Ifag includes a plan with competence and training goals. Users can record the hours taken to achieve the competence goals and are assessed against the goals to be achieved. The system is primarily used in education, but it can also be used in further or subsequent education. Ifag is an Internet based text book for apprentices and course participants. A teaching company, educational institution or course organiser can use Ifag for interim assessment of apprentices/participants against identified competence goals. For an education office, Ifag can simplify following up on apprentices and can be used as an administration and documentation system. The tool has been developed so as to suit all industries and can be adapted to different training plans and competence goals [108].

8. Barriers

Summary of chapter 8:

- The most important barrier to energy efficiency in buildings, from society's point of view, is the generally low and sometimes zero attention given to energy use and energy related measures. A low energy price will tend to maintain that barrier.
- The real potential for energy efficiency in buildings depends on whether the owners of buildings and homes consider these measures to be financially beneficial. It is however more important for triggering the potential if the owners are open to renovating or upgrading their buildings. It is therefore important to reach the home-owners or owners of non-residential buildings who are preparing for renovation or upgrade activity.
- At a general level, the lack of competence is a barrier than might prevent energy measures from being taken. For example, it might be important that the tradesmen who come into contact with households have the knowledge to sell up to ambitious renovation at low-energy or passive house level instead of simple renovation, since the home is to be renovated anyway.
- A lack of knowledge and competence might also affect the financial, technical and practical conditions that next prevent energy efficiency measures, especially in non-residential buildings.
- A lack of time and high course costs stand out as the most important barriers to tradesmen's participation in courses. Other factors that may be mentioned are a lack of motivation and that the courses are mainly found in cities rather than locally.

8.1 About barriers in general

The term "barriers" is used and understood differently and appears to lack a clear definition. The term has however been discussed in a number of works. The usual interpretation of the term is that a barrier is a circumstance of or around a decision maker that prevents the performance of a desirable type of behaviour [109]. There are many types of barriers that prevent increased energy efficiency in buildings. They can be significant individually, as well as working in interaction with each other.

Barriers are often used as the reason why the authorities must devise policies for bringing down the barriers. If it is costs or benefits for society as a whole that are not considered when individual parties are to take a decision, there are grounds for considering whether the authorities should step into the market. It is important however to be clear that the absence of a type of behaviour that is desirable from society's point of view does not necessarily mean that the authorities should step in. For example, lack of profitability as a result of energy prices being too low is not in itself an argument for subsidising energy-efficiency measures. The grounds must lie in an assessment of private and socio-economic factors and that the total costs of breaking down barriers do not exceed the total gain resulting from the barriers being eliminated [110].

Enova's barriers study of 2012 concluded that the real potential for energy efficiency in buildings depends primarily on whether the owners of buildings and homes consider these measures to be financially beneficial. It is however more important for triggering the potential if the owners are open to renovating or upgrading their buildings. The authorities must primarily address home-owners or the owners of non-residential buildings who are open to being influenced into taking measures that could reduce energy consumption [109].

To achieve energy efficiency measures in existing homes, it is important that tradesmen have the knowledge to be able to communicate and sell ambitious energy measures to households that are preparing to start renovating their own homes and are thereby open to carrying out upgrades to their houses.

For all types of homes and buildings, the most important barrier from society's point of view is probably the generally low and sometimes zero attention given to energy use and energy related measures. A generally low energy price will tend to maintain that barrier. This means that not all socio-economically profitable measures will be carried out. At a general level, the lack of competence is a barrier than might prevent energy measures from being taken. However this need not necessarily be perceived as a barrier by companies in the building industry as long as they find a satisfactory demand for the services they already provide.

Enova's study shows that the sequence in which barriers arise is an important piece of information. Also the strengths of the barriers depend on each other. For example, a lack of competence and experience will affect the cost level in the industry and thereby profitability as an economic barrier. When individual parties or whole industries are involved in more and more energy-efficiency projects, they repeat the decisions that are taken on energy efficiency and will exploit gains in the form of barriers being further broken down with each round that passes. In this context it is important to address those who are most positive about taking up new knowledge and new solutions [109].

8.2 Barriers that prevent competence raising

In a survey carried out by Respons Analyse AS for the Low Energy Programme in 2012, about 30% of respondents, who were foremen/site managers in tradesmen companies, believed that lack of time was an issue in being able to take part in organised training. 13% thought that the cost of taking courses was an issue. This may refer to course fees, travel and accommodation or lost income. 32% of the respondents said that there were no problem issues and they took part in the courses they needed [11]. In a corresponding survey carried out by Respons Analyse AS for the Low Energy Programme in 2010, the target group was company managers in the building industry. Here, respondents also thought that the major issues preventing competence raising were lack of time (61%) and lack of money (39%). 14% thought that lack of motivation was a major barrier to implementing competence raising in the field of energy. This was a large proportion compared with companies in project planning (architects and consultant engineers), where only 5% of companies stated lack of motivation as a barrier to competence raising. Only 14% answered that it was quite difficult or very difficult to perform competence raising and updating with regard to the newly introduced changes to the building regulations at that time [95]. Experience from industry organisations may indicate that training activities in new regulatory requirements are normally given a high priority, since this is a condition for being able to carry out building in accordance with legislation and regulations.

That a lack of time and money is a significant barrier to competence raising is also supported by the findings of an evaluation by the educational wing of the Norwegian Association of Building Contractors. Course fees, subsistence, accommodation and lost earnings are all real expenses for companies taking part in courses. Feedback from the companies showed that more than 60% of respondents wanted more local and regional courses. There was a desire for better coordination of courses across regions, making it possible to travel to a neighbouring region for a course instead of having to travel to Oslo for the courses that did not have enough participants in a particular region. Almost none of the respondents outside the area of the capital city thought that more of the courses should be held in Oslo. Almost 30% wanted more internal company courses to be offered. Over 60% also wanted more courses to be available on the internet, because then employees would not need to travel and the courses could be done at the same

time as ordinary activities. Another interesting finding was that almost 60% had the impression that there would be better motivation to participate in courses ("yes" and "to a certain extent") if the courses qualified for study points [107]. This might indicate that barriers connected with a lack of motivation can be countered by giving participants more visible and documentary evidence of the effect of course participation.

8.3 Barriers that prevent energy efficiency in homes

As mentioned in section 8.1, Enova's barriers study of 2012 showed that the most important barrier to energy efficiency in homes, from society's point of view, is the generally low and sometimes zero attention given to energy use and energy related measures for one's own home. This may be partly explained by the fact that household energy expenses only represent about 4-5% of the annual expenditure on consumables [109]. The most important decision makers are the individual private home-owners, since about 75% of all Norwegian households own their own homes [111].

It is also sensible to divide the housing sector into two: new homes and existing homes. From the energy standard point of view, new homes are the least problematical when it comes to changing to a better standard. This is because the distance from the requirements in the current building regulations to low-energy level is not very great [35, 37]. The way forward to passive house for new homes will probably also be entirely possible to realise as requirements in future building regulations [5, 7].

Significant change to existing housing is more of a challenge. The housing standard varies and the energy use depends on how many live in the home, age etc. This is also the great majority of housing and most of these homes will be in use for many decades to come.

Profitability is generally low for major energy renovation measures, and some what better if they are included as part of planned maintenance and renovation. According to a report commissioned by Enova, it is the lack of profitability that is the major barrier to large-scale renovation to a high energy standard. The second largest barrier is the lack of public recommendations and support. The lack of support is often connected with financial support in the form of subsidies, which increases the significance of the first barrier (low profitability). So-called "fuss and bother" is the third most important barrier. Information gathering, organisation, unpleasantness and disturbance to everyday life are significant disadvantages connected with renovation projects, which can represent a considerable barrier for many home-owners [109].

Uncertainty about how energy efficiency measures affect comfort in the home appears as the fourth most important barrier. Together with the fifth barrier, uncertainty about whether the measures will work, this illustrates that doubt about the non-financial benefits can be so considerable that it often prevents such measures being taken [109].

Short periods of residence and a lack of knowledge and information are other barriers. There is also reason to believe that the lack of tradesmen and complete offers will be a significant barrier [109].

Enova's study did not investigate the competence of either planners or tradesmen as a barrier to energy efficiency measures in buildings. But several other reports point to competence raising as a condition of achieving energy efficiency in buildings [5, 6, 7].

8.4 Barriers that prevent energy efficiency in non-residential buildings

Enova's barriers study of 2012 also revealed a number of barriers that could stand in the way of energy efficiency measures in non-residential buildings. It was the financial barriers in

particular that appeared to be important and major barriers. The results of the study could indicate that different barriers will dominate in different phases of the decision making process. In the early phase, where an investment decision is to be taken, it is the financial barriers that dominate. In the project-planning phase, it is the technical barriers that are most important, while in the implementation phase it appears that the lack of knowledge and sufficient competence are the biggest barriers. Table 8-1 shows the barriers to energy efficiency measures in non-residential buildings. As the table shows, many of the same barriers apply to both new and existing buildings.

Table 8-1: Barriers to energy efficiency measures in non-residential buildings. Source: [109]

Reviewing barriers	*Barriers to energy efficiency measures in existing non-residential buildings.*	*Barriers to energy efficiency measures in new non-residential buildings.*
Practical barriers	• Endorsement in own organisation • Conflicting requirements from the authorities • Formulation of contacts between owner and tenant that give the right incentives.	• Endorsement in own organisation • Consistent mindset • Conflicting requirements from the authorities
Technical barriers	• *Not included, since the survey had already taken into account the technical limitations of existing buildings.*	• Complicated calculation models
Financial barriers	• High investment costs • Rigid framework of public agencies • Public sector organisations unable to borrow money	• High investment costs • Distribution of costs between owner and tenant
Attitude barriers	• Low awareness of energy consumption/Myths • Company culture/Doubts about energy efficiency measures	• Users prefer comfort to energy-efficient buildings • Myths surrounding the profitability aspect
Knowledge barriers	• General lack of knowledge about the advantages and profitability of energy efficiency • Lack of competence in building operation	• General lack of knowledge about the advantages and profitability of energy efficiency • Lack of competence in building operation

It is stated that in many cases the lack of knowledge and competence is a type of barrier that is expressed through other categories of barrier. For example, low awareness, myths and prejudiced attitudes about energy efficiency can often be explained by lack of knowledge. Knowledge and competence also affect financial, technical and practical conditions that in turn hinder the energy efficiency of non-residential buildings [109].

8.5 Barriers that prevent the use of renewable heat

In a 2007 study, the lack of a market and lack of profitability stood out as the two biggest barriers to the use of local, renewable heating in buildings. Over 90% of respondents in the survey thought that the lack of infrastructure for water-borne heating in buildings was a concrete, physical barrier that meant that the customer base was too small to be able to realise projects using renewable heat [112]. This barrier applied mainly to the lack of such infrastructure in existing buildings, rather than to new buildings. New rules for energy supply were introduced into building regulations in 2007 that make it difficult to base energy supply to new buildings on direct electric heating alone [35]. The poor profitability barrier was linked to the low price of electricity. A low price of electricity means higher lifetime costs when

converting to renewable heat in existing buildings, especially due to the cost of installing the infrastructure for water-borne heating systems in buildings [112].

In spite of the fact that awareness of water-borne heating based on renewable energy has increased in recent years, there are still uncertainty and incorrect perceptions in respect of the technology and economy of such heating systems. For relatively new and unknown technologies, attitudes are decisive, and solutions and systems are vulnerable to negative coverage [113]. If system faults or errors in assembly arise, these are commented on. This can contribute to increased uncertainty and incorrect perceptions and will in turn represent a barrier to equipping buildings with renewable heating. It is also important to avoid unnecessarily expensive heating systems, since the motivation behind the choice of a heating system is often financial [113]. Heating systems designed for room heating needs at today's regulatory level would be over dimensioned for passive houses. In such cases, it is important to bear in mind that simplified heating systems can lead to financial savings [114].

9. Conclusions

The government has adopted an objective of a 30 TWh increase in renewable energy production and energy efficiency measures between 2001 and 2016. The government also wishes to tighten up the requirements in building regulations, to passive house level in 2015 and to near-zero energy level in 2020. Competence among tradesmen in the building industry in passive house, renovation with ambitious energy goals and installation of renewable heating has been identified as a barrier to achieving more rapid energy efficiency and energy remodelling of buildings. For example, competent tradesmen with a good knowledge of energy measures could give households advice about energy measures that could be taken in existing buildings when maintenance or renovation is to be undertaken in any case. This is a key consideration, because most of the built-up area in Norway is owned by private individuals and the greatest potential for improving energy efficiency by 2020 lies in existing buildings.

Surveys that have been carried out for the Low Energy Programme, show that the present day competence level in the field of energy among tradesmen and skilled workers is variable and in some cases lacking altogether. The results of the learning conditions monitor also show that the building and construction industry is less involved in formal further education, continuing education and learning-intensive work than many other industries. It is still positive however that there is a widespread willingness among tradesmen in the building and construction industry to acquire more competence in the energy field. This means that it will be important to facilitate actual competence raising about energy among tradesmen in practice.

Lack of time, high costs and centralised courses appear to be the biggest barriers to achieving organised learning among tradesmen. The Norwegian building industry is however solid and profitable, with expectations of further growth. This also gives opportunities to reach investors in competence raising of the employees and to achieve higher course attendance by tradesmen and skilled workers.

There are more than 100,000 tradesmen in Norway. Easily the biggest group among these are carpenters, followed by electricians and plumbers. Projections show that the building industry will probably need to employ increasing numbers of tradesmen between now and 2020. In order to meet the workforce need, the most important instrument will be to hold on to the workforce that already exists. This involves holding on to the experienced workforce and getting the oldest employees to stay in the industry until retirement age. Lifelong learning measures, in the energy field for example, could help to ensure that more wish to remain in their jobs for longer.

Worker immigration into the building and construction industry has increased rapidly in recent years and this will continue to be needed in future, given a continued high level of activity. This may require measures to increase knowledge of Norwegian building practice among immigrant workers so as to ensure quality of execution.

More work also needs to be done on recruitment from the school system, so as to meet the building industry's workforce needs. This involves both getting more students to choose building as their course of study and reducing the numbers dropping out of vocational training.

The competence goals for the building subjects in upper secondary education are far more general than the identified competence goals for being able to build passive houses, perform ambitious energy measures in existing buildings and install renewable heating solutions. Since few seem to spend much time in further education and training in the building industry, it could be a good competence-raising measure to ensure that those who are undertaking education and training are given knowledge about passive house and energy-efficient building solutions.

There is currently no system for monitoring the level of knowledge in the building industry or measuring the effect of competence-raising measures. Neither is there any system for achieving systematic continuing education and training for tradesmen in the building industry or schemes for ensuring the quality of the courses that are on offer.

To sum up, there is a need for competence-raising measures in the energy field, directed both at employed tradesmen in the building industry and at upper secondary training and education in the building subjects. An evaluation of concrete measures for raising competence levels in the energy field among tradesmen and skilled workers will be the subject of a separate roadmap for competence raising that will be prepared as part two of Build Up Skills.

10. Authors and contributors

This report was written by Gunnar Grini (Low Energy Programme), with written contributions from Mathieu Veulemans (Norwegian Building Authority), Håvard Solem (Enova), Øivind Ørnevik (Norwegian Association of Master Builders), Guro Hauge (Low Energy Programme) and Veslemøy Nestvold (Low Energy Programme).

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12. Glossary

- **Barrier:** A circumstance of or around a decision maker that prevents the performance of a desirable type of behaviour.
- **Foreman:** Leader of a working team on a building site. The foreman does not necessarily have personnel responsibility but leads the work that is to be done and coordinates the distribution of work.
- **Building industry:** The building industry comprises the entire value chain of building and construction, i.e. the building goods industry, building goods wholesale and retail, project planning, execution and property management.
- **Building and construction industry:** The executing part of the building industry in building and construction.
- **Further education:** A technical top-up and perfecting in order to stay up to date and go into one's own trade/subject in more depth.
- **Craft certificate/Journeyman's certificate:** Concluding documents obtained when completing vocational training.
- **Formal further education:** Education in new tasks and positions, but usually based on own subject and competence.
- **Green skills and jobs:** Necessary skills for employees, as well as new or amended professional profiles, which contribute to structural changes that promote a green economy - i.e. growth combined with sustainable development
- **Lifelong learning:** Participation in formal further education, courses and training and informal learning in day-to-day work (learning-intensive work).
- **Near-zero energy building:** Defined i the Energy Performance of Buildings Directive (2010/31/EC) article 2 as a building with a very high energy performance.. The (very) small energy requirement that is necessary should be largely covered by renewable energy, including locally produced renewable energy. There is not yet a Norwegian definition of near-zero energy buildings.
- **Passive house:** Building with a very low energy requirement. In Norway, passive houses are defined in the Norwegian standards NS 3700 (residential) and NS3701 (non-residential).
- **White paper:** Also knows as Report to the Storting. Document that the government presents to the Norwegian parliament when the government wishes to present an item that is not linked to a proposal for adoption. They usually contain a report on work that has been done in a particular field and/or a discussion of future policy.
- **Vocational training:** Upper secondary training that results in a craft or journeyman's certificate.

13. List of boxes, figures and tables

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